PEBBLE PROJECT
ENVIRONMENTAL BASELINE DOCUMENT
2004 through 2008

CHAPTER 42.
MARINE BENTHOS
Cook Inlet Drainages

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ACRONYMS AND ABBREVIATIONS

CIRCAC	Cook Inlet Regional Citizens Advisory Council
IIE	Iniskin/Iliamna Estuary: all marine waters and shorelines (except inner Cottonwood Bay and inner Iniskin Bay) from the east side of the entrance to Iniskin Bay and Scott Island to the south side of the entrance to Iliamna Bay at South Head
ln	natural logarithm
MLLW	mean lower low water
NOAA	National Oceanic and Atmospheric Administration
S	species richness
S_I	Simpson's dominance index
OCSEAP	Outer Continental Shelf Environmental Assessment Program
UAF	University of Alaska Fairbanks

42. MARINE BENTHOS

42.1 Introduction

The littoral and subtidal habitats in lower Cook Inlet support diverse communities of marine and anadromous species. This chapter describes benthic marine flora and fauna in Iniskin and Iliamna bays. Benthic flora is comprised of diatoms, seagrass, kelp (large brown algae), and various other species of algae; benthic fauna includes animals such as sponges, worms, limpets, mollusks, barnacles, crabs, and other bottom dwelling invertebrates, as well as some bottom oriented fish. Information presented in this chapter is based on available literature and field investigations conducted during August/September 2004, July 2005, April/May 2006, and July 2008. Iniskin and Iliamna bays (Figure 42-1A) comprise one of several estuarine complexes and embayments along the west side of lower Cook Inlet and, for this report, are collectively termed the Iniskin/Iliamna Estuary or IIE (Figure 42-1B).

In general, the benthic ecology of southwestern Cook Inlet, from Kamishak Bay, Ursus Cove, and Augustine Island in the south, the IIE and extending to Chinitna Bay in the north (Figure 42-1A), is a function of varied habitat types ranging from mudflats to rocky shoreline and reef habitats. Each of these habitats supports a distinct and diverse assemblage of organisms with specific roles in the overall ecology of the area. Descriptions of habitat types and characteristics in the IIE based on earlier studies and on the present work are provided in Chapter 36.

Rocky intertidal and shallow subtidal habitats are wide spread along the southwestern shoreline of lower Cook Inlet. Rocky habitats support dense growths of kelp and macroalgae and provide habitat for many invertebrate species and produce substantial amounts of organic material that (along with terrestrial sources) helps fuel the detritus-based food web (Lees et al., 1980). Rocky intertidal habitats exhibit vertical zonation by organisms and assemblages with varied tolerances for exposure and inundation. The resulting species composition varies substantially from the splash zone to the subtidal reaches, making for diverse species assemblages that change substantially, often over relatively short distances (depending on vertical steepness). Temporal variation is also high; both intertidal and subtidal algae typically decline in cover and robustness in late summer, after releasing gametes and as light levels decline. At intertidal and shallow subtidal elevations (termed the "littoral" zone), the epibiota may be seasonally destroyed by ice, leaving mostly bare rock surfaces for recolonization each spring.

Mud and sand flats are another prominent habitat, regionally and within IIE. Mud/sand flats (including intertidal beaches) provide nursery and spawning habitats for many species in southwest Cook Inlet. These species include several commercially regulated fish and invertebrates such as Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiosus*), tanner crabs (*Chionoecetes bairdi*), and Dungeness crabs (*Cancer magister*) that are addressed in Chapter 43. Organic material (detritus) produced by macroalgae associated with the rocky intertidal habitat and organic material originating from the surrounding terrestrial forests and wetlands is carried by ebbing and flooding tides over the mudflats. This material then supports an assemblage of suspension and deposit feeding organisms such as bivalves, small crustaceans, and polychaete worms. Many fish, invertebrates, birds (shore birds and waterfowl), and mammals (sea otters, seals) prey upon these suspension and deposit feeding organisms that form the base of the food web regionally. Eelgrass (*Zostera marina*), where present on the mud and sand flats, can further enhance habitat value by producing copious detritus, increasing habitat complexity (providing refuge for smaller animals), and stabilizing the sediment with its substantial root biomass.

Rocky intertidal and mud/sand flat habitats often are found in proximity to each other in southwestern Cook Inlet, including the IIE, and their interconnectivity through the detrital pathway likely has a synergistic effect on habitat value, where each is complimented by the other. This study documents both the biota associated with each habitat and the linkages, interactions, and cross-connections among these habitats.

This Pebble marine benthos study focused on shoreline areas within the IIE. Deeper subtidal benthos also was investigated in selected areas. Early field work in 2004 and 2005 covered a large portion of the IIE. In 2006 and 2008, the field effort focused on benthic habitats at the base of the Back Range (MPS1; Figure 42-1B), and west of Knoll Head (MPS1A), a site with a prior sampling history. Other sites with a sampling history (Blackie Beach, MBB; Scott Island, MSI) were also sampled.

At intertidal elevations, a stratified random sampling design was used to characterize benthic assemblages. Two stations sampled in 2004 through 2008 in this study—one west of Knoll Head (MPS1A) and one on Scott Island (MSI) (Figure 42-1B)—were the same locations sampled during previous investigations (and by the same authors of this study) during the late 1970s (Lees et al., 1980) and in 1996 (Pentec, 1996), thus providing a long-term historical perspective. Infauna was characterized by replicated intertidal core and subtidal grab sampling, and subtidal epibenthos was surveyed by scuba divers. Dermersal fish and invertebrates that interact with and depend upon the marine benthos in the IIE are described in Chapter 43. Marine bird and mammal use of the area is described in Chapters 44 and 45.

42.2 Study Objectives

The overall objective of the marine benthos study was to characterize benthic assemblages in marine habitats in the IIE. Specific objectives of the study follow:

- Review and synthesize available information from past studies of regional and local marine conditions and resources.
- Build on the considerable knowledge already available from these past studies to gain a broader understanding of the benthic ecology of the IIE.
- Establish a baseline that describes, to the extent practical, variation associated with substrate, elevation, season, and year.
- Identify and quantify specific sites, habitats, and benthic resources that are particularly productive or important (e.g., kelp and eelgrass beds, marshes at stream mouths, shellfish resource areas, fish spawning habitats, threatened or endangered species habitats, etc.).
- Document (in conjunction with the marine fish and invertebrate studies reported in Chapter 43) the food web and ecological relationships among key species in the areas studied.

42.3 Study Area

The marine benthos study area, henceforth the IIE, included all marine waters and shorelines, except inner Cottonwood Bay and inner Iniskin Bay, from the east side of the entrance to Iniskin Bay and Scott Island to the south side of the entrance to Iliamna Bay at South Head (Figure 42-1B). The sampling effort in 2004 and 2005 focused on intertidal habitats on Scott Island, and near Knoll Head, North Head, and Diamond Point; subtidal areas off these sites also were investigated. In April 2006, only stations near Knoll Head and at Scott Island were sampled. In July 2008, most previously-sampled stations and elevations were resampled. Key geographic features considered in this study are shown on Figure 42-1B. Site locations for both intertidal and subtidal sampling in 2004 through 2008 included the following:

- MPS1—near Knoll Head (intertidal and subtidal sampling).
- MPS2—southwest side of Iniskin Bay (intertidal and subtidal sampling).
- MPS4—near North Head (north side of entrance to Iliamna Bay; intertidal and subtidal sampling).

Additional benthic intertidal sampling was conducted at five locations:

- MPS3—Diamond Point (north side of entrance to Cottonwood Bay).
- MPSE—mudflats of northern Iliamna Bay south of Williamsport.
- MPS1A—Knoll Head West (the "Knoll Head" site previously sampled by Lees et al. [1980] and Pentec [1996]).
- MBSA1—a rocky outcrop at the south end of AC Point in Iliamna Bay (sampled in 2005 and 2008; upper elevation only).
- MSI—Scott Island, a rocky intertidal area surveyed historically.
- MBB—Blackie Beach, an intertidal sand/mud area surveyed.

Additional subtidal benthic sampling was conducted at two locations:

- White Gull Island—a subtidal area surveyed historically.
- MOPP1—an offshore location.

42.4 Previous Studies

42.4.1 Intertidal Studies

Few studies of marine benthos on the west side of lower Cook Inlet had occurred prior to the initiation of the National Oceanic and Atmospheric Administration's (NOAA's) Outer Continental Shelf Environmental Assessment Program (OCSEAP) in the late 1970s. In 1976, Lees and Houghton (1977), investigators currently involved in the Pebble Project study, conducted an initial reconnaissance of intertidal habitats and their assemblages in Iniskin Bay. In 1978, Lees and Houghton continued their work in the area, leading a group of investigators that established several intertidal stations within the IIE and sampled them repeatedly (Lees et al., 1980). The same investigators resampled these sites in 1996 (Pentec, 1996) with funding from the Cook Inlet Regional Citizens' Advisory Council (CIRCAC). The Pebble Project marine benthos study team has a high confidence that two stations sampled in 2004 through 2008 were the in same areas (Photo 42-1), or even the same patches of rock (quadrats; Photo 42-2) sampled in 1978 and 1996. However, caution should be exercised in making direct comparisons between the 2004 through 2008 intertidal observations and data from the earlier studies because of differences in the times of year when sampling occurred.

Descriptions of the biota and assemblages reported in the earlier studies are summarized below. Please note that several previously accepted scientific names have been changed over time. Relative abundance terms used in these characterizations in include in decreasing order of importance: Abundant, Common, Uncommon, Few, and Present. The actual level of abundance indicated for these terms varied by taxon according to the professional judgment of the observer. For example, one or two large predators (e.g., sunstars, *Pycnopodia helianthoides)*, might be considered "Abundant" while a dozen or more littorine snails might be considered only "Common," based on their relative size and importance in the overall structure of the local benthic assemblage.

42.4.1.1 Benthos in Rocky Habitats

Rocky substrates at the northern end of Blackie Beach and at Fossil Reef were examined in August 1976 by Lees and Houghton (1977). Near Blackie Beach, the rock was steep and clean. Fossil Reef was fairly flat and covered with a thin layer of silt (see Chapter 36, Photo 36-5). Rockweed (*Fucus* sp. now considered to be *F. distichus*, ssp. *evanescens)* dominated the middle intertidal range at both locations. At both sites, the barnacle *Balanus glandula* was abundant, and the periwinkle *Littorina sitkana* was common. Despite the covering of silt, the assemblage at Fossil Reef had higher diversity and supported more organisms. In addition to the species already mentioned, it had substantial populations of small blue mussels, limpets (several species in the Family Lottiidae), the clams *Mya arenaria* and *Macoma balthica*, and the drill *Nucella emarginata*. Under boulders, gammarid amphipods, hairy hermit crabs (*Pagurus hirsutiusculus*), and a fish, the crescent gunnel (*Pholis laeta*) were common. Between mean sea level and MLLW, the red algae *Palmaria hecatensis* (previously reported as *Rhodymenia palmata*) and *P. callophylloides* (previously reported as *Callophyllis* sp.), and the green algae (Chlorophyta) *Ulva intestinalis* (previously reported as *Enteromorpha intestinalis*), *Acrosiphonia* sp. (previously reported as *Spongomorpha* sp.), and *Ulvaria obscura* (previously reported as *Monostroma* sp.) were the most abundant algae on rocks near Blackie Beach; ribbon kelp (*Alaria* sp.) and sugar kelp were present, but were more common toward MLLW. Among animals, the dominant organisms were the sponges *Halichondria panicea* and *Haliclona permollis*. Other common taxa were periwinkles, limpets, blue mussels, and the acorn barnacle *Balanus glandula*. The sea star *Leptasterias hexactis* was abundant under rocks, and the helmet crab *Telmessus cheiragonus* and the crescent gunnel also were common, as were colonies of an encrusting bryozoan.

Below MLLW, both sites had a similar algal composition including the filamentous green alga *Acrosiphonia*, the kelps *Saccharina latissima* (previously reported as *L. saccharina*) and *S. subsimplex* (previously reported as *L. groenlandica*), and the red algae *Mazzaella* sp. and *Palmaria palmata*. Also present at both sites were the sponges *Haliclona*, *Halichondria*, and *Suberites*; the Christmas anemone, *Urticina crassicornis* (previously reported as *Tealia crassicornis*); various barnacle species (or Balanomorpha); and several other crustaceans, snails, and bryozoans (Lees and Houghton, 1977). Sea cucumbers *Chiridota* sp., sea stars (*Leptasterias hexactis*, *L. polaris acervata*), and gunnels (*Anoplarchus purpurescens* and *P. laeta*) were also present under rocks. The reef near Blackie Beach was cleaner and supported a more diverse and luxuriant biota than Fossil Reef. The sites differed primarily in the abundance of kelps (primarily *Saccharina* spp.) and the occurrence of numerous juvenile king crabs

(*Paralithodes kamtschatica*) under large boulders, both of which were more abundant at the Blackie Beach reef.

The trophic dynamics of both areas were complex (Lees and Houghton, 1977). Although microherbivores such as limpets and chitons were common, macroherbivores such as urchins were few or absent. Macrophytes appeared to contribute little to the food chain through direct consumption and most likely contributed most of their primary production to detritus. This was further supported by the relative abundance and diversity of suspension feeders, deposit feeders, and scavengers. Predators were far less abundant, but also were diverse. It appeared that the faunal assemblages in these areas depended heavily on tidal currents to supply suspended organic matter, most likely from the detrital pool. Thus, Lees and Houghton (1977) postulated that the local algal production contributes to the food chain indirectly as it is first broken down through a combination of wave action and bacterial degradation and then becomes available to suspension feeders as waterborne detritus.

In August 1976, the middle intertidal range at the rocky reef in Blackie Cove was dominated by rockweed, the red algae *Palmaria hecatensis* and *P. callophylloides*, and the green alga *Acrosiphonia* sp. Another "pioneer" red alga genus (*Porphyra*) also was present.

Lees and Houghton (1977) also visited Scott Island in August 1976. Scott Island is a low, relatively flat island of about 30 hectares on the east side of the entrance to Iniskin Bay. The island had abundant cover of red algae, particularly *Palmaria hecatensis* and *Neorhodomela oregona* (previously reported as *Rhodomela lycopodioides*). Rockweed was abundant at the higher elevations. Other common taxa included filamentous green alga (*Acrosiphonia* sp.), and the red algae *Halosaccion glandiforme*, *Porphyra* sp., and *Palmaria callophylloides*. The epiphytic brown alga *Soranthera ulvoidea* was abundant on *Neorhodomela*. At the exposed southwest end of the island, barnacles covered much of the rock in the high intertidal elevation and appeared to compete successfully for space with rockweed and *Halosaccion*.

Lees et al. (1980) visited Scott Island again in 1978 and established a sampling station that was later included in this Pebble Project study. The 1978 transect crossed a gently sloping rocky bench interrupted by ridges and surge channels on the southernmost corner of the island. Three elevations along this transect were sampled four times between April and September 1978. The upper transect elevation (Photo 42-4) was located at the elevation of maximum density of brown algae and kelps (or Phaeophyta), dominated by rockweed (Figure 42-2). Other common algae species at this elevation included the red algae (or Rhodophyta) *Neorhodomela oregona* and *Odonthalia floccosa* (probably *O. floccosa* f. *comosa*). Invertebrates at this elevation included barnacles (*Balanus glandula*, *Chthamalus dalli*) and limpets (Figure 42-3), periwinkles, the pulmonate snail *Siphonaria thersites*, drill (*Nucella emarginata)*, and the hairy hermit crab. The middle elevation (Photo 42-5) was dominated by the red algae *Palmaria hecatensis* (reported as *Rhodymenia pacifica*—cover to 64.3 percent) and *P. callophylloides* (reported as *R. liniformis*—cover to 74.2 percent), but also included substantial amounts of rockweed and the red algae *Mastocarpus papillatus* (reported as *Gigartina*) and *Halosaccion glandiforme*. Animals were not conspicuous at this elevation (Figure 42-3). The lower zone (Photo 42-6) supported a modest amount of *Saccharina subsimplex* (reported as *L. groenlandica,* up to 43.3 percent cover, 1,872 grams per square meter biomass), *Palmaria hecatensis* (38 percent cover), and *P. callophylloides* (up to 20 percent cover). *Alaria* was important in July 1978, but had disappeared by September. Other algal genera with more than 5 percent cover included rockweed, the green algae *Ulvaria* and *Acrosiphonia*, and the red alga *M. papillatus*.

Other rocky sampling sites were established at Knoll Head and on White Gull Island (Lees et al., 1980). The Knoll Head site was located at the base of a steep cliff and consisted of a series of rocky benches and ridges separated by channels and tide pools (Photo 42-7). The biota at each elevation was generally similar to that at Scott Island. This site is protected from large swells by an offshore reef (Black Reef), except during the highest tides.

Investigators revisited the Blackie Beach, Scott Island, and Knoll Head sites in early June 1996 (Pentec, 1996). In the upper intertidal zone at Knoll Head (MPS1A), brown algae, predominantly rockweed, was less than half as abundant in 1996 as in 1978 (Figure 42-4); limpets were more abundant (Figure 42-5), and barnacles were somewhat less abundant (Figure 42-5). At the middle elevation (Photo 42-1), kelps (Phaeophyta) and limpets were less abundant in 1996 than in 1978, and red algae (Rhodophyta), predominantly *Palmaria* spp., had similar abundances in both years (Figures 42-4 and 42-5). At Scott Island (Photos 42-4 and 42-5), algae were somewhat less abundant in 1996 than in 1978 at the upper elevation, while the reverse was true for red algae at the middle elevation (Figure 42-2).

42.4.1.2 Benthos in Sand/Mud Habitats

Blackie Beach and Fossil Beach, both along the east shore of Iniskin Bay near its entrance (Figure 42-1B), were sampled in June 1976 (Lees and Houghton, 1977). The upper intertidal zone at Blackie Beach had a moderate amount of drift algae inhabited by large numbers of the beach hopper *Orchestia* sp., a gammarid amphipod. Otherwise, the beach was devoid of animals down to about mean lower low water (MLLW), where the slope became gentle and the substrate changed to fine mud with some cobbles (Photo 42-3). On the mud near MLLW, the spoonworm *Echiurus echiurus alaskanus* became abundant (density about 36 per square meter). Lower on the mudflat, densities declined substantially, but soft shell clams (*Mya* spp.) and sand worms (*Nephtys* nr. *caeca*) became common (0.8 and 1.8 individuals per square meter, respectively). Small pink clams, *Macoma balthica*, and large gapers, *Panomya ampla*, were not common. Pacific sand lance, *Ammodytes hexapterus*, were common, burrowing in the silty sand. Scattered patches of eelgrass occurred toward the middle of the mudflat. The brown algae sugar kelp (*Saccharina latissima,* previously reported as *Laminaria saccharina*) and twisted tube (*Scytosiphon lomentaria),* and a red alga (*Iridaea* sp., now *Mazzaella*) were also common. A similar community was observed on a mudflat about 2 miles north of Keystone Creek that also had cockles, *Clinocardium nuttallii*, and the priapulid worm *Priapulus caudata*.

Because of different sampling protocols, the sampling at Blackie Beach could not be compared between the two years (1978 and 1996). However, Pentec (1996) established a low intertidal zone, soft substrate site that supported moderate quantities of eelgrass (21.4 percent cover; Photo 42-3, left side). All three of these sites (Blackie Beach [MBB], Scott Island [MSI], and Knoll Head [MPSA1]) were incorporated into this Pebble marine benthos study.

42.4.2 Subtidal Studies

In contrast to intertidal habitats, few previous studies have been conducted to characterize subtidal habitats in the IIE. No subtidal sampling had occurred at the four sites under consideration at the time of the 2004 reconnaissance program. Some shallow subtidal diver transects were completed in 1978 (Lees et al., 1980) at Scott Island, Knoll Head Lagoon, and White Gull Island, but no quantitative subtidal sampling occurred there. Prior to 2004, the nearest quantitative subtidal sampling to the IIE occurred in lower Cook Inlet as part of the OCSEAP program (Feder et al., 1980) and was conducted considerably offshore from the Pebble study area.

Dames & Moore conducted shallow subtidal surveys of invertebrate and fish habitats in the Y Valley lagoon area (reported as Knoll Head Lagoon) in 1978 (Dames & Moore, 1979). Kelp was sparse or absent below 3 meters. They assumed the site to be somewhat protected because of Black Reef offshore and noted that tidal currents were not extreme.

In 1978, Dames & Moore also visited White Gull Island, at the entrance to Cottonwood and Iliamna bays (Dames & Moore, 1979) On the east side of the island, which is exposed to both long-fetch waves and tidal currents, a bedrock shelf extended from the intertidal zone to a depth of about –5 feet MLLW, where a vertical face dropped to a depth of about –16 feet MLLW. Kelps did not extend over the edge of the vertical face. Generally, macrophyte production appeared to be low on the west side of lower Cook Inlet, especially below a depth of –10 feet MLLW.

42.5 Scope of Work

The project team conducted the initial background literature research during 2004 and continued these efforts through 2008. Between August 27 and September 1, 2004, the team conducted the following field work:

- Aerial reconnaissance was conducted by Dr. Jon Houghton of Pentec and Dr. Stephen Jewett of the University of Alaska Fairbanks (UAF).
- Intertidal Studies:
  - Intertidal reconnaissance, including both quantitative and qualitative data collection, was conducted by Dr. Jon Houghton, Mr. Dennis Lees of Littoral and Ecological Services, and Dr. Sandra Lindstrom, University of British Columbia.
  - Intertidal sample collection, including samples for sediment-chemistry, infauna, and biological-tissue analyses, was conducted by the above intertidal reconnaissance personnel plus Mr. Jim Starkes of Pentec.
- Subtidal Studies:
  - Subtidal reconnaissance, including both quantitative and qualitative data collection and underwater photography, was conducted by UAF marine biologists/divers Dr. Jewett, Mr. Shawn Harper, and Ms. Heloise Chenelot; marine technician Mr. Gerald Douthit of NW-GEOSciences; and Ms. Lee Ann Gardner of RWJ Consulting.
  - Subtidal sample collection, including samples for sediment/water-chemistry, infauna, and biological-tissue analyses, were conducted by the above subtidal reconnaissance personnel with assistance from Mr. James Nardelli—skipper of the *R*/V *Kittiwake II*—and Mr. Dan Strickland—first mate.
  - Crab- and shrimp-pot sampling was conducted by all of the above intertidal and subtidal personnel.

In 2005, benthic field work was conducted from July 16 through 23 and included:

- Houghton, Lees, and Lindstrom conducted quantitative and qualitative data collection at rocky intertidal sites.
- The above intertidal personnel, aided by Mr. Mark Madden of Bristol Environmental and Engineering Services Corporation, conducted intertidal sample collection, including samples for sediment-chemistry, infauna, and biological-tissue analyses.

In 2006, benthic field work was conducted from April 25 through 28 and included:

- Quantitative and qualitative data collection at rocky intertidal sites was conducted by Houghton and Lees.

In 2008, benthic field work was conducted from July 13 through July 19 and included:

- Houghton, Lees, Lindstrom, and Dr. Jason Stutes of Pentec conducted quantitative and qualitative data collection at rocky intertidal sites.
- The above intertidal personnel, aided by field technicians, conducted intertidal sample collection, including samples for sediment chemistry, infauna, and biological tissue analyses (all chemical analyses are covered in Chapter 35).
- Subtidal dive surveys were conducted by Lees and Mr. Don Peterson of Research Support Services.

Note that epibenthic and demersal invertebrate catches taken in trawl sampling, conducted concurrently with the above tasks, are reported in Chapter 43.

42.6 Methods

42.6.1 Literature Synthesis

Senior biologists with Pentec, UAF, and RWJ Consulting prepared a literature synthesis relevant to the project. Resources searched included online sources, academic libraries in the area, Alaska Department of Fish and Game archives, and discussions with area researchers (a bibliography is provided in Appendix 42A).

42.6.2 Field Surveys and Collections

The 2004 marine reconnaissance studies were supported by the *R/V Kittiwake II*. This 73-foot vessel was capable of transporting and housing up to 10 scientists. Intertidal and subtidal sites were accessed using a skiff. The 2004 field program began with the *R/V Kittiwake II* departing Homer, Alaska, on August 26 and arriving at the IIE on August 27. Sampling and habitat characterization began on August 27 and were completed on September 1. The vessel returned to Homer on September 2.

The 2005 marine benthic studies were supported by the *M/V Outer Limits*. This 60-foot vessel was capable of transporting and housing six scientists. Intertidal sites were accessed with a skiff. The 2005 field program began with the *M/V Outer Limits* departing Homer, Alaska, on July 16 and arriving at the IIE that evening. Field work, including fish and invertebrate sampling (Chapter 43), was conducted from

July 17 through 23, except that weather (high winds) prevented work on July 18. The vessel returned to Homer on July 23.

The April 2006 marine benthic studies also were supported by the *M/V Outer Limits*, which departed Homer, Alaska, on April 24. Field work, including fish and invertebrate sampling (Chapter 43), was conducted from April 24 through 28, and the vessel returned to Homer on April 28. One intertidal transect (Scott Island lower elevation) was completed on May 16, 2006, by Houghton and a crew based on the *M/V Fox Fire* which had embarked from Homer in support of project fish surveys.

The 2008 marine benthic studies were supported by the *M/V Outer Limits*. Intertidal sites were accessed with a skiff. The 2008 field program began with the *M/V Outer Limits* departing Homer, Alaska, on July 11 and arriving at the IIE early the next morning. Field work, including fish and invertebrate sampling (Chapter 43), was conducted from July 12 through 19. The vessel returned to Homer on July 19.

The methods used for sampling marine benthos are provided in the sections below. More detailed methods are also described in the context of the marine biology (not including wildlife) and chemistry programs in the study plans and the quality assurance project plans for each respective year (NDM, 2004, 2005a, 2005b, 2005c, 2006a, 2006b; Pebble Partnership, 2008a, 2008b). Master lists of scientific and common names of intertidal plants and animals referred to in this report are provided in Appendix 42B; subtidal common names are included in Appendix 42C.

42.6.2.1 Intertidal Studies

Intertidal Habitat Mapping

Mapping of intertidal habitat in the IIE by substrate type was based on information available from the CIRCAC and the 2004 aerial survey (see Chapter 36).

Characterization of Rocky Intertidal Benthos

In 2004, aerial and skiff reconnaissance surveys were conducted to select feasible study stations at areas on the west side of Iniskin Bay and at the east side and head of Iliamna Bay (i.e., the Williamsport area). Six rocky intertidal transect stations were surveyed in 2004, seven stations were surveyed in 2005, three of these stations also were surveyed in 2006, and all eight were sampled in 2008 (Figure 42-1B). Two of the stations (MPS1A at Knoll Head West and MSI at Scott Island) were originally sampled in 1978, were resampled in 1996, and were sampled in all four years of the Pebble Project study; however, sampling was not always done in the same month in different years. The two previous studies (1978 and 1996) augment the environmental baseline data collected for the Pebble Project.

On rocky shorelines, the horizontal banding of flora and fauna creates relatively obvious elevation zones (high, middle, and low). When and where possible, all three zones were sampled to determine an accurate zonal distribution of flora and fauna. All stations and elevations sampled in the IIE in 1978 and 1996 were successfully located again in 2004 and, with the help of photographs and previously placed markers, were resampled as near to the original station/elevation as possible in that and subsequent years.

At each elevation sampled, researchers placed a fixed head stake and laid out a 100-foot transect line parallel to shore along the tidal-elevation contour line (e.g., Photo 42-1). Along each transect, five to ten

0.25-square meter quadrats were randomly located (based on a random number table) during the first sampling and permanently marked with pins or marine epoxy. Individual quadrats were found again in subsequent surveys by the measured distances from a head stake and with the aid of photographs. This allowed for repeated measurements at each location (e.g., Photo 42-2). At stations sampled in 1978 and 1996, transects and exact quadrats were located as accurately as possible by these means; in many cases, 1996 elevation head stakes and marine epoxy quadrat markers were found in 2004. In most cases, elevation head stakes and a majority of quadrat makers were successfully relocated in subsequent years.

Field biologists photographed each quadrat and then estimated the percent cover of all algal taxa and all sessile animals. They then made counts of all mobile taxa larger than about 4 millimeters in size. Taxa not readily identified in the field were collected and preserved for future identification in the laboratory. These data provide a quantitative baseline for comparison with previous work in the IIE. Microflora, primarily diatoms, was noted when present, and percent cover was estimated. Because visual detection of diatom films is highly variable, and because diatoms are not true macroalgae, these numbers were not included as a part of the total algal cover in tables or figures.

Intertidal Sediment Collection

Sediment samples were collected for analysis of infauna and sediment chemistry at intertidal stations with soft-bottom habitats (sand or mud; Figure 42-1B). In 2004, intertidal infauna stations were marked by rebar stakes, or other means (e.g., large boulder), and positions were recorded using GPS to aid in relocating the stations in subsequent years. Additional stations were established in 2005 and were similarly marked. Intertidal infauna stations were sampled at one or two elevations, depending on site conditions. At each station and elevation sampled, five randomly located replicate sediment samples for analysis of macroinfauna were taken with a 0.009-square meter, 15-centimeter-deep hand corer (Photo 42-8). Intertidal infauna samples were sieved in the field using a 1.0-millimeter mesh screen and the sieve contents were retained and preserved in a buffered 10 percent solution of formaldehyde in seawater. The number and types of infauna samples collected at each station in each year are summarized in Table 42-1 (i.e., for 2004, 2005, and 2008).

In 2005 and again in 2008, five additional intertidal samples (two each at MBSA1 and MPS2, and one at MPS3) were collected to assess megainfauna (those organisms retained on a 7-millimeter screen). Megainfauna samples were collected by excavating a 0.25-square meter quadrat to a depth of approximately 15 centimeters in sand or mud soft substrates (Photo 42-9). Sediment removed from the excavations was sieved through 7-millimeter-mesh wire screens. Animals remaining on the screen were labeled and preserved for taxonomic identification and enumeration. All samples were fixed in the field with a buffered 10 percent solution of formaldehyde in seawater.

In 2004 and 2005, all infauna samples were sent to UAF for taxonomic identification. In 2008, taxonomic identification was performed by K. Welch of AquaMarine Environmental Services. In all years, individuals of each species (or lowest practical taxonomic level) were counted and then summed by phylum for each replicate. In all years, samples were returned to Pentec for biomass measurements. Taxa were grouped by phylum for comparisons of biomass.

At each of the macroinfauna core locations sediment samples were taken from undisturbed sediment adjacent to the core to provide samples for analysis of sediment grain size, total organic carbon, and total Kjeldahl nitrogen, as well as metals and petroleum hydrocarbon concentrations. Where larger animals such as clams or mussels were observed, specimens were collected for laboratory analysis for naturally-occurring trace elements in 2004, 2005, and 2008. The results of the chemical analyses of sediment and biological tissue samples are provided in Chapter 35.

42.6.2.2 Subtidal Benthic Studies

Diver Transects

Prior to 2004, the offshore subtidal areas of the IIE were poorly characterized. Diver transects were sampled in proximity to stations MPS1, MPS2, and MPS4 and other areas of potentially ecologically important habitat. Transect locations are shown on Figure 42-1B and on the figures in Appendix 42C. In 2004, transects were oriented either perpendicular or parallel to shore; in 2008, all transects were perpendicular to shore, starting at the greatest depth and surveying toward shore until a relative depth of about 4 feet was reached. In 2004, divers took still photographs of bottom habitats when visibility and tidal conditions (i.e., slack water) would allow. In 2008, the majority of each transect was video taped and frame captures were taken of representative features and organisms.

For each transect, a diver/biologist experienced in Alaskan subtidal marine biota, recorded data describing biota, substrate type, visibility, tidal conditions, and water depth. Generally, the biologist recorded the organisms separately within discrete habitat-defined depth ranges along the transect to provide an indication of the vertical zonation. Divers often employed dive lights, particularly at depth or under conditions of higher turbidity. The biologists reviewed the photos or video records to confirm field abundance estimates, identify other taxa occurring in each habitat, and to add these to the species lists compiled during the field surveys. A detailed taxonomic list was compiled for each transect. Dominant taxa were targeted for occasional collection for taxonomic purposes. Frequency of occurrence and general abundance were noted during a review of the video tapes taken during the 2008 survey and these data contributed to abundance designations. Relative abundance was estimated for each taxon: Abundant, Common, Sparse, Uncommon, Few, and Present. The actual level of abundance indicated for these terms varied by taxon according to the professional judgment of the observer. For example, one or two large predators (e.g., sunstars, *Pycnopodia helianthoides)*, might be considered “Abundant” while a dozen or more tube worms might be considered only “Common,” based on their relative size and importance in the overall structure of the local benthic assemblage. All water depths were reported in feet below MLLW.

Subtidal Sediment Collection for Infauna

Subtidal infauna and sediment samples were collected with a 0.1-square meter van Veen grab sampler (Photo 42-10). Additional replicate grab samples were collected for laboratory analysis of metals and hydrocarbon concentrations (Chapter 35), and for grain size. For infauna samples in 2004, the entire grab was sieved in the field using a 1.0-millimeter-mesh screen. In 2008, the infauna sample was taken from within the van Veen grab using the same 0.009-square-meter, 15-centimeter-deep hand corer used for intertidal samples (Photo 42-8). Core samples then were sieved in the field using a 1.0-millimeter-mesh screen. In both years, the sieve contents were retained and preserved using a buffered 10 percent solution of formaldehyde in seawater. The preserved samples were transported to a third-party laboratory (i.e., the UAF laboratory in Fairbanks, Alaska, in 2004 and AquaMarine Environmental Services in 2008) where they were transferred from the formalin solution to a 50 percent isopropyl-alcohol solution for archiving and storage until their analysis. Samples were then sorted and identified to lowest practical taxonomic level. The number of both intertidal and subtidal sediment samples collected at each station for infaunal analyses is shown in Table 42-1.

In areas where larger infaunal taxa such as clams or polychaetes were collected, samples of the animals were collected and were submitted for laboratory analysis of tissues for naturally-occurring trace elements (Chapter 35.4).

A limited number of shrimp pots were deployed in August 2004 in subtidal areas off stations MPS1 and MPS1B. Because few animals (no shrimp) were captured, the effort was not carried forward to subsequent samplings, and no analyses were conducted.

42.6.3 Infaunal Data Statistical Analyses

A variety of statistics were compiled for analysis of the infaunal data. Before compiling the final data base for these analyses, taxa that were not infaunal (i.e., animals such as barnacles that do not live primarily within the sediment), or that were too small to sample quantitatively (e.g., oligochaetes) were excluded from analysis. Average abundance, biomass, and the number of species (i.e., species richness, *S*) were calculated for each location. Within each sampling location, taxa were ranked by average abundance (number per square meter) and biomass (grams per square meter). Three ecological indices were calculated: the Shannon diversity index, Simpson's dominance index, and β diversity.

The Shannon diversity index is calculated as follows:

$$H' = -_i \sum p_i \log p_i \text{ } where \text{ } p_i = \frac{n_i}{N}$$ Where:

n_i = number of individuals of the *i*th taxon

N = total number of individuals

Simpson's dominance index is calculated as follows:

$$S_I = \sum \frac{n_i(n_i - 1)}{N(N-1)}$$

Where:

n_i = number of individuals of the *i*th taxon

N = total number of individuals

Diversity indices provide detailed information about the biological community because they include the relative abundance of each species. The Shannon diversity index provides a measure of the evenness of species and increases both with additional species and with greater evenness in the size of species' populations. Simpson's dominance index provides the likelihood that two randomly chosen individuals will be the same species and indicates the extent to which a community is dominated by abundant (i.e., numerically dominant) species. Values range from 0 to 1, and a high value, such as 0.8, indicates that the community is dominated by a few very abundant species; whereas a low value, such as 0.1, suggests that the community composed of more-or-less equal numbers of individuals of each species. As discussed by

Magurran (2004), these diversity values are not always comparable between studies, but are comparable for similar habitats (e.g., can be compared between years).

Two multivariate tools, cluster analysis and an ordination method, were applied to assess the similarity of assemblages among stations and among replicates within a station. Similarities in both species composition/abundance and in functional group composition were analyzed. First, agglomerative cluster analysis, using unweighted averaging, was used to group similar samples into a hierarchical dendrogram in which similar samples appear in similar branches. With cluster analysis, the break points of groupings in the dendrogram are subjective, but replicates from within a relatively homogenous habitat should aggregate between 60 to 70 percent similarity or higher. In practice, groups of samples within comparatively homogenous marine habitats typically are recognizable at approximately 60 percent similarity or more (e.g., Blanchard et al., 2002), whereas groupings from more dynamic marine habitats may be recognizable at 50 percent similarity (e.g., Feder et al., 2005). The resulting dendrograms and analyses from the multiyear IIE data base were too complex for presentation. Hence, a second, alternative ordination technique called multidimensional scaling was run. Agreement between the two methods provides stronger evidence that interpretations are valid. Multidimensional scaling attempts to construct a “map” or diagram of the sites where similar samples are close together.

For both cluster analysis and ordination, similarity was estimated by a similarity coefficient. The Bray-Curtis coefficient (Bray and Curtis, 1957) was used to calculate similarity matrices. The Bray-Curtis coefficient was based on natural logarithm transformed abundance data [*ln*(individuals per square meter + 1)] and defined as follows:

$$D_{ij} = \left(\frac{\sum_{j=1}^{n} \left| y_{ij} - y_{lj} \right|}{\sum_{j=1}^{n} \left(y_{ij} + y_{lj} \right)} \right) 100$$

Where:

y_{ij} = the transformed abundance of each species at a given station/elevation

y_{lj} = the transformed abundance of each species at a different station/elevation

The coefficient was calculated for all pairwise combinations of all replicates and stations. In this report, ordination matrices are used to present the multidimensional scaling data and to evaluate similarities in samples both among stations and among replicates within a station. The heterogeneities in intertidal macroinfauna species composition and in functional group composition among stations and among replicates within stations were evaluated using a matrix of coefficients for all possible pairwise comparisons of replicates and stations. The matrix was generated in Primer, a multi-dimensional scaling software package.

42.7 Results and Discussion

42.7.1 Intertidal Studies

Qualitative descriptions of the general nature and distribution of intertidal habitats in the IIE are provided in Chapter 36. Oceanographic and water-quality conditions in the IIE are described in Chapter 34. The following sections describe the local conditions and biological assemblages characteristic of dominant intertidal habitat types quantitatively sampled in 2004 through 2008. A cross reference of scientific to common names of intertidal species is provided in Appendix 42B.

42.7.1.1 Rocky Intertidal Benthos

The distribution of vegetation and invertebrates in rocky intertidal habitats is determined by elevation, substrate, and exposure to physical stressors, such as waves, sun, and ice scour. These physical factors, as well as the abundances and growth of intertidal organisms, all exhibit seasonal and interannual variability. Assemblages present at different elevations and stations reflect all of these factors. The following sections describe conditions at individual stations and elevations sampled in 2004 through 2008. Where available, historical data from 1978 and 1996 (Section 42.4.1.2) also are discussed in relation to more recent conditions. A summary of the nature and ecology of rocky shores in the IIE is provided in Section 42.8.1.1.

MPS1, Knoll Head

MPS1 lies on a low bedrock reef projecting seaward in front of vertical cliffs that lie at the base of Knoll Head (Figure 42-1B; Photo 42-11). Only the lower intertidal zone was quantitatively sampled at this site in 2004 and 2005, but upper and middle elevation stations were established and sampled in April 2006 and resampled in July 2008.

The upper elevation (Photo 42-11, bottom) was mostly located on a bedrock bench extending to the south from near the front of the easternmost of the rock arches termed “the Garages” (visible in Photo 42-11, top). During the April 2006 survey, rock surfaces were largely barren, reflecting extreme winter conditions, including ice scour that was observed on adjacent rocks. The most abundant alga was rockweed (mean 4.2 percent cover), followed by the red alga *Neorhodomela oregona* (3.2 percent cover; Table 42-2 and Figure 42-6). Animals also were sparse and only the periwinkle *Littorina sitkana* was present in substantial numbers (280 per square meter). The small barnacle *Chthamalus dalli* covered 5.6 percent of the rock surface (Table 42-2). In July 2008, rockweed coverage was substantially higher (19.2 percent), reflecting spring and summer growth, and red algae, predominantly *N. oregona*, provided about 6 percent cover. The acorn barnacle *Semibalanus balanoides* had become well established in 2008 (compared to the early season data from April 2006) with over 33 percent cover and the drill *Nucella lima* (5.6 per square meter) was actively preying on them. Periwinkles (more than 700 per square meter) and limpets (Lottiidae; 20 per square meter) were much more abundant in 2008 than they were in the April 2006 sampling.

The middle elevation sampled (Photo 42-12, top) was on the same rock bench and the substrate was dominated by bedrock with several pockets of broken cobbles. Like the upper elevation, the middle transect was very barren in April 2006 with few algae or animals present (Photo 42-12, bottom).

Approximately 51 percent of the substrate was covered with diatoms (Table 42-3) in both film and filamentous forms. This cover represented a spring bloom apparently taking advantage of large areas of rock surface having been scraped of sessile organisms by winter ice scour and few herbivores (e.g., limpets and periwinkles) having ventured out of their winter refuges. The primary macroalgae were rockweed (3.4 percent cover) and the red alga *Palmaria hecatensis* (2.1 percent cover). Animals were very sparse with limpets at 18 per square meter and only 1 percent cover by the barnacle *C. dalli.* In July 2008, the biota was much more typical for the habitat and elevation. Rockweed cover was 26 percent and a variety of red algae, again dominated by *P. hecatensis* (10.7 percent), covered a similar percentage of the rock surface (Figure 42-6).

Six quadrats on the lower transect and all on bedrock substrate (Photos 42-11, top, and 42-13) were sampled in the summers of 2004, 2005, and 2008. The lower rock substrate was dominated by brown and red algae (Figure 42-6) and had a mean total algal cover (all taxa combined, including encrusting forms) of 91 percent in August 2004, 143 percent in July 2005, and 131 percent in July 2008 (Table 42-4; Photo 42-13, bottom left). Note that algal cover can exceed 100 percent because kelps, particularly *Alaria* and *Saccharina*, form an overstory layer above many smaller red algae and encrusting algae. Encrusting forms of algae were a significant component of the flora (20 percent or greater) in all samplings (Figure 42-6). In contrast to the rich algal assemblage seen in mid-to-late summer, the lower rock was substantially more barren in early spring (April 27) 2006, when ice bergs from Iniskin Bay were seen abrading nearby rocks in the swells. At that time, the lower transect supported many of the same taxa previously seen, but total algal cover (all taxa combined less diatoms) was 83.8 percent (Table 42-4), with filamentous green algae, not present in summer sampling, contributing 16.7 percent. Most individual plants, especially the red algae such as *Palmaria* spp., were small in size. Kelps, both *Saccharina* and *Alaria,* were still the dominant algal taxa, but most were in small tide pools where their holdfasts were protected from ice scour.

Animals were typically sparse during the summer, consisting mostly of small snails (e.g., the grazer *Lacuna* sp. and *Margarites pupillus*) and scavenging hermit crabs (*Pagurus* spp.). Among the few animals present in April, only the small snail *Margarites pupillus* and the lined chiton, *Tonicella lineata,* exceeded 5 per square meter (Table 42-4).

MPS1A, Knoll Head West.

The Knoll Head West site (MPS1A; Photos 42-1, 42-7, and 42-14) lies among rocky benches and headlands between MPS1 and the entrance to the lagoon between Knoll Head and North Head (Figure 42-1B). This site was previously sampled several times in 1978 by Lees et al. (1980) and in June 1996 by Pentec (1996).

The upper elevation at MPS1A is on top of a low exposed ridge where pockets in the rock form small tide pools. The upper transect was sampled along a bedrock ledge in six different years (1978, 1996, 2004 through 2006, and 2008), although the timing of the sampling has varied from year to year (Figures 42-4 and 42-5). Photographs of one quadrat taken during several sampling events (Photo 42-2) show intra- and interannual fluctuations in cover by barnacles and rockweed. The dominant algal species through 2005 was rockweed (13.1 percent cover in June 1996 to 54.4 percent cover [reported as all Phaeophyta] in June 1978; Figure 42-4). However, in the early spring sampling in 2006, rockweed cover was only 5.5 percent with algal dominance shifting to filamentous green algae at 16.6 percent cover (Table 42-5). From 1978 through 2008, the red alga *Neorhodomela oregona* was a consistent contributor to algal cover

(4.8 to 14.1 percent). Encrusting algae were much more abundant in 1978 than during any subsequent sampling (Figure 42-4), which may be a sign of increased herbivory since 1978.

Sessile animals (mostly barnacles of the genera *Balanus, Semibalanus*, and *Chthamalus*) and motile periwinkles (*Littorina sitkana*), limpets, hairy hermit crabs, and the drill (*Nucella lima*) were also present in all years, but only *L. sitkana* was abundant in April 2006 (Table 42-5). This latter species occurred at over 200 per square meter in all samplings from 1996 on but was not present in 1978. Three species that were common in 1996 (e.g., the pulmonate snail *Siphonaria thersites*, the drill *Buccinum baeri*, and the sea star *Leptasterias hexactis*) were not present from 2004 through 2008, suggesting large-scale temporal variability.

The middle elevation at Knoll Head West (Photo 42-1) lies on the crest of a low bedrock ridge with moderate slope to the southeast and a range in elevation from MLLW to about +2 feet MLLW. In 1978 and 1996, habitats at this elevation were dominated by red algae (especially *Palmaria* spp.; Figure 42-4). In 2004 there was a dramatic shift to a codominance of red and brown algae (rockweed); however, in July 2005 and 2008, the bedrock ridge was again dominated by red algae (Figure 42-4), particularly *Palmaria hecatensis* and *P. callophylloides*. Rockweed returned in 2005 to a percent coverage that was similar to that in 1978, however, in 2008 there was very limited coverage (3.2 percent) in quadrats sampled. The filamentous green alga *Acrosiphonia arcta* was substantially more abundant in 2005 than in previous surveys but green algae were largely absent in July 2008. In April 2006 the middle elevation was quite devoid of macroalgae when compared to the more than 100 percent cover in later summer surveys. Algal cover (not including diatoms) was just 46 percent and was again dominated by small blades of *P. hecatensis* (20.6 percent) with lesser amounts of filamentous green algae (14.4 percent; Table 42-6).

Generally, few animals were present at this elevation in any sampling. One exception was the occurrence of large numbers of the small snail *Lacuna* sp. in 2004. Also, a population of the barnacle *S. balanoides* became established in 2004 and 2005, but had disappeared by spring 2006. The green sponge *Halichondria panicea* was consistently present during summer samplings from 1978 through 2005 but was absent in 2006 and 2008. This elevation was especially devoid of fauna during the spring 2006 sampling when only one taxon, the hydroid *Abietinaria* sp., was present (Table 42-6).

The lower elevation at Knoll Head West was not sampled quantitatively after 1978, but the area was qualitatively surveyed in 2004. The lower elevation consists of a mosaic of bedrock ridges, tide pools, and boulders (Photo 42-7). This habitat diversity provides an abundance of microhabitats and shelter from annual ice scour, and the area supports a much greater diversity of plants and animals than was seen at higher elevations. A variety of snails, sea stars, and crustaceans occurred in this rocky habitat, while sediment pockets in tide pools held a number of large clams (deposit feeders and filter feeders), polychaetes, and the burrowing spoonworm, *Echiurus echiurus*.

MPS2, Southwest Iniskin Bay.

The shoreline at MPS2 is a combination of rock fall and bedrock at the upper and middle elevations, with fine mud at lower elevations (Photo 42-15). The mudflat revealed at low tide is the southern tip of a vast mudflat that expands northward, covering the inner two-thirds of Iniskin Bay.

In the July 2005 and 2008 surveys, the upper intertidal zone was surveyed in five quadrats, all on a bedrock wall. The coverage of the rock by plants and sessile animals was remarkably consistent between the two years (Table 42-7). The dominant alga was rockweed, with encrusting green algae and some red algae present as well (Table 42-7). The barnacle *S. balanoides* largely dominated the sessile invertebrates, with mussels (*Mytilus trossulus*) and other barnacles (*Chthamalus dalli)* combined covering less than 3.1 percent of the rock surface in 2008 (Table 42-7). Of the motile invertebrates, periwinkles (*L. sitkana*; to about 1,240 per square meter in 2008) and limpets (to 54.4 per square meter in 2005) were most abundant (Table 42-7).

The substrate along the middle transect at MPS2 was varied (Photo 42-15, left), with three quadrats characterized as mixed substrate of boulder/cobble/gravel and two quadrats as a combination of only boulder and cobble. The middle elevation was dominated by the red alga *Neorhodomela oregona* in 2004 and 2008 (14 and 22 percent cover, respectively), whereas in 2005 the filamentous red alga *Pterosiphonia bipinnata* was the most common species (19.6 percent cover; Table 42-8). Barnacle coverage was dominated by *Chthamalus dalli* in both 2004 and 2005 but this species was replaced as the dominant by *S. balanoides* in July 2008. Periwinkles (*Littorina sitkana*), limpets, drills (*Nucella lima),* and hairy hermit crabs. There was a shift in dominant motile invertebrates from periwinkles in 2004 to limpets in 2005, and a shift back to periwinkles, along with drills, in 2008 (Table 42-8). In addition, motile invertebrates were more prevalent on the boulder/cobble quadrats than on the mixed substrate. The low mudflat had widely scattered, very small patches of eelgrass but otherwise, supported, a limited epibiota that was not sampled.

MPS3, Diamond Point.

This site is located on a rocky bench at the northern side of the entrance to Cottonwood Bay (Photo 4-16; Figure 42-1B). At the upper elevation, which was surveyed in July 2005 and 2008, the substrate was exclusively bedrock. At this elevation, algal coverage was dominated by rockweed (32 to 50 percent cover) and to a lesser extent by some encrusting red algal forms (2 to 6 percent cover; Table 42-9). Sessile fauna was dominated by abundant barnacles, particularly *Semibalanus balanoides* (49 to 67 percent cover; Table 42-9). Motile invertebrates were dominated by the periwinkle *Littorina sitkana*, with numbers in excess of 640 per square meter in both years. Limpets, drills (*Nucella* sp.) and hermit crabs were common in both years (Table 42-9).

The middle elevation at MPS3 was surveyed in 2004, 2005, and 2008. The substrate was bedrock and, like most middle elevation rocky areas in the IIE, was dominated by rockweed with coverage ranging from 38 to 64 percent (Table 42-10). The red algae *Neorhodomela oregona* and *N. aculeata* were subdominant and combined cover of the two species was consistently 8 to 14 percent over the 3 years. In each year sampled, a cumulative total of between 17 and 18 macroalgal taxa were identified in the 5 to 10 quadrats sampled at middle elevation stations. The abundance of barnacles at the middle elevation also was stable over the three sample years with *S. balanoides* ranging from 27 percent to 37 percent cover. On the other hand, the small barnacle *Chthamalus dalli* declined steadily from 9 percent cover in 2004 to less than 1 percent in 2008. As at other rocky sites, periwinkles (*L. sitkana*) dominated numbers of motile fauna with densities varying from 175 per square meter to nearly 700 per square meter. At the middle elevation, in contrast to the upper elevation, appreciable numbers of limpets, hermit crabs, and drills (*Nucella* sp.) were also present. Drill density was quite consistent, ranging from 40 per square meter to 56 per square meter over the three different years; drill predation was a probable cause of the somewhat lower density of barnacles at the middle elevation compared to the upper elevation.

The lower elevation at MPS3 was composed, in part, of bedrock similar to that at the higher elevation (Photo 42-16), but boulder/cobble habitat was encountered in four of the 10 quadrats. At the lower elevation, vegetative cover was substantially higher (67.7 percent vs. 48.7 percent) and more diverse (25 taxa vs. 17 taxa) in 2005 than in 2004 (Table 42-11). Algal diversity was relatively high (compared to that at the middle elevation) on the bedrock habitat (29 unique taxa represented overall), though many of the taxa unique to the 2005 survey were ephemeral red algae. In both years, rockweed was the most abundant alga on the bedrock, while the green alga *Ulva* sp., encrusting red algae, and red algae in the genus *Porphyra* were more prevalent on the boulder/cobble substrate. Kelps, which are dominant on lower-elevation rock habitats at more exposed stations, were largely absent. Coverage by sessile invertebrates at the low elevation was dominated by the sponge *Halichondria panicea* and barnacles (*Balanus* and *Semibalanus* spp.), although barnacle coverage was less than at the middle elevation (Tables 42-10 and 42-11). Motile invertebrates, hairy hermit crabs in particular, were common in both years (Table 42-11), but snails and limpets were much less abundant than at the upper and middle elevations.

MPS4, North Head.

This site is located in a small bight on the west side of North Head. The upper elevation is characterized as pocket beach with pebble-sized gravel and is contained by a rocky outcrop to the west (Photo 42-17). Detailed data were not collected from the upper elevation at MPS4 in 2004, although anecdotal information indicated a high cover (up to 80 percent) of barnacles, while rock crevices contained mussels, drills, limpets, and sea stars. In 2005, a permanent transect was established on the bedrock outcrop west of the beach and resampled in July 2008. Rockweed was the primary vegetation present covering 33 percent of the bedrock surface in 2005 and twice that (66 percent) in 2008 (Table 42-12). The black lichen *Verrucaria* sp. provided 5 percent cover in 2005 but was not recorded in 2008 when the encrusting red alga *Hildenbrandia rubra* had 12 percent cover. Barnacles were the only common sessile invertebrates covering approximately 27 percent of the substrate in 2004 and 43 percent in 2008. The motile periwinkle, *L. sitkana,* was abundant (827 per square meter to 1,116 per square meter) and limpets and drills were common (Table 42-12).

The middle elevation at MPS4 consists of a boulder/cobble substrate set in a sandy matrix. Rockweed dominated in both years surveyed, with coverage increasing from 16 percent in 2004 to 46 percent cover in 2008 (Table 42-13). Trends in the remaining algae were less consistent and red algae, encrusting red algae, and the green alga *Acrosiphonia* sp. all increased in abundance between 2004 and 2005 (Table 42-13). However, all of these taxa were less abundant or absent in 2008. Both sessile and motile invertebrates were scarce at the middle elevation.

The lower elevation, as with the middle elevation, is characterized as a boulder/cobble substrate set in a sandy matrix. In 2004, rockweed was the dominant vegetation at this elevation (27.7 percent cover), along with, to a lesser extent, the filamentous green alga *Acrosiphonia* sp. and the red algae *Palmaria* spp. (Table 42-14). In 2005, the vegetative cover was quite different (Table 42-14) and substrate dependent. In the boulder/cobble habitat, *Palmaria* spp. were the most abundant taxa. In the habitat characterized by boulder/cobble substrate mixed with sandy matrix, the green alga *Ulva linza* was common, as was kelp (*Saccharina latissima*; 11.7 percent cover) and rockweed (37.9 percent cover). This difference in algal cover based on proximity to sand suggests a dynamic system subject to a high degree of interannual variability possibly linked to large-scale weather patterns. Both sessile and motile invertebrates were relatively scarce and scattered in both years with hermit crabs, snails (*Lacuna* sp.), and limpets present in both years (Table 42-14).

MBSA1, Beach Seine Site (AC Point).

MBSA1 is on a bedrock face at the south end of the AC Point beach seine site (Figure 42-1B). Only the steep upper bedrock face was sampled in July 2005 and 2008. The site was nearly devoid of algae, with only three taxa present; total algal cover (including the black lichen *Verrucaria* sp.) did not exceed 1.0 percent in either year (Table 42-15). Among sessile fauna, barnacles were abundant, with *S. balanoides* covering an average of 45 percent of the substrate in 2005 and 62 percent in 2008. Likewise, the periwinkle *L. sitkana* was abundant, averaging 702 per square meter in 2005 and 1,327 per square meter in 2008. Very few limpets were present in 2005 and none were seen in 2008.

MSI, Scott Island.

This site near the entrance to Iniskin Bay (Figure 42-1B) like MPS1A was previously sampled in 1978 (Lees et al., 1980) and in 1996 (Pentec, 1996).

The upper elevation lies approximately at +6 to +7 feet MLLW along a flat bedrock bench (Photo 42-4). In June 1978, vegetative cover displayed a pattern of brown and red algal abundance similar to that seen in the 2004 through 2008 summer surveys; brown algae (primarily rockweed) were two or more times as abundant as the red algae (Figure 42-2). In contrast, in June 1996, red and brown algae were nearly equal in abundance. In April 2006, rockweed had only 19 percent coverage (probably as a result of winter ice); while red algae only had 7.2 percent cover (Table 42-16). However, somewhat higher early spring cover by rockweed at upper elevations at this site compared to the Knoll Head sites may reflect less ice damage on this side of Scott Island, which is more removed from sources of ice from within Iniskin Bay. The red alga *N. oregona* was remarkably constant from 1996 through 2008 samplings ranging only from 7 percent cover (April 2006) to 12 percent (June 1996). Barnacle coverage also was fairly similar from 1978 through 2008 (between 8 and 14 percent, except for very low cover in September 1978 and 2004) (Figure 42-3). The sponge *Halichondria panicea* and the pulmonate snail *Siphonaria thersites* were common at this elevation in 1978 (Lees et al., 1980), and *Siphonaria* was abundant (nearly 20 per square meter) in 1996, but neither species occurred in sampling after 1996.

At the middle tidal elevation at Scott Island (Photo 42-5), vegetative cover was relatively similar in 1978 and 1996, with Rhodophyta (mostly *Palmaria* spp.) being most abundant (>80 percent cover) and the other macroalgal groups providing about 10 percent coverage each (Figure 42-2). In September 2004, Phaeophyta and Rhodophyta were nearly equal in abundance, with the increase in Phaeophyta driven by rockweed (Table 42-17). In 2005, the trend of increasing importance of rockweed continued, with increases in coverage by Rhodophyta noted as well. The apparent increase in total algal cover in 2004 and 2005 relative to 1996 may reflect a seasonal pattern, with the lowest total cover seen in April (2006) followed by early June (1996) and July (2005) when coverage peaked. Declining algal cover in early September (2004) is commonly observed in northern temperate waters, including lower Cook Inlet (Lees et al., 1980). In July 2008, the relative amounts of red and brown algae had returned to the 1978 and 1996 pattern (Figure 42-2).

Sessile invertebrates were low in coverage at the middle elevation compared to the upper elevation, and the limpets that were present in 1978 and 1996 were absent in subsequent sampling. Barnacles were present in very small numbers in mid to late summer (2004, 2005, 2008), but were completely absent in 1978 (April through September), June 1996, and April 2006 (Table 42-17; Figure 42-3). The sponge *Halichondria* sp. was rare but present in June 1978 (Lees et al., 1980), was common (2.4 percent cover) in June 1996 (Pentec, 1996) and July 2008, but was much more abundant in 2004 and 2005 (over 7 percent in both years; Table 42-17) during the period of high rockweed abundance at this elevation. Other than this sponge, most animals were absent in April 2006. Once again, these results must be considered in the context of seasonal patterns.

In all years, the low-elevation station at Scott Island was dominated by red algae (especially *Palmaria* spp. but including many genera) and kelp (especially *Saccharina* spp. but with considerable amounts of *Alaria* sp. and rockweed). Green algae (*Ulva* or *Ulvaria* spp., *Acrosiphonia* sp., and others) also were generally common through September 2004, but were less common subsequently (Figure 42-2). Total algal cover was highest in the Pebble Project study in July 2008 (Table 42-18); Lees et al. (1980) clearly showed that the peak in algal growth at this (and other) stations in the IIE occurred in mid-summer (June or July; see Figure 42-7). Sessile invertebrates were generally rare at this elevation. Motile taxa were never abundant at the lower elevation (Figure 42-3), but a considerable diversity of taxa was present, especially in September 2004 (22 taxa), reflecting the diversity of microhabitats present (boulder, bedrock, tide pool, sediment; Photo 42-6). The small snail *Lacuna* sp. was the most abundant animal counted in the low-elevation Scott Island surveys (137 per square meter in September 2004; Table 42-18).

42.7.1.2 Soft (Gravel, Sand, Mud) Intertidal Benthos

The distribution and abundance of animals living upon (epibenthos) and within (infauna) unconsolidated beaches of uniform or mixed gravel, sand, and silt or mud (referred to as “soft” or “mixed-soft” substrates) are a function of elevation, sediment grain-size distribution, circulation patterns, wave action, delivery of organic carbon, and icing. This section focuses on the habitat conditions and associated biota at several soft and mixed-soft habitats in the IIE. The results of the chemical analyses of sediment samples are discussed in Chapter 35, Section 35.4. Grain size, TOC, and TKN data were highly variable and showed no consistent correlations with the infaunal statistics. Those data are not reported in detail in this chapter.

Habitat Descriptions and Epibiota

MBSA1, (AC Point). The steep gravel beach that surrounds AC Point intersects the broader mudflat of central Iliamna Bay at about +2 to +4 feet MLLW. Sediment samples from this station were collected at approximately +1 foot MLLW in the sheltered flat through which the outflow from AC Point Lagoon flows at low tide. This flat is silty sand with inclusions of gravel and occasional broken cobble-sized rock and little epibiota was apparent during any visit.

MPS1A, (Knoll Head West). Only small pockets of gravel or sand habitat are found on the basically rocky intertidal substrate at MPS1A. Sediment samples for infaunal analyses (Table 42-1) were taken from a small pocket beach of sand and gravel east of the rocky site described in Section 42.7.1.1. The elevation was approximately –2 feet MLLW; little epibiota was apparent during any visit.

MPS2, (Southwest Iniskin Bay). Infauna samples (Table 42-1) from the middle elevation were taken at the break between the mudflat and the rocky middle elevation described in Section 42.7.1.1. Lower-elevation samples were taken on the broad mudflat at a tidal elevation of approximately –0.5 feet MLLW (Photo 42-15, bottom right).

The mudflat at MPS2 is relatively uniform in substrate (fine sand and mud) and texture (small ripple marks) with occasional low-density patches of eelgrass. The mudflat slopes very gradually toward the central channel of Iniskin Bay to the east. Few animals were present on the sediment surface except near widely scattered large boulders. The mud surface had scattered holes presumably (based on previous sampling in the area) made by polychaetes, the bivalve *Mya* spp., and the spoonworm *Echiurus echiurus*. Macroalgae were sparse and scattered, and composed mostly of the kelp *Saccharina latissima* and green algae *Ulva* spp.

MPS3, (Diamond Point). Sediment samples for infaunal analyses (Table 42-1) were taken about mid-way along the face of the beach that arcs northwest into Cottonwood Bay from Diamond Point (Figure 42-1B). Middle-elevation samples were taken from the upper mud and sand flat, just below the break in slope (about +1 foot MLLW) from the moderately sloping middle and upper sandy-gravel beach. A single excavation of about 1/16 square meter in this area yielded seven *Echiurus*, three polychaetes (*Nephtys* sp.), and one bivalve (*Mya* sp.; 112, 48, and 16 per square meter, respectively).

Low-elevation infaunal samples were taken in 2004 only from a soft mud ridge at the lower elevation (about –1 foot MLLW) on the broad flat (Photo 42-18) that extends west into Cottonwood Bay from the rocky sampling site at Diamond Point. The flat includes a mix of relatively firm and relatively soft mud and sand, with standing water over much of the surface at low tide and many drainage channels. The flatter and firmer areas with standing water supported substantial patches of eelgrass. Macroalgae were found only occasionally when a hard substrate such as a stray cobble or boulder was available and included the green algae *Ulva* sp., *Ulva linza*, and *U. intestinalis;* the kelp *Saccharina* sp.; tufts of filamentous red algae; and the saccate red alga *Halosaccion firma*. Also on the boulders were the green sponge *Halichondria panicea*, along with mussels, barnacles (*S. balanoides*), and their predator, the drill *Nucella lima*. Other macrofauna noted or indicated in the soft sediments during the survey included fecal mounds indicative of the polychaete *Abarenicola pacifica* and siphon holes of the clam *Mya* sp. Also noted were numerous nemerteans (*Paranemertes peregrina*), hairy hermit crabs, and in shallow surface water, small cottid fish (Cottidae), probably *Clinocottus acuticeps*. Larger infauna was sampled on middle elevation mudflats just northeast of the rocky intertidal site (background in Photo 42-18, bottom).

MPS4, (North Head). Sediment samples for infaunal analyses (Table 42-1) were taken at the middle elevation at MPS4 in 2004, 2005 and 2008. These samples were taken to the south of the area sampled for epibiota (described in Section 42.7.1.1) near MLLW. In 2004 and 2005 they were taken just below the break in the gradient between the upper, more steeply sloping gravel beach (Photo 42-17) and the lower boulder-strewn sand flat. In 2008, because of poor tides, the middle intertidal location was sampled above MLLW in silty to coarse sand. Small worm burrows and fecal mounds were present.

MPSE, (Williamsport area existing port site). The inner (northern) portions of Iliamna Bay consist of a continuation of the large mudflats that extend northward up the bay beginning at Diamond Point. At low tide, the majority of these flats are exposed, except for a drainage channel that carries the outflow from the several freshwater streams entering the bay. In general, this channel is east of the centerline of the bay. Very small patches of eelgrass were seen widely scattered over the inner third of this area during the August 2004 survey (Photo 42-19), and patchy eelgrass was reported in the area by the CIRCAC habitat surveys (CIRCAC and EVOS, 2005).

Infauna samples from MPSE were taken in 2004 and 2008 at a middle tidal elevation (approximately +6 to +7 feet MLLW) from the central mudflat south of the points of land that demarcate the entrance to the Williamsport Channel. These samples were located west of the central drainage channel. In 2005, the infauna samples were collected at a somewhat higher elevation (approximately +8 feet MLLW) near the rocks that lie just south of the western of these two points. A second location east of the central channel (MPSE2) was sampled in 2008 to expand our understanding of the mudflat area. This sample location, although north of MPSE, also is part of the large mudflat leading to Williamsport and is characterized as silty/muddy sand with a robust soft sediment bivalve population as indicated by siphon holes and shell debris in the sediment. This eastern mudflat habitat is not as broad as the mudflat west of the low tide drainage channel.

MBB, (Blackie Beach). Blackie Beach lies in a bight, partially protected by Scott Island and the Mushroom Islets, on the eastern side of the entrance to Iniskin Bay (Figure 42-1B; Photo 42-3). In earlier studies, this beach was sampled in the 1970s (Lees et al., 1980) and in 1996 (Pentec, 1996). The upper beach is a relatively long and uniform sand and gravel beach that transitions into a very broad and firm sand flat at about MLLW. The location sampled in 2004 was as near as possible (with the aid of photographs) to the location sampled in previous work (Photo 42-3) and lies at about –0.5 feet MLLW. In 1996, eelgrass coverage was 21.4 percent at this station (Pentec, 1996)—a sharp contrast to the less than one percent eelgrass coverage seen in 2004. Eelgrass cover remained low (although it was not measured) in 2005, but rebounded to 56 percent cover in 2008 (Table 42-19). There was considerable evidence of recent beach erosion in 2004, with remaining patches of eelgrass elevated above the surrounding beach and many dead articulated *Mya* sp. shells still oriented vertically at the sediment surface.

Intertidal Macroinfauna

Dominant Infauna. Polychaete worms dominated the intertidal macroinfauna numerically (Table 42-20). Polychaete worms of the genus *Nephtys* (three species) were abundant at most stations, but smaller polychaetes of the families Cirratulidae (*Chaetozone* sp.), Cossuridae (*Cossura* sp.), Orbiniidae (*Scoloplos armiger*), Paraonidae (*Aricidea lopezi*), and especially Spionidae (*Pygospio elegans* and *Polydora* sp.) also were numerically important. Macroinfaunal densities increased in 2005, primarily as a result of large increases in a few worms (e.g., *Polydora* sp. at MBB-Low and MPS3-Low).

In 2008, there was an increase in infaunal density at several Iliamna Bay locations, mostly attributed to a high abundance of *Macoma balthica* at MPS3-Mid (1,756 per square meter), MPSE (1,667 per square meter), and MPSE2 (2,578 per square meter), along with several annelid species at MPS4 and MPS3-Mid (Table 42-20). At MPS4-Mid, dominance by polychaetes in 2004 shifted to co-dominance with the diminutive bivalve *Mysella planata* in 2005, and to dominance by Oligochaeta with 2,178 individuals/ square meter in 2008 (Table 42-20). (Note that *Lacuna* and *Littorina*, the primarily epibenthic gastropods, were included in the infaunal statistics because they were closely associated with the sediments).

Based on biomass (Table 42-21), infauna was dominated by larger taxa such as the polychaete *Nephtys* spp. in Iniskin Bay, and the bivalve *Macoma* spp. in Iliamna Bay in 2004. This dominance by annelids in Iniskin Bay continued at MBB and MPS2 in 2005 and 2008. In Iliamna Bay, there was a noticeable decrease in molluscan biomass at MPS4 in 2005 and molluscs were not encountered at this site in 2008, likely due to the change in sample location. At MPSE-Mid, infaunal biomass dropped by an order of magnitude in 2005, reflecting reduced biomass of the bivalve *M. balthica* (Table 42-20); this drop likely resulted from the fact that, because of tidal conditions, only a somewhat higher elevation was accessible for sampling in 2005. Biomass rebounded in 2008, when the approximate elevation sampled in 2004 was resampled and showed an almost three-fold increase in molluscan biomass from the 2004 sampling. In 2008, an MPSE2-Mid intertidal station was added just northeast of MPSE and east of the channel draining Iliamna Bay (Figure 42-1B). Molluscs dominated these middle intertidal cores, with annelids comprising only a small fraction of the biomass (Table 42-21); species composition and relative abundance was generally similar to that at MPSE (Table 42-20).

In 2004, average infaunal abundance ranged from 222 per square meter in relatively high energy sand at station MPS1A-Mid to 2,178 per square meter in more sheltered silty sand at MPS4-Mid (Table 42-22). In 2005, average total infaunal abundance exhibited a wider range, from 133 per square meter at station MPS1A-Mid to 4,911 per square meter at MBB-Low (Table 42-22). In 2005, abundance tended to be more variable among sites and between cores (replicates) within sites. Average abundance was much higher in 2008 at several stations; exceptions were seen at MBB-Low and MPS3-Low both of which decreased by an order of magnitude from 2005. In the case of MPS3-Low, this reduction likely resulted from the fact that the 2008 tides dictated sampling at a higher and more energetic part of the beach.

In 2004, average wet weight biomass ranged from 3.1 grams per square meter for MPS1A-Mid to 2,562 grams per square meter for MPS4-Mid (Table 42-22). Average overall biomass for 2005 compared to 2004 exhibited a mixed pattern, with half the sites (MPS1A-Mid, MPS2-Low, and MPS3-Low) showing increases, and the other half (MBB-Low, MPS4-Low, and MPSE-Mid) showing decreases. These changes were mostly linked to the relative abundance of bivalves at these sites. The average biomass between 2005 (wet weight) and 2008 (dry weight) was also a mixed pattern, with MBB-Low, MPS2-Low and MPS4-Mid showing marked decreases that are difficult to interpret because of the change to dry weight measurements in 2008. In contrast, MBSA1-Mid, MPS3-Low and MPSE-Mid showed large increases of anywhere from 4 to 9 times the previous sampling averages despite the change to dry weight measures (Table 42-21). Change of this magnitude (an order of magnitude, if an 8 wet to 1 dry weight ratio is assumed) also is attributed to changes in the relative abundance of bivalves at these sites and, at MPS1A-Middle, by the additional presence of gastropods in 2005 that were absent in 2004.

Species Richness and Diversity. The average number of infaunal taxa observed per core in 2004 ranged from 1.6 taxa for MPS1A-Mid and MPS2-Low to 8.0 taxa at MPS4-Mid (Table 42-22). In 2005, the number of taxa increased nearly three fold from 2004 at MPS3-Low and decreased over a two fold from 2004 at MPSE as a result of the higher elevation sampled; other stations changed little. Interestingly, the change in biomass at several sites resulted primarily from changes in mollusc density and size, and the number of taxa did not change concomitantly with biomass at these sites. Similarly, order-of-magnitude changes in biomass between years were accompanied at several sites by only proportional changes (less than one order of magnitude) in overall density. In 2008, the average number of species/core ranged from 1.6 at MBB-Low to 14.2 at MPS3-Mid. The drop at MBB-Low was a large change from the 2005 (and 2004) numbers, as were the decreases at MPS 4-Mid and MPS3-Low. Species numbers at all other stations were substantially greater in 2008 than in previous samplings.

Two estimates of point (not integrative) numerical diversity were calculated, Simpson’s dominance and Shannon diversity indices. In 2004, Simpson’s dominance index ranged from 0.24 at station MPS4-Mid—a low value of dominance indicative of the presence of several numerically abundant taxa—to 0.84 at station MPS2-Low—a high value of dominance indicative of the presence of one or few numerically dominant taxa (Tables 42-20 and 42-22). For 2005, the overall range in values (0.26 to 0.94) was slightly larger than in 2004. As seen in Table 42-20, MPSE-Mid was largely dominated by Oligochaeta, with only two other taxa present in low abundance, resulting in a high value of dominance, 0.94 (Table 42-22). Conversely, MPS3-Low had a low value of dominance, 0.26 (Table 42-22), because of the large number of abundant species (Table 42-20). In 2008, the range of dominance values was similar to that in previous years with *Macoma balthica* abundances driving the dominance index values at MPSE-Mid (0.49) and, in particular, at MPSE2-Mid (0.74). Also, MPS4-Mid was largely dominated by Oligochaeta, resulting in a dominance value of 0.80 (Table 42-22).

Over all three years of sampling, mean values of Shannon diversity were low at all sites, ranging from 0.11 at MPSE-Mid in 2005 to 1.89 at MPS3-Mid in 2008 and indicating low diversity with dominance by few taxa. Within sample locations there were, however, large differences in Shannon diversity among years. At all sites, mean values of Shannon diversity reflected differences in the mean number of taxa. At MPS3-Low, Shannon diversity increased from 1.13 in 2004 to 1.76 in 2005 and then decreased again in 2008 to 2004 values (0.93). Shannon diversity did not differ between 2004 and 2008 at MPS3-Mid (no samples in 2005). At MPSE-Mid, Shannon diversity decreased from 0.76 in 2004 to 0.11 in 2005 (when a higher elevation was sampled) and then increased again to 2004 values in 2008 (1.09). At MBSA1-Mid, Shannon diversity increased from 1.12 in 2005 to 1.84 in 2008 (no samples in 2004). At both MPS4-Mid and MBB-Low, Shannon diversity was similar in 2004 and 2005, but decreased in 2008. There were no relative differences in Shannon diversity values among years within sites MPS1A or MPS2-Low.

Multivariate Analysis. The Bray-Curtis coefficient (Bray and Curtis, 1957) was used to calculate similarity matrices for ordination. In 2004, infaunal species abundance was highly variable among replicates within stations (Figure 42-8a). Only a small number of replicates had greater than 60 percent similarity based on the relative abundances of species. The only site that appeared to be fairly homogeneous between replicates was MPSE-Mid (Figure 42-8a). MPS3-Low and MBB-Low had a few replicates with greater than 40 percent similarity, but overall, the replicate sites sampled in 2004 appeared to be quite dissimilar from each other at the species level. In contrast, most replicates and most stations sampled were at least 60% similar in the similarity matrix for relative abundances of each functional group (Figure 42-8), a broader classification than phylogeny or species composition that takes into account ecological relationships among species, e.g., similar mollusc species share the same functional group. This similarity in functional group occurrence and abundance among samples shows that many species occupy similar niches or provide similar ecosystem services (i.e., species substitution in these systems may yield little if any change in ecosystem function and such substitutions may be a regular occurrence due to annual ice scour). In lower Cook Inlet, these functionally redundant species also tend to have clumped distributions (e.g., several species of suspension feeding bivalves). Replicates at station MPSE-Mid differed from other replicates both in species abundances and in functional group abundances. This difference occurred because MPSE samples in 2004 and 2008 were taken from the center portion of the broad mudflat in the inner third of Iliamna Bay while the 2005 samples were taken from nearshore intertidal area, which clearly supports a different fauna. Most other stations and replicates formed into groups at 60 percent similarity, although a few other groups formed only at 40 percent similarity.

Replicates within each station were more similar in 2005, with greater than 40 percent similarity in most pairwise comparisons and in some cases 100 percent similarity between replicates both for relative species abundances and relative functional group abundances (Figure 42-9a). Among stations, however, few samples are even 40 percent similar in relative species abundances. Similarities between stations with similar environments (i.e., tide height, beach structure, etc.) were expected, but this did not seem to be the case for species abundance. This lack of similarity between stations in similar environments also emerged for several of the mid-intertidal stations based on functional group classifications (Figure 42-9b). Much like the 2004 sampling, MPSE-Mid did not show much similarity to any of the other stations, and there was a shift at MPS2-Low away from the infaunal communities of the other low-intertidal sites. In general, the infaunal assemblages did not appear to be as similar between stations in 2005 as they were in 2004.

In 2008, replicates within each station were more similar than in previous years, both in relative species abundance and in functional group abundance. Similarities among stations also were greater than in previous years, with many pairwise comparisons more than 40% similar in relative species abundances, e.g., similar pairs of stations included MPS3-Mid and MBSA1-Mid; MPS3-Low and MPS4-Mid, MPS2-Low, and MBB-Low; and most notably, MPSE-Mid and MPSE2-Mid (Figure 42-10a). A number of interesting patterns were revealed by analyzing the assemblages by the relative abundance of functional groups. Infaunal assemblages in 2008 were quite homogeneous across stations, with the majority of replicates having at least 40 percent similarity to other similar intertidal zones (i.e., mid-intertidal stations or low-intertidal stations; Figure 42-10b). An exception to this, MPS4-Mid (placed in a relatively clean sand substrate) did not show similarity to the other middle intertidal stations; even more interesting was that MPS3-Mid-Rep2 was the most similar to MPS4, but was dissimilar from the other four mid-intertidal stations (Figure 42-10b). This was due mainly to the absence of bivalves and large polychaete worms in these samples and to the dominance of small worms and small crustaceans in 2008. Another striking result was the lack of similarity between the MBB-Low assemblage and all of the mid-intertidal stations. Of the 125 middle intertidal replicate pairings, there were only 12 with 40 to 59 percent similarity to an MBB replicate; this is likely due to dominance by small worm species.

Interannual variability at stations sampled in all 3 years showed little similarity in relative species or functional group abundances between years. Only MPS4-Mid exhibited greater than 60 percent similarity between 2004 and 2005 (Figure 42-11a). This suggests that from year to year, the macroinfauna community experiences large shifts in abundance and composition. Interannual variability by functional groups showed much more overlap between years and between stations, as well. In fact, MPS4-Mid was the only station that did not have at least 40 percent similarity between all years sampled (2004 and 2008 were dissimilar, probably because of variation in specific locations sampled) (Figure 42-11b). This suggests that, although the macroinfaunal community experiences shifts in species abundance from year to year, the overall community remains fairly stable from a functional group perspective. This suggests broad functional redundancy within a species-group and reflects the clumped distribution of individuals in those groups.

Intertidal Megainfauna

Larger intertidal infauna was sampled by excavating 0.25-square meter quadrats to approximately 30 centimeters deep, and sieving the sediment through a 7.0-millimeter-mesh screen. One or two samples were taken at each of three stations (MBSA1, MPS2, and MPS3-Low) in July 2005 (Table 42-1).

The three stations exhibited marked differences in both abundance and diversity of megainfauna. In 2005, Diamond Point (MPS3-Low, n=1) had the highest diversity and biomass with 22 taxa contributing to an average biomass greater than 2,364 grams per square meter. Both MBSA1 (n=2) and MPS2 (n=1) had at least an order of magnitude lower average abundance and average biomass in 2005 (Table 42-23). In 2008, MBSA1 (n=2) had the highest diversity with 10 taxa contributing to an average biomass of 240 grams per square meter and 290 individuals per square meter, but average biomass of the MPS3-Mid sample (n = 1) was an order of magnitude higher at 1,147 grams per square meter (Table 42-23).

Overall, megainfauna samples were dominated by molluscs, both in biomass and in numbers (Table 42-23) and comprising mainly the deposit-feeding and suspension-feeding bivalves of the genera *Macoma* and *Mya*, respectively, both of which are commonly found in soft-sediment habitats in Cook Inlet (e.g., Lees et al., 1980). A distant second in overall dominance were the annelids, mainly larger worms from the genus *Nephtys,* which were more evenly distributed among sites than the molluscs. At MBSA1 in 2005, a single sand lance (*Ammodytes hexapterus*) was found in one of the excavations. Sand lance is a species of high importance in local and regional food webs that commonly seeks refuge by burying itself in soft sediments. In addition, a large proportion of the miscellaneous biomass recorded for MPS2 in 2005 and MBSA1 in 2008 was contributed by Alaskan spoonworms (*Echiurus echiurus alaskanus)*, which play an uncertain role in area ecology.

Most interesting are the differences in taxa recorded at MBSA1 versus MPS3-Low. Of the 22 taxa recorded at MPS3-Low and the six taxa recorded at MBSA1 in 2005, only two, both of which were annelids (unidentified Polychaeta and *Nephtys* sp.), occurred at both locations. These two stations lie on opposite sides of Iliamna Bay; MPS3-Low, along the western shore, has a more heterogeneous habitat type of mixed gravel and cobbles in a sand/mud matrix, and MBSA1, while it has a similar substrate, is influenced by freshwater runoff from AC Point Lagoon. In 2008, the mollusc *Macoma balthica* occurred at all three locations, suggesting this species has a wide range of tolerances for habitat and substrate types. Note that MPS3-Low was not sampled in 2008.

Diversity and multivariate analyses were not performed on these samples because of insufficient sample size. This does not discount the qualitative differences noted above.

42.7.2 Subtidal Studies

Subtidal benthic studies in 2004 and 2008 consisted of diver transects and van Veen grab sampling of sediments (Photo 42-10). In addition, water samples were collected with a Van Dorn bottle for the water quality study (Chapter 34), and offshore bottom trawling was conducted for the nearshore fish and invertebrates study (Chapter 43). A cross reference between scientific and common names of subtidal species is provided in Appendix 42C.

42.7.2.1 Subtidal Diver Transects

In 2004, six diver transects were completed near stations MPS1, MPS2, and MPS4 and at White Gull Island (Figure 42-1B) during the last three days of August 2004. (No diver transects were conducted in the vicinity of MPS3 because of the shallow depth, fine mud substrate, and limited in-water visibility [generally less than 1 foot]). In 2008, five transects were completed in the vicinity of MPS1, MPS3, MPS4, and MTR1 on July 12 and 14. Adverse weather precluded additional diving work. The results of the diver surveys are briefly summarized below and are presented in detail in Appendix 42C (also see Photos 42-20 through 42-28).

MPS,1 (Knoll Head.

Two transects were surveyed at MPS1 on August 29, 2004.

The first transect ran for almost 800 feet perpendicular to shore at water depths of −11.2 feet to –49.6 feet MLLW. Sea stars of the genus *Leptasterias* were the dominant epifaunal organisms and occurred on mixed sand/gravel/cobble substrates near shore and on mostly gravel substrate at the deep end of the transect. Other animals abundant at the site included dense mats of tubicolous suspension-feeding sabellid polychaetes, predominantly *Schizobranchia insignis* (Photo 42-20), hermit crabs (*Pagurus beringanus*, *Elassochirus* spp.; Photos 42-21 and 42-22), and sea stars (*Crossaster papposus, Henricia leviuscula)*.

The second transect at MPS1 ran 437 feet and was conducted parallel to shore at –15.2 to –16.9 feet MLLW, with the southern terminus of the transect being approximately at Entrance Rock. Mats of tubeworms (probably *S. insignis*, Photo 42-20) were patchy on a gravel substrate. Other common animals were rock jingles (*Pododesmus macroschisma*), chitons (*Tonicella lineata*, *T. insignis*, and *Mopalia ciliata*), and crabs (*Pagurus* sp., *Cancer oregonensis, Hyas lyratus, and Pugettia gracilis*).

Adverse wind conditions prevented revisiting this transect in 2008.

MPS1B, (midway between MPS1 and MPS2).

The diver transect surveyed in August 2004 at MPS1B (approximately midway between MPS1 and 2; Figure 42-1B), was almost 670 feet long and stayed near shore between +1.6 feet and −10.8 feet MLLW. An orange sponge, possibly *Esperiopsis* sp., was the most abundant organism present on a mixture of substrates from sand/silt to gravel and boulders. Patchy mats of what appear to be tubeworms (possibly *S. insignis*; Photo 42-20), hermit crabs (Photos 42-21 and 42-22), blue mussels (*Mytilus trossulus)*, Arctic surfclam (*Mactromeris polynyma*), and the cockle *Clinocardium nuttallii* also were present. Divers experienced very strong currents on this transect during a flooding tide.

In July 2008, a transect near the 2004 transect was begun in the deep hole off MPS1 at −50 feet MLLW and continued up to –4.2 MLLW. The substratum was relatively uniform along this transect (Table 42-2) and comprised a relatively steep slope of fine unsculptured mud with scattered cobbles and small boulders, probably erratics that fell from the bottom of ice floes. Water depth ranged from −50.2 to –4.2 feet MLLW.

Divers observed only 15 taxa on this transect. The most common species was the hermit crab *Elassochirus tenuimanus.* Uncommon taxa included two taxa of both sponges and sea anemones, immature specimens of barnacles covering an appreciable portion of the surface of the erratic cobbles, a few more species of hermit crab, and uncommon colonies of the fleshy moose-horn bryozoan (*Alcyonidium* sp.). Fishes were apparently very uncommon; only a few small structure-associated or benthic fish species were observed, mostly whitespotted greenling (*Hexagrammos stelleri*), starry flounder (*Platichthys stellatus*), and unidentified juvenile flatfishes.

No organisms were particularly important on this transect; community structure, species richness, and diversity, and trophic structure were highly impoverished, probably as a consequence of the combination of strong tidal currents, sediment instability, and high turbidity.

MPS2, Southwest Iniskin Bay.

The diver transect at MPS2 in 2004 ran for approximately 310 feet perpendicular to shore at depths of –10.6 feet to –33.5 feet MLLW. This was the shortest diver transect because visibility at deeper than –20 feet MLLW was too limited to adequately characterize the transect. Divers had difficulty seeing their gages below the 20-foot depth. Because of poor visibility (1 to 2 feet), only barnacles (*Balanus* sp.) and bryozoans (Flustrellidae) were observed on sandy gravel substrate.

MPS4, North Head.

The transect sampled at MPS4 (North Head) in 2004 ran from –7.8 feet to –19.6 feet MLLW (Photos 42-23 through 42-25). Numerous nudibranchs (*Onchidoris bilamellata*) occurred on sandy substrate with boulders interspersed nearshore and on a sand/silt bottom at greater depths. Other animals prevalent at this location were sea stars (*Leptasterias spp*. and *Henricia leviuscula*) and polychaetes (*S. insignis* and *Potamilla* sp.). This transect was more than 1,200 feet long and was the longest of the transects sampled in the IIE in August 2004.

White Gull Island.

The diver transect near White Gull Island in 2004 was more than 400 feet long and ran from depths of –3.5 feet to –27.3 feet MLLW (Photos 42-26 through 42-28). The shallow end of the transect was in boulders that transitioned to gravel substrate at greater depths. Animal and algal diversity was high relative to other subtidal areas in the IIE, with several taxa being very abundant. These abundant taxa included brown algae (*Alaria* sp., *Agarum* sp., and *Saccharina* spp.), sea stars (*Leptasterias* spp. and *Henricia leviuscula*), the brittle star *Ophiopholis aculeata,* chitons (*Mopalia ciliata, Tonicella lineata*, and *T. insignis*), the nudibranch *Onchidoris bilamellata,* and the hermit crab *Pagurus beringanus*.

42.7.2.2 Subtidal Infauna

Dominant Infauna

A station in Cook Inlet just outside (south) of the IIE was sampled in 1976 by Feder et al. (1980a; Station 54). This station was numerically dominated by the polychaetes *Lumbrineris zonata*, *Lumbrineris* spp. *Prionospio* sp. (likely *P. steenstrupi*), and *Magelona japonica* (Feder et al., 1980a). In terms of biomass, the polychaetes *Nephtys rickettsi* and *Praxillella gracilis,* and the bivalve *Macoma moesta alaskana* were dominant.

At the stations sampled in 2004 in the IIE, average abundance and average biomass varied substantially among stations (Table 42-24). Sites sampled in 2004 were numerically dominated by the polychaete worms *Ampharete* sp., *Lumbrineris luti*, *Prionospio steenstrupi*, *Scoloplos armiger, Spiophanes bombyx*, and an unidentified terebellid. By biomass, dominants included the bivalves *Ennucula tenuis*, *Macoma* sp., and *Yoldia hyperborea* and polychaetes of the genera *Nephtys* and *Lumbrineris* and the Family Terebellidae.

Average abundance at the stations (all taxa) ranged from 2,210 per square meter for MPS2 to 5,150 per square meter for MOPP1 (Table 42-24). Biomass ranged from 25.9 grams per square meter in the single grab at MOPP1 to 298 grams per square meter for MPS1. The number of taxa observed ranged from 26 for MPS4 to 40 for MPS1.

Most sites sampled in 2004 shared five to six dominant genera with the reference Station 54 sampled in 1976. Only MOPP1 demonstrated extreme difference when compared to the reference site, sharing only three genera. Of the numerically dominant genera among the 2004 sites, the polychaete genera *Leitoscoloplos* and *Lumbrineris* were found at all four sites. These same two genera also were dominant in terms of biomass, along with the clam *Ennucula*. The genus *Macoma* was found in three (all except MOPP1) of the four sites sampled in 2004 and, when present, ranked quite high as a dominant contributor to overall infaunal biomass but was not among the top ten abundant species at any of the sites (Tables 42-25 and 42-26).

In 2008, a slight shift occurred in the worm assemblage with *Nephtys caeca* and *Scoletoma luti* ranking in the top five most abundant species found at the three stations sampled (Table 42-25). Both the average biomass and average abundance decreased by at least 50 percent from the 2004 to 2008 samplings (Table 42-24). This decline could simply be interannual variability or may be the result of small scale differences in exact sampling locations. Regardless, these populations seem very dynamic and heterogeneous in distribution between years without any local anthropogenic influences. At MPS1, there was a shift from molluscs to annelid worms dominating the biomass (Table 42-26), while the opposite trend was noted at the deeper site, MOPP1, where molluscs remained unchanged and annelid biomass decreased by an order of magnitude from 2004 to 2008.

Diversity

Simpson's dominance ranged from 0.09 at MPS2 in 2004 to 0.27 at MPS4 in 2008 (Table 42-24). Simpson's dominance increased between 2004 and 2008 at MPS4 and MPS1, indicating slightly greater dominance by numerically abundant taxa in 2008. Simpson's dominance did not differ between years at MOPP1 (MPS2 was sampled only in 2004).

Shannon diversity ranged from 1.4 at MPS4 in 2008 to 2.9 at MPS2 in 2004. Shannon diversity decreased at all three stations sampled in 2008 (the fourth station was sampled only in 2004), reflecting marked decreases in the average number of taxa between 2004 and 2008. Overall, subtidal stations had lower dominance by a single species and higher diversity that intertidal stations did (Table 42-22).

Multivariate Analyses

The similarity matrix for the 2004 subtidal infauna replicates showed a high degree of similarity both within sites (replicates) and between stations (Figure 42-12a). All stations had at least one replicate that was greater than 40 percent similar to all other stations, with MOPP1 being the least similar to MPS1 and MPS2. All of the MPS1 replicates were greater than 60 percent similar, indicating high homogeneity within the station. Overall, the similarity between subtidal replicates and stations in 2004 was much higher than seen in the intertidal infauna, indicating a higher variance in habitat type and quality between intertidal stations.

In 2008, there was still a relatively high degree of similarity between replicates, with most pairings within a station having more than 40 percent similarity (Figure 42-12b). The between-station comparisons, however, were not as homogeneous as the 2004 sampling. MOPP1 had very little similarity with either

MPS4 or MPS1, and even the infaunal communities at MPS1 and MPS4 are not as similar as they were in 2004. These are dynamic changes in community similarity between sampling events and may be indicative of populations experiencing modest to high levels of physical disturbance by wave surge or bottom currents on an annual level within the IIE, resulting in an infaunal assemblage with a high degree of interannual variability.

42.8 Summary

The marine benthos component of the Pebble Project environmental baseline studies investigated marine ecological conditions and taxa of the IIE. This work builds on data collected in the IIE during the 1970s under the OCSEAP Program and other investigations in lower Cook Inlet.

42.8.1 Epibiota

42.8.1.1 Intertidal

Field surveys were conducted in late August and early September 2004, July 2005 and 2008, and April/May 2006 to investigate the ecological conditions and typical assemblages along shorelines in the IIE. The different timing of sampling in various years limits conclusions about seasonal changes that can be drawn from these data. However, seasonal data that were gathered at stations in the IIE and elsewhere in Cook Inlet in 1978 (Lees et al., 1980) provide a basis for generalizing about the nature of intertidal epibiotic cycles in the Pebble study area as demonstrated at Scott Island (MSI; Figure 42-7).

Diversity of both plants and animals among the rocky stations tended to decrease with declining wave exposure and salinity and increasing suspended-sediment load. Scott Island and MPS1 (Knoll Head) were the most exposed and had the greatest diversity of algae, with MPS1A (Knoll Head West) only slightly less diverse. MPS2 (in southwest Iniskin Bay) and MPS4 (inside North Head in Iliamna Bay) were intermediate in exposure and richness, while MPS3 (Diamond Point) had the least diverse biota, reflecting its semi-protected location and the influence of higher suspended-sediment loads from Iliamna Bay.

Generally, the intertidal areas sampled represent a wide range of habitat types from bedrock to mudflat. Each habitat type supports a distinct mix of resident organisms that have adapted to the physically rigorous environment in the IIE. For example, ice is a major stressor that, as seen at MPS1 and elsewhere in April 2006 and March 2008, can largely remove sessile epibiota from all rock surfaces except crevices and tide pools; potentially all of the IIE shorelines may experience icing at some point during the winter. The effects of moving ice are exacerbated by swells that repeatedly move the ice against the shore. Ice damage and low light levels combine to greatly reduce intertidal epibiota each winter. For example, the reach of shoreline from the Y Valley creek mouth to North Head has many near vertical rock faces that never develop mature intertidal communities, suggesting a consistent annual scouring by wave-driven ice. Here, and elsewhere, plants generally recolonize the exposed substrate each spring from ice-resistant holdfasts or encrusting life phases, or through settlement of gametes from plankton. In many ice-affected areas, sessile animals persist through the winter in cracks and crevices or under boulders and recolonize from planktonic larvae. More motile animals may also take shelter in cracks, crevices, or under boulders, or may migrate to subtidal areas. They may also recolonize from planktonic larvae. Early in the spring, as light levels increase, algal growth may be preceded by blooms of unicellular diatoms, as was seen in April 2006. These diatoms, some green algae, and early colonizing films of other algae encourage grazers such as limpets and periwinkles to move out of winter refuges to graze. This cycle of spring renewal is followed by an early summer peak in abundances of many algae that then decline after releasing reproductive products.

The periodic monitoring conducted at Scott Island in April through September 1978 (Lees et al., 1980; Figure 42-7) is illustrative of the middle part of this cycle, but winter logistics precluded sampling from October through March. In the 1978 data from Scott Island, the upper-elevation algae are relatively constant over the spring to early fall, while the middle and lower elevations exhibit greater seasonality. Green algae are more abundant in the early part of the season at the lower elevation, while red and brown algae are at highest abundance in July to September.

Each intertidal habitat type provides feeding areas for different pelagic and demersal fish and invertebrates that forage over the intertidal zone during high tides. The estuarine and nearshore rearing habitats of juvenile salmonids are an important component of the intertidal zone, especially for pink and chum salmon that outmigrate from streams along the IIE shoreline and elsewhere in Cook Inlet. Another important component of the intertidal zone is the substrate used for spawning by Pacific herring. In spring 2008, herring spawn was moderately abundant along lower intertidal rocky habitats from Entrance Rock nearly to MPS1, with lesser spawning intensity observed toward the Y Valley lagoon and around Scott Island (see Chapter 43). Spawn was also common on eelgrass in beach drift and in trawl samples during late May and early June. In addition, rearing of larval and juvenile herring resulting from nearby spawning is clearly important along IIE shorelines, as indicated by beach seine sampling (Chapter 43).

At stations in the IIE sampled sporadically since 1978, intertidal conditions had not changed dramatically as of 2004 and descriptions based on previous studies (Section 42.4) remained largely valid. An exception was the apparent shift in algal dominance at middle intertidal rocky stations at Scott Island and Knoll Head West between 1978/1996 and 2004 (Figures 42-2 and 42-4). At these locations, the dominant algae shifted from Rhodophyta, especially *Palmaria* spp.—which are capable of recolonizing rapidly (e.g., from remnant holdfasts) following physical abrasion such as ice scour—to a co-dominance with rockweed, a perennial brown alga that requires a few years without disturbance to reach maturity. This shift suggests that fewer ice-scouring events may have occurred at these sites immediately prior to the 2004 sampling event than occurred prior to either the 1978 or 1996 sampling events (Lees et al., 1978; Pentec, 1996). This co-dominance of red algae and rockweed persisted at the Scott Island middle station through July 2005. In 2005 at Knoll Head West (MPS1A) middle station and in April 2006 and July 2008 at Scott Island middle station, there was a return to red algal dominance. The low cover of rockweed in April 2006 at Scott Island may reflect more severe ice damage over the winter of 2006, although this result must be interpreted cautiously because sampling was performed earlier in the year in 2006 than in the previous two years. Coincident with the shift to rockweed co-dominance with red algae at these two middle intertidal stations, was an increase in the cover by barnacles (Figures 42-2 and 42-3) that are not typically present in these areas, another indication of less ice scouring at these sites prior to sampling in 2004.

42.8.1.2 Subtidal

Six qualitative reconnaissance dives were performed in the IIE nearshore region in 2004 to survey the habitats and benthic assemblages in areas of interest. In general, the water visibility was limited, often less than six feet, because of high turbidity. For the diver transects that were oriented perpendicular to shore, the substrate generally graded from coarsest nearshore to finest offshore, with a mixture throughout. Fauna at the shallowest depths tended to be relatively sparse, presumably because of occasional scouring by ice. Kelp were mainly prevalent closest to shore at MPS4 and White Gull Island, and also at MPS1B, but at relatively low density.

Dominant macroinvertebrates on soft subtidal substrates were mainly a tube-dwelling sabellid polychaete, probably *S. insignis*. Dense mats of this suspension-feeding worm also were present in the IIE area in the 1970s (Lees et al., 1980).

Because coarse substrates predominated on most diver transects, invertebrate fauna was dominated by attached and mobile organisms and not by burrowing infauna. Common attached invertebrates included sponges, hydroids, sea anemones, the rock jingle, and bryozoans. Common mobile invertebrates included several species of snails, chitons, nudibranchs, crabs, and sea stars.

Few demersal fish were observed on diver transects, while more bottom-oriented fish like the whitespotted greenling, starry flounder, and unidentified juvenile flatfishes were most common. All of the common plants, invertebrates, and fishes seen in 2004 and 2008 also were prevalent in dive surveys in the IIE area in the 1970s (Lees et al., 1980).

42.8.2 Infauna

Sediment samples for infauna analysis were collected at six intertidal stations in August/September 2004; four subtidal stations in the IIE in August/September 2004; seven intertidal stations in July 2005; and seven intertidal stations and four subtidal stations in the IIE in July 2008.

42.8.2.1 Intertidal

The infaunal communities of the sampled intertidal sites comprised organisms commonly found in Alaskan waters. Polychaetes generally dominated in terms of abundance, while in terms of biomass, bivalves, because of their typically larger size, shared dominance with a few larger polychaetes. In 2008, there were a few exceptions where small polychaetes dominated in the absence of large polychaete and bivalve species. At the genus level, all of the animals identified during the Pebble marine benthos study are abundant in marine communities in Alaska (e.g., Jewett et al., 1999; Blanchard and Feder, 2003; Blanchard et al., 2003). A few worms—*Capitella capitata*, *Chaetozone* sp., *Prionospio* sp., and *Polydora* sp.—are known to occur in disturbed environments in Alaskan coastal environments (Jewett et al., 1999; Blanchard et al., 2002, 2003; Blanchard and Feder, 2003). Their presence in moderately high numbers during some years in the IIE may reflect frequent movement or disturbance of sediments within the intertidal region, a result of the moderate- to high-energy physical environment.

Several shifts in species abundance, biomass, and diversity were noted from 2004 to 2008, such as the generally greater abundances and biomass of bivalves in 2005 and to some extent in 2008. These changes were likely reflective of small-scale spatial and temporal phenomena and demonstrate the constantly changing baseline condition within the intertidal infaunal community. Interannual variability by functional groups (cf. species) showed much more overlap between years and between stations. This suggests that, although the macroinfaunal community experiences shifts in species abundance from year to year, the overall community remains fairly stable from a functional group perspective. This suggests broad functional redundancy within a species-group and reflects the clumped distribution of individuals in those groups.

42.8.2.2 Subtidal

The dominant taxa among the subtidal sampling locations are widely observed in faunal communities in Alaska (Jewett et al., 1999; Blanchard and Feder, 2003). The polychaete worms found in the study area, including *Lumbrineris*, *Nephtys*, *Cossura*, and *Prionospio steenstrupi*, are common in shallow subtidal regions in northern waters.

The variability of the results of faunal measures among sampling locations and elevations falls largely within the range expected based on the results of studies of similar marine communities elsewhere (Jewett et al., 1999; Blanchard et al., 2002; Blanchard and Feder, 2003; Feder et al., 2005). Simpson dominance is low, suggesting that communities are dominated by a few taxa with high abundance. The moderate values of the Shannon diversity index suggest a moderately diverse assemblage of taxa within sites. The selected measure of between-habitat diversity, β diversity, was moderate, suggesting moderate variations in taxa occurrence among the sites. Average abundance of subtidal infauna decreased by 50 percent or more and average biomass decreased by an order of magnitude between 2004 and 2008. On the whole, fewer taxa were encountered in the subtidal samples in 2008 with many of the dominant taxa differing between the two years. Nonetheless, most of the species in both years fell into two functional groups (molluscs and annelids) that dominated infaunal biomass or abundance at most of the sites. Ordination results indicated high variability among replicate samples within sites, suggesting a lack of homogeneity within the sites over very small spatial scales. Only one site, MPS1, showed groupings of replicates indicative of a homogenous marine environment. Conversely, MPS4, and to a lesser extent MPS2, showed much scattering and a low similarity among replicates, indicating a lack of homogeneity. The low similarity in the cluster analysis and ordination may be due to sampling multiple habitats within a site, possibly as a result of a high diversity of habitats (from either horizontal zonation or habitat mosaics/patchiness) within a site.

Within some genera, different species were reported in the lists of dominant subtidal macroinfauna (Table 42-20) in 1976 (Feder et al., 1980) and in 2004. This may be an artifact of taxonomic revisions, and two different species names may, in fact, represent the same species. Extensive records for a long-term monitoring program in Port Valdez, Alaska (Blanchard et al., 2002, 2003), and other studies (Feder and Matheke, 1980a; Feder and Jewett, 1987) suggest that such synonymies are common. Because taxonomic identifications for the 1976 study were made by the same personnel identifying organisms for the early studies in Port Valdez (Feder et al., 1973; Feder and Matheke, 1980b), similar taxonomic changes could be expected. For example, uncertainties exist with the taxonomy of the polychaete genus *Magelona*, and it is possible that *M. japonica* (1976) is synonymous with *M. longicornis* (2004). In addition, it is likely that *Prionospio* sp. (1976) is synonymous with *P. steenstrupi*, which is common in the Gulf of Alaska and Prince William Sound (Blanchard, personal observation; Blanchard et al., 2002, 2003). In any case, animals of different species, but in the same genera and family level, probably function similarly within the subtidal benthic environment.

42.8.2.3 Infaunal Comparisons

Overall, subtidal infauna was generally more abundant and more diverse than was intertidal infauna, with lower values of Simpson's dominance index and higher values of the Shannon diversity index (Tables 42-22 and 42-24). All of these differences reflect the greater stability and lower stress of subtidal environments, compared to intertidal environments where wave action, large temperature and salinity shifts, and seasonal ice gouging exert influences not felt in subtidal habitats. Despite these stresses, some areas of the intertidal environment showed substantial biomass of larger infauna (i.e., Station MPS3, Table 42-19) that far exceeded the subtidal biomass (Table 42-21). This may be partly attributable to sample bias in that the subtidal grab sampler did not penetrate deep enough to sample some larger animals that may have been present. This difference also likely reflects the minimal influence of large predators (e.g., sea stars) on bivalves in these intertidal areas. In addition, the subtidal stations exhibited a higher degree of similarity among themselves than did the intertidal stations, a reflection of the greater relative diversity of intertidal substrates that were sampled and the considerable influence on the infaunal assemblages of tide height and the harsh nature of the intertidal environment.

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42.10 Glossary

Benthic—relating to or occurring at the bottom of a body of water.

Bryozoan—aquatic mostly marine invertebrates that reproduce by budding and usually form permanently attached branched or mossy colonies.

Chlorophyta—green algae.

Demersal—term describing mobile animals (fish and invertebrates) living on or above soft bottom sediments when inundated.

Deposit feeder—animal that feeds by ingesting sediment and digesting organic matter such as bacteria and other microorganisms from it.

Detritus—Dead and decaying bits of plant or animal matter.

Drift—Unattached, usually dead organisms found on the shore or floating on the water surface.

Epibenthic—associated with the sediment/water interface (i.e., on or above the bottom).

Epibenthos—plants and animals that live on top of or above the surface of the substrate in aquatic habitats.

Epibiota—organisms (plants and animals) that live on or above the substrate in aquatic habitats.

Epifauna—animals that live on or above the substrate in aquatic habitats.

Gametes—reproductive products

Gastropod—a mollusc with a head, eyes, a large flattened foot, and often a single shell, e.g., limpets, snails, slugs.

Infauna—animals that live below the surface of the substrate in aquatic habitats.

Intertidal—referring to the zone from the high tide splash zone to the lowest tidal elevation (about -4 feet relative to MLLW).

Littoral—referring to the zone from the high tide splash zone to shallow subtidal depths (-10 feet MLLW).

Macrobiota—organisms (plants and animals) large enough to see with the naked eye.

Macroinfauna—infauna retained on a screen with 1-mm square openings.

Macrophyte—a large plant, i.e., one clearly visible with the naked eye.

Megainfauna—infauna retained on a screen with 7-mm square openings.

Nearshore—associated with the shoreline.

Offshore—associated with waters beyond the littoral zone.

Pelagic—associated with the water column (as opposed to benthic or epibenthic).

Phaeophyta—brown algae including kelps.

Polychaetes—marine worms characterized by a segmented body.

Pulmonate—breathing through rudimentary lungs (as opposed to gills)

Rhodophyta—red algae.

Sessile animals—an animal, such as a barnacle, that is permanently attached to something.

Suspension feeder—an animal that feeds by sifting food out of the water column.

TABLES[1]

[1] A master list of scientific and common names of plants and animals referred to in this report is provided in Appendix 42B.

Table 42-1
Infauna Samples Collected from Iniskin and Iliamna Bays, 2004, 2005, and 2008

		Number of Samples Collected				
		2004	2005		2008	
Station	Habitat	Macro-Infauna	Macro-Infauna	Mega-Infauna	Macro-Infauna	Mega-Infauna
MBB-Low	Low intertidal	5	5		5	
MBSA1-Mid	Mid intertidal		5	2	5	2
MOPP1-Sub	Subtidal	1			5	
MPS1-Sub	Subtidal	5			5	
MPS1A-Mid	Mid intertidal	3	4			
MPS2-Low	Low intertidal	5	5	1	5	1
MPS2-Sub	Subtidal	5				
MPS3-Low	Low intertidal	5	5	1	5	
MPS3-Mid	Mid intertidal	5			5	1
MPS4-Mid	Mid intertidal	5	5		5	
MPS4-Sub	Subtidal	5			5	
MPSE-Mid	Mid intertidal	5	4		5	
MPSE2-Mid	Mid intertidal				5	
TOTAL		**49**	**33**	**4**	**55**	**4**

Table 42-2

Macrobiota at Knoll Head (MPS1), Upper Tidal Elevation, 2006 and 2008

	Upper Elevation			
	Apr 2006		Jul 2008	
	n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Fucus distichus subsp. *evanescens*	4.2	2.2	18.8	6.9
Fucus distichus subsp. *evanescens* (germlings)	-	-	0.4	0.1
Leathesia difformis	-	-	0.2	0.1
Soranthera ulvoidea	-	-	0.2	0.2
Corallina frondescens	-	-	0.1	0.1
Neorhodomela oregona	3.2	3.0	6.2	6.0
Encrusting coralline algae	0.8	0.8	1.0	1.0
Hildenbrandia rubra	-	-	0.8	0.6
Total Algal Cover (%)	**8.2**		**27.7**	
Animals (#/m^2)				
Littorina sitkana	280.8	84.4	733.6	83.5
Lottia pelta	1.6	1.6	2.4	1.6
Lottiidae spp.	0.8	0.8	-	-
Lottiidae spp. (juvenile)	-	-	15.2	4.8
Nucella lima	-	-	5.6	4.7
Pagurus granosimanus	3.2	3.2	-	-
Pagurus hirsutiusculus	-	-	0.8	0.8
Tectura scutum	-	-	2.4	1.6
Total Lottiidae	**2.4**		**20.0**	
Animal Area Cover (%)				
Chthamalus dalli	5.6	2.5	1.1	0.2
Mytilus trossulus	-	-	0.1	0.1
Semibalanus balanoides	0.4	0.2	29.4	13.1
Semibalanus balanoides (set)	-	-	4.4	2.7
Total Balanomorpha	**6.0**		**34.9**	
Dead Animals (%)				
Chthamalus dalli (dead)	2.1	1.0	0.1	0.1

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-3

Macrobiota at Knoll Head (MPS1), Middle Tidal Elevation, 2006 and 2008

	Middle Elevation			
	Apr 2006		Jul 2008	
	n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Acrosiphonia sp.	-	-	0.6	0.4
Blidingia minima	-	-	0.1	0.1
Filamentous green algae	1.3	0.8	-	-
Monostroma grevillei	-	-	1.7	0.5
Ulva linza	-	-	0.1	0.1
Ulva/Ulvaria sp.	0.2	0.1	0.1	0.1
Diatoms	51.1	8.9	-	-
Elachista fucicola	-	-	0.1	0.1
Fucus distichus subsp. *evanescens*	3.4	1.5	25.7	6.1
Fucus distichus subsp. *evanescens* (germlings)	-	-	0.4	0.1
Cryptosiphonia woodii	-	-	0.1	0.1
Halosaccion glandiforme	0.6	0.1	3.5	0.8
Mastocarpus dichotomus	0.8	0.2	-	-
Mazzaella sp.	-	-	0.4	0.2
Neorhodomela oregona	0.1	0.1	0.1	0.1
Odonthalia floccosa f. *comosa*	-	-	0.1	0.1
Palmaria callophylloides	0.2	0.1	6.3	2.5
Palmaria hecatensis	2.1	0.7	10.7	3.9
Palmaria mollis	-	-	1.0	1.0
Porphyra aestivalis	-	-	2.5	1.0
Pterosiphonia bipinnata	-	-	1.5	0.7
Encrusting coralline algae	1.3	1.2	0.8	0.7
Encrusting green algae	0.6	0.5	-	-
Petrocelis phase of *Mastocarpus*	-	-	4.5	1.4
Total Algal Cover (%)	**61.6**		**60.1**	
Animals (#/m^2)				
Anthophleura artemisia	-	-	0.8	0.5
Gammaridea sp.	0.2	0.2	-	-
Leptasterias hexactis	-	-	0.4	0.4
Littorina sitkana	4.4	2.6	5.6	5.6
Lottia pelta	2.0	2.0	-	-
Lottiidae spp.	16.4	6.4	-	-
Lottiidae spp. (juvenile)	-	-	4.4	2.2
Nucella lima	2.8	1.7	-	-
Pagurus granosimanus	0.4	0.4	-	-
Pagurus hirsutiusculus	-	-	1.6	0.9
Tectura scutum	-	-	17.2	6.2
Total Lottiidae	**18.4**		**21.6**	
Animal Area Cover (%)				
Bryozoan, encrusting	-	-	0.6	0.3
Chthamalus dalli	1.0	0.5	2.0	0.7
Chthamalus dalli (set)	-	-	-	-
Halichondria panicea	0.1	0.1	1.9	1.7
Semibalanus balanoides	-	-	2.2	2.0
Semibalanus balanoides (set)	-	-	0.3	0.1
Total Balanomorpha	**1.0**		**4.4**	

	Middle Elevation			
	Apr 2006		Jul 2008	
	n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Dead Animals (%)				
Chthamalus dalli (dead)	3.1	1.1	0.2	0.1
Dead Animals (#/m^2)				
Mopalia sp. (dead)	0.1	0.1	-	-

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-4

Macrobiota at Knoll Head (MPS1), Lower Tidal Elevation, 2004, 2005, 2006, and 2008

	Lower Elevation							
	Aug 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 6		n = 6		n = 6		n = 7	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)								
Acrosiphonia arcta	3.8	3.3	1.4	0.7	-	-	-	-
Acrosiphonia duriuscula	-	-	0.2	0.2	-	-	-	-
Acrosiphonia sp.	-	-	-	-	0.5	0.5	3.3	1.6
Clathromorphum reclinatum	0.1	0.1	-	-	-	-	-	-
Filamentous green algae	-	-	-	-	16.7	7.9	-	-
Monostroma grevillei	-	-	0.1	0.1	-	-	0.6	0.4
Protomonostroma undulatum	-	-	-	-	-	-	0.1	0.1
Ulva sp.	0.4	0.1	2.6	0.8	-	-	-	-
Ulva/Ulvaria sp.	-	-	-	-	0.2	0.1	1.6	1.4
Ulvaria obscura var. *blyttii*	-	-	0.7	0.7	-	-	-	-
Diatoms	-	-	-	-	21.7	6.7	-	-
Alaria marginata	6.7	5.7	-	-	-	-	-	-
Alaria sp.	-	-	-	-	10.0	3.4	4.9	3.5
Alaria taeniata	0.5	0.5	10.2	6.4	-	-	-	-
Fucus distichus subsp. *evanescens*	1.2	1.0	5.7	4.9	0.4	0.3	0.6	0.6
Petalonia fascia	-	-	-	-	-	-	0.3	0.3
Saccharina latissama	-	-	-	-	3.8	3.3	-	-
Saccharina sp.	15.8	11.6	8.3	8.3	-	-	27.4	9.7
Saccharina sp. (juvenile).	-	-	3.3	3.3	-	-	-	-
Saccharina subsimplex	8.8	4.8	27.8	7.9	-	-	-	-
Articulated coralline algae	-	-	-	-	0.1	0.1	0.1	0.1
Bosiella plumosa	-	-	0.8	0.4	-	-	-	-
Bosiella sp.	-	-	-	-	0.8	0.5	-	-
Constantinea subulifera	1.2	0.6	1.5	0.8	2.0	0.8	0.9	0.7
Corallina frondescens	0.9	0.2	0.8	0.5	-	-	2.4	1.9
Corallina officinalis	-	-	-	-	-	-	0.1	0.1
Cryptosiphonia woodii	0.3	0.3	0.7	0.4	-	-	-	-
Halosaccion glandiforme	0.3	0.2	0.3	0.2	0.3	0.1	-	-
Mastocarpus dichotomus	1.7	0.8	10.8	5.4	3.5	1.2	0.5	0.3
Mazzaella parvula	0.9	0.8	-	-	-	-	-	-
Mazzaella phyllocarpa	1.3	1.3	-	-	-	-	0.4	0.3
Mazzaella sp.	-	-	0.7	0.4	2.7	2.5	0.4	0.2
Neohypophyllum midendorfii	0.2	0.2	-	-	-	-	-	-
Odonthalia kamschatica	-	-	0.4	0.3	-	-	-	-
Pachyarthron cretaceum	-	-	0.2	0.2	-	-	-	-
Palmaria callophylloides	3.0	1.9	11.5	8.0	2.4	1.3	13.1	7.2
Palmaria hecatensis	18.5	6.7	26.8	11.4	12.2	4.7	34.3	9.5
Palmaria mollis	0.9	0.8	0.8	0.5	-	-	8.9	4.2
Pilayella littoralis	0.1	0.1	0.1	0.1	-	-	-	-
Porphyra aestivalis	3.3	1.7	-	-	-	-	4.0	2.1
Porphyra cuneiformis	-	-	0.7	0.7	-	-	-	-
Porphyra variegata	0.1	0.1	-	-	-	-	-	-
Pterosiphonia bipinnata	-	-	1.5	1.3	-	-	0.3	0.1
Tokidadendron bullatum	-	-	0.5	0.5	-	-	-	-
Blue-Black-Green algal crust	-	-	0.3	0.3	-	-	-	-
Encrusting coralline algae	20.1	8.5	21.8	10.6	25.3	6.1	23.1	10.8
Encrusting red algae, unid.	-	-	0.2	0.2	-	-	-	-
Petrocelis phase of *Mastocarpus*	0.1	0.1	-	-	-	-	1.3	0.6
Ralfsia fungiformis	0.5	0.3	0.7	0.5	3.0	1.3	2.1	2.1
Ralfsia sp.	0.7	0.7	1.8	0.8	-	-	0.4	0.3
Total Algal Cover (%)	**91.3**		**143.1**		**83.8**		**130.9**	

	Lower Elevation							
	Aug 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 6		n = 6		n = 6		n = 7	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animals (#/m^2)								
Anemone, unid.	0.7	0.7	-	-	2.0	2.0	-	-
Anemone, white	-	-	2.0	0.9	-	-	-	-
Anthopleura artemisia	-	-	-	-	-	-	2.3	1.2
Buccinum baeri	-	-	-	-	0.7	0.7	-	-
Cancer oregonensis	0.7	0.7	-	-	-	-	-	-
Sea Cucumber, unid.	0.7	0.7	-	-	-	-	-	-
Henricia leviuscula	0.7	0.7	-	-	-	-	-	-
Hiatella arctica	-	-	0.7	0.7	-	-	-	-
Lacuna sp.	-	-	0.3	0.3	2.0	1.4	-	-
Leptasterias sp.	0.7	0.7	3.3	1.6	-	-	-	-
Lottia pelta	0.7	0.7	-	-	-	-	-	-
Margarites pupillus	1.3	0.8	0.7	0.7	6.7	4.7	-	-
Metridium senile	-	-	1.3	0.8	-	-	-	-
Metridium sp.	-	-	-	-	-	-	0.6	0.6
Mopalia sp.	-	-	1.3	0.8	0.7	0.7	-	-
Nucella lamellosa	-	-	2.0	1.4	0.7	0.7	-	-
Pagurus beringanus	8.0	2.7	4.7	1.9	-	-	-	-
Pagurus hirsutiusculus	8.7	2.2	8.7	4.4	1.3	1.3	0.6	0.6
Pagurus sp.	-	-	-	-	0.7	0.7	-	-
Pugettia gracilis	2.0	1.4	-	-	-	-	-	-
Serpula vermicularis	0.3	0.3	-	-	-	-	-	-
Sertularidae sp.	1.3	0.8	-	-	0.7	0.7	-	-
Tectura scutum	0.7	0.7	-	-	-	-	1.7	0.8
Tonicella lineata	2.0	1.4	14.0	5.5	6.7	5.9	2.3	1.7
Trichotropis insignis	-	-	0.7	0.7	-	-	-	-
Urticina crassicornis	0.7	0.7	0.7	0.7	3.3	1.6	1.7	0.8
Total Lottiidae	**1.3**		**0.0**		**0.0**		**1.7**	
Animal Area Cover (%)								
Abietinaria sp.	-	-	0.3	0.2	-	-	0.2	0.1
Ascidian (colonial)	-	-	1.5	1.3	0.9	0.8	-	-
Balanus crenatus	-	-	9.3	3.5	-	-	0.1	0.1
Balanus rostratus (juvenile)	30.1	10.5	-	-	-	-	-	-
Balanus sp.	-	-	-	-	0.2	0.1	-	-
Balanus/Semibalanus (set)	-	-	0.1	0.1	-	-	0.1	0.1
Bryozoan, encrusting	0.5	0.2	0.3	0.2	-	-	0.4	0.2
Chthamalus dalli	-	-	-	-	-	-	0.1	0.1
Chthamalus dalli (set)	-	-	-	-	-	-	0.1	0.1
Halichondria panicea	-	-	0.2	0.2	-	-	-	-
Porifera, orange	0.9	0.5	0.5	0.3	0.1	0.1	0.1	0.1
Rhynchozoan bispinosum	-	-	0.3	0.2	-	-	-	-
Spirobidae, unid.	-	-	-	-	0.3	0.1	0.1	0.1
Total Balanomorpha	**30.1**		**9.3**		**0.2**		**0.4**	
Dead Animals (%)								
Balanus rostratus (dead)	1.2	0.8	-	-	-	-	-	-

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-5
Macrobiota at Knoll Head West (MPS1A), Upper Tidal Elevation, 2004, 2005, 2006, and 2008

	Upper Elevation							
	Aug 2004 n = 10		Jul 2005 n = 10		Apr 2006 n = 10		Jul 2008 n = 8	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)								
Blidingia minima	-	-	0.1	0.1	-	-	-	-
Filamentous green algae	-	-	-	-	16.6	7.3	-	-
Ulva intestinalis	-	-	0.1	0.1	-	-	-	-
Ulva linza	0.3	0.3	0.4	0.1	-	-	-	-
Ulva sp.	-	-	0.1	0.1	-	-	-	-
Ulva/Ulvaria sp.	0.1	0.1	-	-	0.3	0.2	-	-
Urospora neglecta	-	-	0.1	0.1	-	-	-	-
Diatoms	-	-	-	-	3.0	2.0	-	-
Analipus japonicus	0.2	0.1	-	-	-	-	-	-
Elachista fucicola	0.2	0.1	0.6	0.3	-	-	-	-
Fucus distichus subsp. *evanescens*	14.8	4.5	33.5	11.4	5.5	2.4	21.9	5.1
Fucus distichus subsp. *evanescens* (germlings)	0.2	0.1	-	-	0.1	0.1	-	-
Leathesia difformis	0.1	0.1	0.9	0.5	-	-	-	-
Melanosiphon intestinalis	-	-	-	-	0.1	0.1	-	-
Petalonia fascia	-	-	-	-	0.1	0.1	-	-
Soranthera ulvoidea	3.9	1.6	2.5	0.9	-	-	0.7	0.3
Articulated coralline algae	-	-	-	-	0.2	0.2	0.3	0.2
Bangia sp.	-	-	0.1	0.1	-	-	-	-
Corallina frondescens	0.1	0.1	0.2	0.2	-	-	-	-
Corallina vancouveriensis	0.3	0.3	-	-	0.1	0.1	-	-
Halosaccion glandiforme	0.3	0.1	0.1	0.1	0.4	0.1	-	-
Mastocarpus dichotomus	-	-	0.2	0.1	1.4	1.0	-	-
Mazzaella sp.	1.0	0.8	0.8	0.8	-	-	0.2	0.1
Neorhodomela oregona	13.9	5.6	14.1	6.1	4.8	1.9	8.4	3.7
Porphyra aestivalis	0.5	0.2	1.0	0.5	-	-	-	-
Pterosiphonia bipinnata	0.4	0.2	0.2	0.1	-	-	-	-
Black crust	-	-	0.1	0.1	-	-	-	-
Blue-Black-Green algal crust	-	-	-	-	0.4	0.4	-	-
Encrusting coralline algae	0.8	0.4	0.1	0.1	1.9	1.1	0.8	0.5
Encrusting green algae	-	-	-	-	-	-	0.3	0.3
Encrusting red algae, unid.	0.4	0.2	-	-	-	-	-	-
Hildenbrandia rubra	1.6	1.0	1.1	0.4	-	-	-	-
Petrocelis phase of *Mastocarpus*	-	-	-	-	-	-	1.1	0.7
Ralfsia sp.	-	-	0.1	0.1	-	-	-	-
Total Algal Cover (%)	**38.7**		**55.9**		**31.7**		**33.6**	
Animals (#/m²)								
Chiton unid. Cyanoplax	-	-	-	-	-	-	1.0	0.7
Littorina sitkana	294.4	50.6	439.6	96.0	580.4	157.5	949.5	209.3
Lottia pelta	8.4	3.7	1.2	0.9	0.4	0.4	-	-
Lottiidae spp.	26.4	15.2	47.6	7.7	13.6	2.8	5.0	4.0
Lottiidae spp. (juvenile)	-	-	-	-	-	-	19.0	6.5
Nucella lima	8.4	4.7	16.0	9.7	2.8	1.6	32.5	17.2
Onchidella borealis	-	-	0.4	0.4	-	-	-	-
Pagurus granosimanus	-	-	0.4	0.4	-	-	-	-
Pagurus hirsutiusculus	11.6	3.9	14.0	3.5	0.8	0.8	6.0	3.0
Tectura scutum	1.2	0.6	2.4	1.4	-	-	-	-
Trichotropis insignis	-	-	0.4	0.4	-	-	-	-
Total *Lottiidae*	**36.0**		**51.2**		**14.0**		**24.0**	

	Upper Elevation							
	Aug 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 10		n = 10		n = 10		n = 8	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animal Area Cover (%)								
Balanus glandula	-	-	-	-	0.1	0.1	-	-
Chthamalus dalli	8.4	3.1	12.2	3.7	2.5	0.7	0.6	0.1
Chthamalus dalli (set)	0.1	0.1	-	-	-	-	-	-
Halichondria panicea	1.5	1.0	0.9	0.7	-	-	-	-
Mytilus trossulus (spat)	-	-	0.1	0.1	-	-	-	-
Mytilus trossulus	-	-	0.2	0.1	0.1	0.1	-	-
Semibalanus balanoides	3.2	1.1	5.0	2.4	0.4	0.2	9.0	2.1
Semibalanus balanoides (set)	-	-	4.0	2.4	-	-	5.8	1.6
Total *Balanomorpha*	**11.6**		**21.1**		**3.0**		**15.4**	
Dead Animals (%)								
Balanus/Semibalanus (dead)	0.3	0.2	-	-	-	-	-	-
Chthamalus dalli (dead)	0.2	0.1	-	-	4.3	1.9	-	-
Semibalanus balanoides (dead)	0.2	0.1	-	-	1.4	1.2	-	-
Semibalanus cariosus (dead)	-	-	-	-	0.1	0.1	-	-

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-6

Macrobiota at Knoll Head West (MPS1A), Middle Tidal Elevation, 2004, 2005, 2006, and 2008

	Middle Elevation							
	Aug 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 10		n = 7		n = 5		n = 7	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)								
Acrosiphonia arcta	-	-	8.1	5.0	-	-	-	-
Acrosiphonia coalita	-	-	0.9	0.7	-	-	-	-
Acrosiphonia sp.	1.5	0.5	-	-	-	-	0.7	0.4
Filamentous green algae	-	-	-	-	14.4	3.3	0.1	0.1
Ulva linza	-	-	0.5	0.3	-	-	0.1	0.1
Ulva sp.	-	-	0.5	0.3	-	-	-	-
Ulva/Ulvaria sp.	0.4	0.1	-	-	0.1	0.1	0.6	0.2
Diatoms	-	-	-	-	57.0	16.3	-	-
Elachista fucicola	0.5	0.2	0.1	0.1	-	-	-	-
Elachista lubrica	0.1	0.1	0.1	0.1	-	-	-	-
Fucus distichus subsp. *evanescens*	46.2	9.5	20.6	7.8	5.5	1.9	3.2	1.8
Saccharina subsimplex	-	-	1.1	1.1	-	-	-	-
Ahnfeltia fastigiata	0.2	0.1	-	-	-	-	-	-
Corallina frondescens	-	-	-	-	-	-	0.1	0.1
Corallina vancouveriensis	-	-	-	-	0.1	0.1	-	-
Cryptosiphonia woodii	0.5	0.3	1.7	1.0	-	-	-	-
Halosaccion glandiforme	0.8	0.2	1.6	0.8	0.4	0.1	0.4	0.4
Mastocarpus dichotomus	0.4	0.2	0.6	0.4	-	-	-	-
Mazzaella parvula	-	-	0.7	0.7	-	-	-	-
Mazzaella sp.	1.1	0.5	-	-	-	-	-	-
Neorhodomela oregona	-	-	-	-	-	-	0.9	0.7
Palmaria callophylloides	5.0	2.1	10.4	3.8	2.0	0.4	4.3	1.6
Palmaria hecatensis	41.4	6.3	65.4	9.3	20.6	3.7	65.7	11.7
Palmaria mollis	-	-	-	-	-	-	4.3	1.3
Porphyra aestivalis	0.8	0.3	0.5	0.4	-	-	1.4	0.7
Porphyra cuneiformis	-	-	3.1	2.8	-	-	-	-
Pterosiphonia bipinnata	0.6	0.3	1.6	0.5	-	-	-	-
Rhodomela tenuissima	0.1	0.1	-	-	-	-	-	-
Encrusting coralline algae	0.2	0.1	-	-	-	-	0.3	0.3
Encrusting green algae	1.2	0.3	1.6	0.5	2.7	1.9	1.0	0.5
Encrusting red algae, unid.	37.8	5.3	12.3	2.8	0.2	0.2	-	-
Ralfsia sp.	-	-	-	-	-	-	28.6	8.0
Total Algal Cover (%)	**138.6**		**131.3**		**46.0**		**111.6**	
Animals (#/m^2)								
Gammaridea sp.	-	-	0.3	0.3	-	-	-	-
Henricia sp.	-	-	0.6	0.6	-	-	-	-
Henricia tumida	0.4	0.4	-	-	-	-	-	-
Lacuna sp.	746.0	149.2	not counted		-	-	-	-
Leptasterias sp.	0.8	0.8	-	-	-	-	0.6	0.6
Lottia pelta	-	-	0.6	0.6	-	-	-	-
Lottiidae spp.	0.4	0.4	1.7	1.7	-	-	0.6	0.6
Lottiidae spp. (juvenile)	0.4	0.4	-	-	-	-	-	-
Nucella lima	-	-	1.1	0.8	-	-	-	-
Pagurus hirsutiusculus	0.8	0.5	1.1	0.8	-	-	-	-
Pugettia gracilis	-	-	0.6	0.6	-	-	-	-
Tectura scutum	0.8	0.8	1.1	1.1	-	-	1.1	0.7
Telmessus cheiragonus	-	-	0.6	0.6	-	-	-	-
Tonicella lineata	0.8	0.8	0.6	0.6	-	-	-	-
Total Lottiidae	**1.6**		**3.4**		**0.0**		**1.7**	

	Middle Elevation							
	Aug 2004 n = 10		Jul 2005 n = 7		Apr 2006 n = 5		Jul 2008 n = 7	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animal Area Cover (%)								
Abietinaria sp.	-	-	-	-	0.1	0.1	-	-
Balanus sp.	3.8	2.0	-	-	-	-	-	-
Balanus/Semibalanus (set)	-	-	2.3	1.7	-	-	-	-
Bryozoan, arborescent	-	-	0.1	0.1	-	-	-	-
Bryozoan, encrusting	-	-	0.4	0.3	-	-	0.4	0.3
Halichondria panicea	9.6	2.7	14.3	7.3	-	-	-	-
Rhynchozoan bispinosum	0.5	0.1	0.1	0.1	-	-	-	-
Semibalanus balanoides (set)	-	-	5.6	4.9	-	-	-	-
Total Balanomorpha	**3.8**		**7.9**		**0.0**		**0.0**	

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-7

Macrobiota at Southwest Iniskin Bay (MPS2), Upper Tidal Elevation, 2005 and 2008

	Upper Elevation			
	Jul 2005		Jul 2008	
	n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Codium sp.	0.1	0.1	-	-
Fucus distichus subsp. *evanescens*	11.1	7.4	14.4	5.8
Fucus distichus subsp. *evanescens* (germlings)	-	-	0.1	0.1
Soranthera ulvoidea	-	-	-	-
Neorhodomela oregona	0.7	0.6	1.0	0.8
Encrusting coralline algae	0.1	0.1	-	-
Encrusting green algae	1.0	0.8	-	-
Hildenbrandia rubra	1.6	0.8	1.0	1.0
Ralfsia sp.	-	-	0.7	0.6
Total Algal Cover (%)	**14.6**		**17.2**	
Animals (#/m^2)				
Anthophleura artemisia	0.8	0.8	-	-
Anthophleura sp.	-	-	1.6	1.6
Littorina sitkana	959.2	92.9	1,236.8	365.1
Lottia pelta	2.4	2.4	-	-
Lottiidae spp.	52.0	15.4	16.0	6.1
Lottiidae spp. (juvenile)	-	-	1.6	1.6
Nucella lima	0.8	0.8	0.8	0.8
Pagurus hirsutiusculus	0.8	0.8	0.8	0.8
Total Lottiidae	**54.4**		**17.6**	
Animal Area Cover (%)				
Chthamalus dalli	0.4	0.1	0.2	0.1
Mytilus trossulus	1.4	0.7	2.9	1.8
Mytilus trossulus (spat)	0.1	0.1	-	-
Semibalanus balanoides	52.4	11.9	57.0	10.4
Semibalanus balanoides (set)	2.9	1.0	6.4	1.4
Total Balanomorpha	**55.7**		**63.6**	

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-8
Macrobiota at Southwest Iniskin Bay (MPS2), Middle Tidal Elevation, 2004, 2005, and 2008

	Middle Elevation					
	Aug 2004 n = 5		Jul 2005 n = 5		Jul 2008 n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)						
Fucus distichus subsp. *evanescens*	0.1	0.1	-	-	-	-
Soranthera ulvoidea	0.5	0.2	0.2	0.1	0.3	0.1
Neorhodomela oregona	14.2	6.7	8.0	2.5	22.0	6.8
Pterosiphonia bipinnata	1.8	1.1	19.6	10.9	-	-
Hildenbrandia rubra	0.1	0.1	0.1	0.1	-	-
Total Algal Cover (%)	**16.7**		**27.9**		**22.3**	
Animals (#/m^2)						
Abarenicola sp. (casts)	4.8	1.5	-	-	-	-
Anid polychaete (white)	-	-	-	-	0.8	0.8
Anthophleura artemisia	-	-	0.8	0.8	0.8	0.8
Littorina sitkana	207.2	50.3	69.6	21.8	550.4	163.0
Lottiidae spp.	108.0	29.4	171.2	34.7	25.6	9.7
Lottiidae spp. (juvenile)	-	-	-	-	17.6	5.2
Nucella lima	36.8	20.3	6.4	3.7	48.8	43.9
Pagurus granosimanus	-	-	-	-	0.8	0.8
Pagurus hirsutiusculus	47.2	30.5	12.8	5.9	1.6	1.0
Pholidae sp.	1.6	1.0	-	-	-	-
Total Lottiidae	**108.0**		**171.2**		**43.2**	
Animal Area Cover (%)						
Balanus crenatus	0.2	0.2	-	-	-	-
Balanus rostratus	0.1	0.1	-	-	-	-
Balanus/Semibalanus spp.	0.5	0.2	-	-	-	-
Chthamalus dalli	8.6	3.1	11.4	3.9	1.3	0.5
Mytilus trossulus	-	-	0.1	0.1	0.2	0.1
Nucella eggs	0.2	0.1	0.3	0.2	0.2	0.2
Semibalanus balanoides	0.2	0.2	1.9	1.1	28.6	7.2
Semibalanus balanoides (set)	-	-	0.7	0.4	1.2	0.2
Total Balanomorpha	**9.6**		**14.0**		**31.1**	
Dead Animals (%)						
Balanus/Semibalanus (dead)	-	-	0.2	0.2	0.1	0.1

Notes:
Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-9

Macrobiota at Diamond Point (MPS3), Upper Tidal Elevation, 2005 and 2008

	Upper Elevation			
	Jul 2005		Jul 2008	
	n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Fucus distichus subsp. *evanescens*	31.6	4.7	50.0	7.6
Fucus distichus subsp. *evanescens* (germlings)	0.1	0.1	-	-
Mastocarpus dichotomus	0.1	0.1	0.2	0.2
Neorhodomela aculeata	0.4	0.4	-	-
Neorhodomela oregona	-	-	0.5	0.4
Porphyra aestivalis	-	-	0.1	0.1
Encrusting red algae, unid.	6.0	1.7	-	-
Hildenbrandia rubra	-	-	1.9	0.8
Total Algal Cover (%)	**38.2**		**52.7**	
Animals (#/m^2)				
Littorina sitkana	735.2	142.0	646.4	108.6
Lottia pelta	-	-	1.6	1.0
Lottiidae spp.	20.8	4.1	4.0	2.2
Lottiidae spp. (juvenile)	-	-	4.0	2.2
Nucella lima	17.6	10.0	4.0	3.1
Pagurus beringanus	-	-	0.8	0.8
Pagurus hirsutiusculus	4.0	3.1	4.8	3.9
Tectura persona	0.8	0.8	-	-
Total Lottiidae	**21.6**		**9.6**	
Animal Area Cover (%)				
Balanus glandula	0.1	0.1	-	-
Chthamalus dalli	1.0	0.3	0.3	0.1
Mytilus trossulus	0.1	0.1	0.1	0.1
Mytilus trossulus (spat)	0.2	0.1	-	-
Semibalanus balanoides	48.8	11.4	64.4	9.9
Semibalanus balanoides (set)	-	-	2.8	1.2
Total Balanomorpha	**49.9**		**67.5**	

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-10

Macrobiota at Diamond Point (MPS3), Middle Tidal Elevation, 2004, 2005, and 2008

	Middle Elevation					
	Aug 2004		Jul 2005		Jul 2008	
	n = 10		n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)						
Acrosiphonia sp.	0.2	0.1	-	-	0.1	0.1
Chaetomorpha sp.	0.3	0.3	0.1	0.1	0.1	0.1
Ulva sp.	0.3	0.2	1.1	1.0	-	-
Ulva/Ulvaria sp.	-	-	-	-	0.5	0.5
Elachista fucicola	-	-	0.1	0.1	-	-
Filamentous brown algae	-	-	-	-	0.2	0.2
Fucus distichus subsp. *evanescens*	38.2	7.1	64.3	5.3	51.2	5.0
Leathesia difformis	0.1	0.1	-	-	0.1	0.1
Melanosiphon intestinalis	-	-	-	-	0.1	0.1
Scytosiphon lomentaria	-	-	-	-	0.1	0.1
Soranthera ulvoidea	3.8	2.1	2.2	1.1	0.9	0.4
Sphacelaria rigidula	-	-	0.1	0.1	-	-
Ceramium cimbricum	0.1	0.1	-	-	-	-
Cryptosiphonia woodii	0.1	0.1	-	-	-	-
Halosaccion glandiforme	0.7	0.5	0.7	0.4	1.6	0.7
Mazzaella parvula	-	-	-	-	0.9	0.5
Mazzaella sp.	0.8	0.4	0.4	0.2	-	-
Neorhodomela aculeata	5.8	4.0	11.4	5.6	-	-
Neorhodomela oregona	9.7	4.1	1.3	1.2	8.5	3.1
Palmaria callophylloides	0.3	0.3	0.2	0.2	0.2	0.2
Porphyra aestivalis	-	-	0.7	0.4	-	-
Porphyra cuneiformis	-	-	0.1	0.1	-	-
Porphyra sp.	-	-	-	-	2.7	1.1
Pterosiphonia bipinnata	0.5	0.3	0.3	0.2	0.4	0.3
Encrusting coralline algae	1.1	0.6	0.4	0.3	0.9	0.5
Encrusting red algae, unid.	0.5	0.5	-	-	-	-
Hildenbrandia rubra	0.8	0.4	1.1	0.5	0.6	0.3
Ralfsia sp.	0.1	0.1	0.1	0.1	-	-
Total Algal Cover (%)	**63.0**		**84.2**		**68.8**	
Animals (#/m²)						
Gammaridea sp.	0.2	0.2	-	-	-	-
Lacuna sp.	0.4	0.4	-	-	-	-
Littorina sitkana	697.2	104.1	174.8	28.9	668.8	109.7
Littorina sitkana egg cases	0.4	0.4	-	-	-	-
Lottia pelta	1.6	0.7	1.2	0.6	1.2	1.2
Lottiidae spp.	74.4	12.8	79.6	9.6	1.2	0.9
Lottiidae spp. (juvenile)	-	-	-	-	22.0	5.0
Nucella lima	56.0	14.1	40.4	18.0	46.8	11.3
Pagurus hirsutiusculus	26.0	12.7	28.0	5.5	13.2	6.0
Paranemertes peregrina	-	-	-	-	0.4	0.4
Pholidae sp.	0.4	0.4	-	-	-	-
Pholidae sp. (juvenile)	-	-	-	-	0.4	0.4
Tectura persona	0.4	0.4	-	-	-	-
Tectura scutum	-	-	0.4	0.4	-	-
Tonicella lineata	0.4	0.4	-	-	-	-
Total Lottiidae	**76.4**		**81.2**		**24.4**	

Taxon	Middle Elevation Aug 2004 n = 10 Mean	SE	Jul 2005 n = 10 Mean	SE	Jul 2008 n = 10 Mean	SE
Animal Area Cover (%)						
Alcyonidium sp.	-	-	0.2	0.2	-	-
Balanus crenatus	0.1	0.1	-	-	-	-
Bryozoan, encrusting	-	-	-	-	0.2	0.2
Chthamalus dalli	9.0	3.1	6.3	2.6	0.6	0.2
Halichondria panicea	0.8	0.8	3.3	2.0	0.3	0.2
Hydroids campanulariid	-	-	-	-	0.1	0.1
Mytilus trossulus	-	-	-	-	0.1	0.1
Mytilus trossulus (spat)	-	-	-	-	0.1	0.1
Semibalanus balanoides	33.5	8.8	19.5	8.1	32.8	5.0
Semibalanus balanoides (set)	-	-	7.5	3.7	2.0	0.6
Total Balanomorpha	**42.5**		**33.3**		**35.4**	
Dead Animals (%)						
Balanus/Semibalanus (dead)	0.4	0.2	-	-	-	-
Chthamalus dalli (dead)	0.2	0.1	-	-	-	-
Semibalanus balanoides (dead)	0.4	0.2	-	-	-	-

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-11
Macrobiota at Diamond Point (MPS3), Lower Tidal Elevation, 2004 and 2005

	Lower Elevation			
	Aug 2004		Jul 2005	
	n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Acrosiphonia arcta	-	-	3.7	1.5
Acrosiphonia sp.	0.8	0.5	-	-
Ulva linza	0.4	0.3	7.0	2.9
Ulva sp.	1.5	1.0	0.7	0.3
Elachista fucicola	0.6	0.4	0.5	0.4
Fucus distichus subsp. *evanescens*	15.3	5.4	15.0	6.3
Fucus distichus subsp. *evanescens* (germlings)	0.2	0.1	0.1	0.1
Saccharina sp. (juvenile)	-	-	0.1	0.1
Scytosiphon sp.	-	-	0.1	0.1
Soranthera ulvoidea	-	-	0.1	0.1
Sphacelaria rigidula	-	-	2.8	2.7
Sphacelaria sp.	1.2	1.0	-	-
Ceramium cimbricum	0.3	0.1	0.1	0.1
Cryptosiphonia woodii	-	-	0.1	0.1
Filamentous red algae	1.2	0.9	-	-
Halosaccion glandiforme	-	-	1.8	1.5
Mastocarpus dichotomus	-	-	0.2	0.1
Mazzaella sp.	1.1	0.5	2.3	1.2
Neorhodomela oregona	-	-	0.1	0.1
Palmaria callophylloides	7.5	3.0	8.2	3.7
Palmaria hecatensis	1.6	0.9	1.6	1.1
Polysiphonia pacifica	0.4	0.3	-	-
Polysiphonia sp.	-	-	0.6	0.5
Porphyra aestivalis	0.6	0.4	2.4	1.8
Porphyra cuneiformis	-	-	2.9	1.3
Pterosiphonia bipinnata	0.3	0.2	1.3	0.5
Rhodomela tenuissima	-	-	0.1	0.1
Encrusting red algae, unid.	13.8	5.6	14.2	3.9
Rhodochorton purpureum	2.3	1.6	2.1	2.0
Total Algal Cover (%)	**48.7**		**67.7**	
Animals (#/m²)				
Amphiporus sp.	-	-	0.4	0.4
Anthophleura artemisia	-	-	0.4	0.4
Clam shows / siphons	-	-	2.4	2.4
Clinocardium nutalli	0.4	0.4	-	-
Lacuna sp.	4.4	3.2	-	-
Leptasterias sp.	0.4	0.4	1.6	0.7
Lottiidae spp.	4.4	3.3	-	-
Nucella lima	0.4	0.4	-	-
Pagurus hirsutiusculus	13.2	3.0	8.8	2.5
Paranemertes peregrina	-	-	0.4	0.4
Pholidae sp.	-	-	0.4	0.4
Polyclad worm	-	-	0.8	0.5
Pugettia gracilis	-	-	0.4	0.4
Tectura scutum	0.8	0.5	3.2	2.8
Total Lottiidae	**5.2**		**3.2**	

	Lower Elevation			
	Aug 2004		Jul 2005	
	n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Animal Area Cover (%)				
Balanus crenatus	3.5	2.0	0.2	0.1
Balanus/Semibalanus (set)	-	-	0.5	0.3
Bryozoan, encrusting	0.4	0.4	0.7	0.3
Chthamalus dalli	1.4	0.5	0.6	0.4
Chthamalus dalli (set)	0.1	0.1	-	-
Halichondria panicea	9.0	5.8	19.1	3.2
Scrupocellaria sp.	-	-	0.1	0.1
Semibalanus balanoides	7.1	7.0	1.9	1.5
Semibalanus balanoides (set)	8.4	8.0	12.4	6.1
Total Balanomorpha	**20.5**		**15.5**	
Dead Animals (%)				
Balanus crenatus (dead)	-	-	0.2	0.1
Balanus/Semibalanus (dead)	0.4	0.2	-	-

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-12
Macrobiota at North Head (MPS4), Upper Tidal Elevation, 2005 and 2008

	Upper Elevation			
	Jul 2005		Jul 2008	
	n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Chaetomorpha sp.	0.1	0.1	-	-
Codium sp.	0.2	0.2	-	-
Fucus distichus subsp. *evanescens*	33.0	6.8	66.0	10.7
Neorhodomela oregona	-	-	0.1	0.1
Black crust	0.3	0.2	-	-
Hildenbrandia rubra	2.7	0.7	12.0	4.6
Ralfsia sp.	-	-	0.2	0.2
Verrucaria sp.	4.0	4.0	-	-
Total Algal Cover (%)	**40.3**		**78.3**	
Animals (#/m^2)				
Gammaridea sp.	0.8	0.8	-	-
Littorina sitkana	827.2	118.2	1,116.0	228.6
Lottia pelta	0.8	0.8	-	-
Lottiidae spp.	28.0	6.1	12.8	6.1
Nucella lima	7.2	3.9	1.6	1.0
Pagurus hirsutiusculus	-	-	1.6	1.0
Paranemertes peregrina	-	-	0.8	0.8
Pholis laeta	0.8	0.8	-	-
Total Lottiidae	**28.8**		**12.8**	
Animal Area Cover (%)				
Chthamalus dalli	2.5	1.9	1.4	0.7
Mytilus trossulus	0.3	0.1	-	-
Semibalanus balanoides	21.6	7.0	40.0	8.1
Semibalanus balanoides (set)	2.7	0.9	1.5	0.4
Total Balanomorpha	**26.8**		**42.9**	

Notes:
Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-13

Macrobiota at North Head (MPS4), Middle Tidal Elevation, 2004, 2005 and 2008

	Middle Elevation					
	Aug 2004		Jul 2005		Jul 2008	
	n = 10		n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)						
Acrosiphonia arcta	-	-	7.5	3.3	-	-
Acrosiphonia sp.	2.2	0.9	-	-	0.4	0.1
Blidingia minima	-	-	-	-	0.1	0.1
Monostroma grevillei	-	-	-	-	0.5	0.3
Ulva linza	1.8	1.0	5.4	1.4	0.4	0.4
Ulva sp.	2.4	0.9	-	-	-	-
Ulva/Ulvaria sp.	-	-	-	-	0.1	0.1
Ulvaria obscura var. *blyttii*	-	-	0.2	0.2	-	-
Diatoms	3.9	1.2	-	-	-	-
Diatoms, filamentous	-	-	-	-	1.1	0.8
Elachista fucicola	0.6	0.3	-	-	-	-
Elachista lubrica	-	-	-	-	0.1	0.1
Fucus distichus subsp. *evanescens*	13.0	3.8	37.3	9.6	45.6	7.8
Fucus distichus subsp. *evanescens* (germlings)	3.2	1.9	0.1	0.1	-	-
Saccharina latissama	-	-	-	-	1.5	1.5
Saccharina sp.	0.1	0.1	0.3	0.3	-	-
Saccharina sp. (juvenile).	0.8	0.7	-	-	-	-
Saccharina subsimplex	-	-	4.5	4.5	-	-
Halosaccion firmum	0.1	0.1	-	-	-	-
Halosaccion glandiforme	-	-	0.1	0.1	0.1	0.1
Mazzaella parvula	-	-	-	-	0.3	0.2
Mazzaella sp.	0.3	0.3	0.2	0.1	-	-
Neorhodomela oregona	0.1	0.1	-	-	0.1	0.1
Palmaria callophylloides	5.0	2.1	5.3	1.8	5.9	1.7
Palmaria hecatensis	1.1	0.4	1.0	0.4	0.5	0.2
Palmaria mollis	0.2	0.2	0.1	0.1	-	-
Pilayella littoralis	-	-	-	-	2.6	0.6
Porphyra aestivalis	-	-	1.2	0.6	-	-
Porphyra cuneiformis	0.1	0.1	2.5	1.0	-	-
Rhodomela tenuissima	-	-	0.1	0.1	-	-
Encrusting red algae, unid.	4.6	2.0	17.3	3.0	-	-
Hildenbrandia rubra	-	-	-	-	1.2	1.0
Petrocelis phase of *Mastocarpus*	-	-	-	-	7.1	2.3
Ralfsia sp.	-	-	0.1	0.1	-	-
Rhodochorton purpureum	-	-	2.6	1.7	-	-
Total Algal Cover (%)	**39.1**		**85.5**		**67.3**	
Animals (#/m^2)						
Lacuna sp.	2.0	2.0	-	-	-	-
Leptasterias sp.	-	-	0.4	0.4	-	-
Lottiidae spp.	1.2	1.2	2.4	2.4	-	-
Lottiidae spp. (juvenile)	-	-	-	-	1.2	1.2
Pagurus hirsutiusculus	2.0	0.7	4.4	0.9	-	-
Pholidae sp.	0.4	0.4	-	-	-	-
Tectura scutum	-	-	1.2	0.9	2.4	0.9
Tonicella lineata	-	-	0.4	0.4	-	-
Total Lottiidae	**1.2**		**3.6**		**3.6**	

	Middle Elevation					
	Aug 2004		Jul 2005		Jul 2008	
	n = 10		n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animal Area Cover (%)						
Balanus crenatus	-	-	0.7	0.4	-	-
Balanus/Semibalanus (set)	1.2	0.4	1.1	0.5	-	-
Bryozoan, arborescent	-	-	-	-	-	-
Bryozoan, encrusting	0.1	0.1	0.1	0.1	-	-
Caulibugula	-	-	-	-	0.2	0.1
Chthamalus dalli	0.5	0.4	-	-	-	-
Halichondria panicea	3.7	1.6	5.0	1.4	1.7	1.0
Rhynchozoan bispinosum	0.3	0.3	-	-	-	-
Semibalanus balanoides	0.2	0.1	1.2	0.8	-	-
Semibalanus balanoides (set)	-	-	2.3	1.5	-	-
Total Balanomorpha	**1.9**		**5.3**		**0.0**	
Dead Animals (%)						
Semibalanus balanoides (dead)	0.2	0.1	-	-	-	-

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-14

Macrobiota at North Head (MPS4), Lower Tidal Elevation, 2004 and 2005

	Lower Elevation			
	Aug 2004		Jul 2005	
	n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Acrosiphonia arcta	-	-	11.6	2.5
Acrosiphonia sp.	5.5	1.8	-	-
Ulva linza	0.8	0.5	4.4	1.3
Ulva sp.	1.1	0.3	1.6	0.8
Diatoms	3.3	1.8	-	-
Diatoms, filamentous	1.3	0.5	-	-
Desmarestia aculeata	0.1	0.1	-	-
Elachista fucicola	0.1	0.1	-	-
Fucus distichus subsp. *evanescens*	27.7	6.1	37.9	6.6
Saccharina latissima	-	-	11.7	3.8
Saccharina sp.	1.7	1.2	-	-
Saccharina sp. (juvenile)	0.2	0.1	-	-
Saccharina subsimplex	0.4	0.4	-	-
Sphacelaria rigidula	0.1	0.1	-	-
Articulated coralline algae	0.3	0.2	-	-
Halosaccion firmum	0.2	0.1	-	-
Mastocarpus pacificus	-	-	0.1	0.1
Mazzaella sp.	1.5	0.6	0.9	0.4
Odonthalia kamschatica	0.1	0.1	-	-
Palmaria callophylloides	2.8	0.9	6.6	1.9
Palmaria hecatensis	5.8	2.5	6.0	2.3
Palmaria mollis	0.1	0.1	-	-
Phycodrys riggii	0.8	0.4	0.3	0.2
Phyllophoraceae unid.	0.7	0.5	-	-
Polysiphonia sp.	0.3	0.1	0.7	0.3
Porphyra aestivalis	-	-	1.6	0.5
Porphyra cuneiformis	0.4	0.2	13.6	2.1
Encrusting coralline algae	0.1	0.1	0.1	0.1
Encrusting red algae, unid.	5.6	1.8	14.6	3.2
Purple crust, unid	-	-	1.0	1.0
Rhodochorton purpureum	-	-	0.2	0.1
Total Algal Cover (%)	**60.6**		**112.8**	
Animals (#/m^2)				
Anemone, orange (*Urticina* ?)	-	-	0.4	0.4
Haliclystus sp.	0.4	0.4	-	-
Lacuna sp.	48.4	21.3	2.8	1.9
Leptasterias sp.	0.4	0.4	0.8	0.5
Lottiidae spp.	0.4	0.4	-	-
Pagurus beringanus	0.4	0.4	0.4	0.4
Pagurus hirsutiusculus	2.0	0.9	2.0	1.2
Pholidae sp.	-	-	0.8	0.8
Tectura scutum	0.4	0.4	0.4	0.4
Telmessus cheiragonus	-	-	0.8	0.5
Total Lottiidae	**0.8**		**0.4**	

Taxon	Lower Elevation Aug 2004 n = 10 Mean	SE	Jul 2005 n = 10 Mean	SE
Animal Area Cover (%)				
Balanus crenatus	0.1	0.1	-	-
Balanus sp.	2.5	1.7	-	-
Balanus/Semibalanus (set)	2.3	1.1	1.3	0.5
Bryozoan, arborescent	-	-	1.7	0.8
Bryozoan, encrusting	0.4	0.3	0.6	0.2
Chthamalus dalli (set)	0.3	0.1	-	-
Halichondria panicea	0.1	0.1	0.3	0.3
Hydroidea sp.	0.9	0.3	-	-
Rhynchozoan bispinosum	-	-	0.6	0.4
Scrupocellaria californica	-	-	3.8	1.2
Semibalanus balanoides (set)	-	-	1.6	0.9
Semibalanus cariosus (set)	0.2	0.1	-	-
Spirobidae, unid.	-	-	0.5	0.2
Total Balanomorpha	**5.3**		**2.9**	
Dead Animals (%)				
Garveia sp. (dead)	0.1	0.1	-	-

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-15

Macrobiota at AC Point (MBSA1), Upper Tidal Elevation, 2005 and 2008

	Upper Elevation			
	Jul 2005		Jul 2008	
	n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)				
Fucus distichus subsp. *evanescens*	0.5	0.4	0.6	0.4
Hildenbrandia rubra	0.1	0.1	0.3	0.2
Verrucaria sp.	0.1	0.1	-	-
Total Algal Cover (%)	**0.7**		**0.9**	
Animals (#/m^2)				
Littorina sitkana	702.4	98.9	1,327.2	264.4
Lottiidae spp.	3.2	3.2	-	-
Red mites	-	-	2.4	1.0
Total Lottiidae	**3.2**		**0.0**	
Animal Area Cover (%)				
Balanus glandula	0.1	0.1	-	-
Chthamalus dalli	6.8	1.7	1.5	0.6
Semibalanus balanoides	43.4	8.1	60.0	13.3
Semibalanus balanoides (set)	2.0	1.2	1.6	1.0
Total Balanomorpha	**52.3**		**63.1**	

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-16

Macrobiota at Scott Island (MSI), Upper Tidal Elevation, 2004, 2005, 2006, and 2008

	Upper Elevation							
	Sep 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 8		n = 5		n = 10		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)								
Filamentous green algae	-	-	0.1	0.1	-	-	-	-
Ulothrix flacca	-	-	0.1	0.1	-	-	-	-
Ulva linza	2.5	2.5	-	-	-	-	-	-
Elachista fucicola	0.1	0.1	-	-	-	-	0.1	0.1
Fucus distichus subsp. *evanescens*	37.5	10.1	49.0	5.6	19.0	2.7	69.5	5.8
Fucus distichus subsp. *evanescens* (germlings)	0.1	0.1	-	-	0.1	0.1	0.1	0.1
Melanosiphon intestinalis	-	-	0.2	0.2	-	-	-	-
Soranthera ulvoidea	8.3	3.1	1.6	0.7	-	-	0.1	0.1
Halosaccion glandiforme	0.1	0.1	-	-	-	-	-	-
Mastocarpus dichotomus	2.1	0.7	1.6	0.8	0.6	0.1	-	-
Mazzaella sp.	0.1	0.1	-	-	-	-	0.2	0.1
Neorhodomela oregona	11.1	3.9	7.4	3.4	6.6	3.4	8.7	7.4
Pterosiphonia bipinnata	0.1	0.1	0.7	0.6	-	-	-	-
Black crust	-	-	0.1	0.1	-	-	-	-
Encrusting coralline algae	-	-	-	-	10.4	4.6	-	-
Encrusting green algae	1.3	1.3	-	-	-	-	-	-
Encrusting red algae, unid.	27.5	5.1	7.6	4.6	3.7	1.4	-	-
Hildenbrandia rubra	-	-	8.4	6.8	-	-	20.2	6.0
Total Algal Cover (%)	**90.6**		**76.8**		**40.3**		**98.8**	
Animals (#/m^2)								
Amphiporus sp.	-	-	-	-	-	-	0.4	0.4
Lacuna sp.	7.5	7.5	-	-	-	-	-	-
Littorina sitkana	160.0	46.0	31.2	11.3	494.4	38.7	223.6	81.4
Lottia pelta	-	-	-	-	-	-	0.8	0.5
Lottia strigatella	-	-	-	-	-	-	1.2	0.9
Lottiidae spp.	3.0	1.0	14.4	6.8	8.8	2.8	3.6	2.2
Lottiidae spp. (juvenile)	-	-	-	-	-	-	4.4	1.8
Nucella lima	-	-	1.6	1.0	2.0	1.1	15.6	4.6
Pagurus hirsutiusculus	12.5	6.6	12.0	5.2	0.4	0.4	6.0	1.5
Pagurus sp.	-	-	0.8	0.8	-	-	-	-
Tectura scutum	-	-	-	-	-	-	5.2	3.6
Telmessus cheiragonus	-	-	-	-	-	-	1.6	1.6
Total Lottiidae	**3.0**		**14.4**		**8.8**		**15.2**	
Animal Area Cover (%)								
Balanus glandula	-	-	-	-	0.1	0.1	-	-
Balanus/Semibalanus (set)	0.1	0.1	-	-	-	-	0.1	0.1
Chthamalus dalli	1.8	0.4	0.8	0.6	2.1	0.6	3.6	0.7
Chthamalus dalli (set)	-	-	-	-	-	-	0.1	0.1
Semibalanus balanoides	1.1	0.3	0.8	0.1	8.4	2.8	3.1	1.2
Semibalanus balanoides (set)	-	-	10.3	6.4	-	-	0.8	0.1
Semibalanus cariosus	-	-	-	-	0.1	0.1	-	-
Total Balanomorpha	**3.0**		**11.9**		**10.6**		**7.7**	
Dead Animals (%)								
Balanus/Semibalanus (dead)	0.2	0.1	-	-	-	-	-	-
Chthamalus dalli (dead)	0.3	0.2	-	-	0.7	0.3	0.1	0.1
Semibalanus balanoides (dead)	-	-	-	-	0.4	0.2	0.1	0.1

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-17

Macrobiota at Scott Island (MSI), Middle Tidal Elevation, 2004, 2005, 2006, and 2008

	Middle Elevation							
	Sep 2004		Jul 2005		Apr 2006		Jul 2008	
	n = 8		n = 6		n = 7		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)								
Acrosiphonia arcta	0.1	0.1	-	-	-	-	-	-
Acrosiphonia sp.	-	-	-	-	0.3	0.3	-	-
Blidingia minima	-	-	-	-	-	-	0.6	0.3
Filamentous green algae	-	-	0.2	0.2	2.3	1.0	-	-
Monostroma grevillei	0.1	0.1	0.1	0.1	-	-	2.1	0.6
Ulva linza	0.9	0.6	1.3	0.5	-	-	-	-
Ulva sp.	1.2	0.5	1.1	0.8	-	-	-	-
Ulva/Ulvaria sp.	-	-	-	-	1.1	0.4	0.6	0.3
Diatoms	-	-	-	-	32.1	7.0	-	-
Elachista fucicola	4.6	0.9	8.0	1.7	-	-	0.6	0.3
Fucus distichus subsp. *evanescens*	58.8	6.8	81.2	5.7	8.4	2.3	7.7	2.2
Fucus distichus subsp. *evanescens* (germlings)	0.1	0.1	-	-	-	-	0.1	0.1
Pilayella littoralis	0.1	0.1	-	-	-	-	0.7	0.2
Articulated coralline algae	-	-	-	-	-	-	0.2	0.1
Cryptosiphonia woodii	0.2	0.1	0.2	0.2	-	-	0.1	0.1
Halosaccion glandiforme	1.4	0.3	0.8	0.3	0.4	0.2	1.1	0.4
Mastocarpus dichotomus	-	-	-	-	0.4	0.2	0.2	0.2
Mazzaella sp.	7.1	1.5	2.2	0.5	0.1	0.1	0.7	0.3
Neorhodomela aculeata	0.3	0.3	-	-	-	-	0.2	0.2
Neorhodomela larix	-	-	-	-	0.1	0.1	-	-
Neorhodomela oregona	-	-	-	-	-	-	0.1	0.1
Palmaria callophylloides	24.0	6.3	32.5	9.8	25.0	4.5	36.6	5.5
Palmaria hecatensis	28.1	1.4	30.2	4.9	40.7	5.2	44.3	3.4
Palmaria mollis	-	-	-	-	-	-	0.8	0.8
Porphyra aestivalis	2.0	1.2	1.1	0.8	-	-	1.2	0.2
Porphyra cuneiformis	-	-	1.7	1.3	-	-	-	-
Pterosiphonia bipinnata	0.3	0.3	0.4	0.3	-	-	-	-
Black crust	-	-	3.7	1.5	-	-	-	-
Encrusting coralline algae	0.3	0.2	-	-	-	-	-	-
Encrusting green algae	2.3	0.8	-	-	0.1	0.1	-	-
Encrusting red algae, unid.	8.8	3.2	5.2	1.6	-	-	3.2	2.0
Hildenbrandia rubra	0.3	0.3	-	-	-	-	0.8	0.4
Petrocelis phase of *Mastocarpus*	-	-	-	-	-	-	5.4	1.4
Ralfsia sp.	-	-	0.1	0.1	-	-	-	-
Total Algal Cover (%)	**140.8**		**169.8**		**79.0**		**106.9**	
Animals (#/m²)								
Lacuna sp.	30.0	12.7	-	-	-	-	-	-
Leptasterias sp.	0.5	0.5	-	-	-	-	-	-
Nucella lima	0.5	0.5	-	-	-	-	-	-
Pagurus hirsutiusculus	3.5	1.6	7.3	1.2	-	-	2.0	0.9
Pagurus sp.	-	-	0.7	0.7	0.6	0.6	-	-
Pugettia gracilis	0.5	0.5	-	-	-	-	-	-
Tectura scutum	-	-	-	-	-	-	2.0	1.6
Total Lottiidae	**-**		**-**		**-**		**2.0**	

	Middle Elevation							
	Sep 2004 n = 8		Jul 2005 n = 6		Apr 2006 n = 7		Jul 2008 n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animal Area Cover (%)								
Balanus crenatus	1.6	0.4	-	-	-	-	-	-
Balanus/Semibalanus (set)	-	-	0.8	0.5	-	-	-	-
Bryozoan, encrusting	0.1	0.1	0.1	0.1	-	-	-	-
Chthamalus dalli (set)	-	-	-	-	-	-	0.1	0.1
Halichondria panicea	7.1	2.3	8.6	3.6	2.2	1.0	2.1	1.5
Semibalanus balanoides	0.3	0.1	-	-	-	-	0.2	0.1
Semibalanus balanoides (set)	-	-	0.6	0.3	-	-	0.3	0.1
Total Balanomorpha	**1.8**		**1.4**		**0.0**		**0.5**	

Notes:

Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-18

Macrobiota at Scott Island (MSI), Lower Tidal Elevation, 2004, 2006, and 2008

	Lower Elevation					
	Sep 2004		May 2006		Jul 2008	
	n = 5		n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)						
Acrosiphonia arcta	-	-	-	-	1.6	0.9
Acrosiphonia coalita	-	-	-	-	0.8	0.8
Acrosiphonia sp.	0.5	0.4	0.7	0.6	-	-
Filamentous green algae	-	-	0.1	0.1	-	-
Monostroma grevillei	-	-	-	-	0.5	0.4
Ulva linza	1.5	0.9	-	-	0.1	0.1
Ulva sp.	12.2	2.5	-	-	-	-
Ulva/Ulvaria obscura var. blyttii	-	-	4.6	1.6	2.3	1.9
Diatoms	-	-	1.8	0.8	-	-
Alaria sp.	-	-	-	-	3.0	3.0
Alaria taeniata	2.0	2.0	-	-	-	-
Elachista fucicola	0.2	0.2	-	-	-	-
Elachista lubrica	-	-	-	-	0.1	0.1
Fucus distichus subsp. *evanescens*	11.0	6.6	9.0	4.9	14.4	12.7
Fucus distichus subsp. *evanescens* (germlings)	1.0	1.0	-	-	-	-
Leathesia difformis	0.4	0.4	-	-	-	-
Petalonia fascia	-	-	0.2	0.1	-	-
Saccharina latissama	-	-	2.0	1.3	20.0	20.0
Saccharina sp.	-	-	-	-	42.0	17.8
Saccharina subsimplex	31.0	12.9	21.6	8.7	-	-
Articulated coralline algae	-	-	0.3	0.1	-	-
Constantinea subulifera	0.6	0.6	1.1	0.7	4.1	4.0
Corallina frondescens	1.6	0.9	-	-	1.1	0.5
Corallina officinalis	0.2	0.2	-	-	0.3	0.2
Cryptoneura sp.	-	-	0.4	0.4	-	-
Cryptosiphonia woodii	-	-	0.8	0.4	0.6	0.4
Filamentous red algae	-	-	0.3	0.2	-	-
Halosaccion glandiforme	1.7	0.5	1.8	0.9	0.4	0.2
Mastocarpus dichotomus	1.8	1.4	4.9	1.6	1.2	0.8
Mazzaella phyllocarpa	-	-	-	-	2.6	1.7
Mazzaella sp.	3.5	1.5	2.6	1.5	4.2	1.7
Neodilsea borealis	0.8	0.8	-	-	-	-
Neorhodomela oregona	0.3	0.2	-	-	-	-
Odonthalia kamschatica	-	-	-	-	0.1	0.1
Palmaria callophylloides	5.2	1.7	3.4	0.7	6.2	4.8
Palmaria hecatensis	21.4	12.5	26.3	10.5	21.2	11.1
Palmaria mollis	-	-	-	-	13.8	5.1
Phycodrys riggii	1.0	0.6	-	-	0.3	0.2
Porphyra cuneiformis	-	-	-	-	0.2	0.1
Pterosiphonia bipinnata	0.2	0.2	-	-	-	-
Rhodomela tenuissima	-	-	-	-	0.1	0.1
Encrusting coralline algae	10.2	5.1	2.8	1.4	10.6	7.4
Encrusting coralline algae (dead)	-	-	-	-	0.4	0.4
Encrusting green algae	0.2	0.2	-	-	0.2	0.2
Encrusting red algae, unid.	1.6	1.6	-	-	-	-
Petrocelis phase of *Mastocarpus*	-	-	-	-	7.0	5.8
Ralfsia fungiformis	0.4	0.4	0.6	0.2	1.0	0.6
Ralfsia sp.	0.2	0.2	1.8	0.7	-	-
Total Algal Cover (%)	**110.7**		**85.3**		**160.4**	

	Lower Elevation					
	Sep 2004		May 2006		Jul 2008	
	n = 5		n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Animals (#/m²)						
Anthophleura artemisia	4.0	3.1	0.8	0.8	0.8	0.8
Clam shows / siphons	-	-	4.8	3.9	-	-
Colonial fleshy tunicate, unid.	-	-	-	-	0.4	0.4
Lacuna sp.	137.6	73.6	1.6	1.6	0.8	0.8
Leptasterias hexactis	-	-	1.6	1.6	-	-
Leptasterias sp.	2.4	1.6	-	-	0.8	0.8
Lottiidae spp.	0.8	0.8	-	-	-	-
Margarites pupillus	0.8	0.8	0.8	0.8	-	-
Margarites set	-	-	-	-	0.4	0.4
Modiolus modiolus	4.8	4.8	4.8	2.9	-	-
Mya sp.	0.8	0.8	-	-	-	-
Pagurus beringanus	1.6	1.0	2.4	1.0	0.8	0.8
Pagurus hirsutiusculus	4.0	1.8	-	-	1.6	1.6
Paranemertes peregrina	0.8	0.8	-	-	-	-
Pugettia dalli	-	-	-	-	0.8	0.8
Pugettia gracilis	0.8	0.8	-	-	-	-
Shrimp	1.6	1.6	-	-	-	-
Solitary tunicate, orange	-	-	-	-	2.4	2.4
Tectura scutum	-	-	-	-	2.4	1.6
Telmessus cheiragonus	-	-	-	-	2.4	1.6
Tonicella lineata	14.4	3.2	4.0	1.3	3.2	2.0
Total Lottiidae	**0.8**		**0.0**		**2.4**	
Animal Area Cover (%)						
Balanus crenatus	0.6	0.2	-	-	-	-
Balanus/Semibalanus (set)	-	-	-	-	0.1	0.1
Balanus/Semibalanus spp.	0.2	0.1	0.1	0.1	-	-
Bryozoan, arborescent	-	-	-	-	0.2	0.2
Bryozoan, encrusting	1.0	0.6	-	-	0.2	0.2
Bryozoan, plunoa	-	-	0.1	0.1	-	-
Chthamalus dalli	0.2	0.1	-	-	0.1	0.1
Garveia sp.	0.2	0.1	-	-	-	-
Halichondria panicea	0.2	0.2	0.1	0.1	0.4	0.2
Haliclona sp.	-	-	0.2	0.2	-	-
Hydroidea sp.	-	-	-	-	0.1	0.1
Porifera, orange	1.0	0.8	1.1	1.0	-	-
Semibalanus balanoides	-	-	-	-	0.2	0.2
Semibalanus balanoides (set)	-	-	-	-	0.1	0.1
Serpulidae sp.	0.4	0.2	-	-	-	-
Spirobidae, unid.	0.2	0.1	0.3	0.1	-	-
Suberites sp.	-	-	0.6	0.6	-	-
Total Balanomorpha	**1.0**		**0.1**		**0.5**	

	Lower Elevation					
	Sep 2004		May 2006		Jul 2008	
	n = 5		n = 5		n = 5	
Taxon	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Dead Animals (%)						
Balanus crenatus (dead)	0.2	0.2	-	-	-	-
Semibalanus balanoides (dead)	-	-	-	-	0.1	0.1

Notes:
Chlorophyta (non-encrusting) - greens
Ochrophyta (diatoms)
Phaeophyta (non-encrusting) - browns
Rhodophyta (non-encrusting) - reds
All Encrusting Forms

Lottiidae
Balanomorpha
Set = Area of young-of-the-year recruitment
m^2 = square meters

Table 42-19

Macrobiota at Blackie Beach (MBB), Lower Tidal Elevation, 2004 and 2008

	Lower Elevation			
	Sep 2004		Jul 2008	
	n = 5		n = 10	
Taxon	**Mean**	**SE**	**Mean**	**SE**
Plants (% cover)*				
Zostera marina	2.6	1.2	56.0	8.3
Ulva linza	-	-	0.3	0.3
Ulva sp.	2.0	0.9	0.8	0.6
Dictyosiphon foeniculaceus	-	-	0.5	0.5
Saccharina sp.	-	-	0.5	0.5
Porphyra aestivalis	-	-	0.1	0.1
Total Algal Cover (%)	**4.6**		**58.2**	

Notes:

Chlorophyta (non-encrusting) - greens

Ochrophyta (diatoms)

Phaeophyta (non-encrusting) - browns

Rhodophyta (non-encrusting) - reds

All Encrusting Forms

Lottiidae

Balanomorpha

Set = Area of young-of-the-year recruitment

m^2 = square meters

Table 42-20

Ranking of Numerically Dominant Intertidal Macroinfaunal Taxa (first ten) by Average Abundance

	2004			2005			2008		
Station	**Taxon**	**#/m^2**	**SE**		**#/m^2**	**SE**		**#/m^2**	**SE**
MPS3-Low	*Macoma* sp.	156	44	Oligochaeta	1,644	808	*Nephtys ciliata*	156	27
	Nephtys cornuta	156	83	*Polydora* sp.	711	303	Oligochaeta	111	70
	Nephtys ciliata	133	42	Harpacticoida	333	253	*Macoma balthica*	67	27
	Ampharetidae	44	27	*Nephtys cornuta*	244	74	*Ampharete crassiseta*	22	22
	Mya sp.	44	27	*Nephtys ciliata*	200	82	*Clinocardium nuttallii*	22	22
	Clinocardium nuttallii	22	22	*Spio filicornis*	200	54	*Glycinde picta*	22	22
	Mysella planata	22	22	*Lacuna vincta*	156	83	*Spio filicornis*	22	22
	Pygospio elegans	22	22	*Mysella planata*	133	82			
				Sabellidae	111	70			
MPS3-Mid	*Nephtys ciliata*	111	70	*N/A*			*Pygospio elegans*	2,533	1,183
	Scoloplos armiger	111	70				*Cumella vulgaris*	1,756	636
	Polychaeta, unid.	89	22				*Macoma balthica*	1,756	212
	Polydora sp.	89	42				Oligochaeta	689	194
	Macoma balthica	67	44				Arenicolidae	200	82
	Orbiniidae	67	67				*Sphaerosyllis* sp. N1	200	108
	Abarenicola pacifica	22	22				*Spio filicornis*	156	57
	Bivalvia	22	22				*Tubulanus* sp. A	133	82
	Capitella capitata	22	22				*Glycinde picta*	111	61
	Echiurus echiurus	22	22				*Eteone* sp.	111	50
MPSE-Mid	*Macoma balthica*	822	67	Oligochaeta	489	462	*Macoma balthica*	1,667	157
	Abarenicola pacifica	89	22	*Macoma* sp.	89	42	*Mya arenaria*	244	74
	Bivalvia	67	67	*Eteone longa*	22	22	*Eteone* sp.	133	65
	Mya sp.	44	44				*Pontoporeia femorata*	89	65
	Polychaeta, unid.	44	27				*Rochefortia tumida*	89	42
	Eteone sp.	22	22				*Capitella capitata*	67	44
	Priapulidae	22	22				*Echiurus echiurus alaskanus*	44	27
	Pygospio elegans	22	22				*Glycinde picta*	44	27
							Oligochaeta	44	27
							Ampharete crassiseta	22	22
MPSE2-Mid	*N/A*			*N/A*			*Macoma balthica*	2,578	237
							Eteone sp.	200	82
							Spio filicornis	89	42
							Mya arenaria	44	27
							Oligochaeta	44	44
							Pygospio elegans	44	27
							Nephtys ciliata	22	22
							Pontoporeia femorata	22	22

Station	2004 Taxon	#/m²	SE	2005 Taxon	#/m²	SE	2008 Taxon	#/m²	SE
MBSA1-Mid	*N/A*			*Pygospio elegans*	2,156	1,117	*Pygospio elegans*	1,489	558
				Macoma sp.	111	0	*Rhynchospio glutaea*	1,356	576
				Polychaeta, unid.	111	0	*Macoma balthica*	911	82
				Macoma balthica	89	65	*Tubulanus* sp. A	311	170
				Nephtys ciliata	89	54	*Eteone* sp.	200	65
				Orbiniidae	67	44	Oligochaeta	156	75
				Lacuna vincta	44	27	*Capitella capitata*	133	42
				Nephtys sp.	44	27	*Spio filicornis*	111	35
				Polydora sp.	44	27	*Nephtys caeca*	111	50
				Ampharetidae	22	22	*Laonome kroeyeri*	89	54
MPS4-Mid	*Polydora* sp.	578	376	*Mysella planata*	511	349	Oligochaeta	2,178	657
	Nephtys ciliata	333	153	*Polydora* sp.	511	430	*Protodriloides chaetifer*	222	222
	Nephtys sp.	244	133	*Lacuna vincta*	244	142	*Amphiporus* sp.	22	22
	Mysella planata	156	109	*Polychaeta, unid.*	111	0	*Aricidea lopezi*	22	22
	Polychaeta, unid.	111	0	*Eteone longa*	67	44	*Gammaropsis* sp.	22	22
	Scoloplos armiger	111	61	*Leitoscoloplos panamensis*	67	44	*Hoplonemertea*	22	22
	Capitellidae	89	54	*Nephtys ciliata*	67	27	*Mya* sp.	22	22
	Chaetozone sp.	67	44	*Nephtys* sp.	67	27	*Paramoera* sp.	22	22
	Eteone sp.	67	44	*Capitella capitata*	44	44	*Tetrastemma* sp.	22	22
	Nephtys cornuta	67	67	Cirratulidae	44	44			
MPS1A-Mid	*Cossura* sp.	67	67	*Spio filicornis*	67	27	*N/A*		
	Nephtys longosetosa	44	27	*Lacuna vincta*	22	22			
	Polychaeta, unid.	44	27	*Littorina sitkana*	22	22			
	Macoma sp.	22	22	*Nephtys longosetosa*	22	22			
	Nemertea	22	22						
	Prionospio sp.	22	22						
MPS2-Low	*Nephtys cornuta*	200	133	*Nephtys ciliata*	67	27	*Nephtys ciliata*	133	65
	Nephtys ciliata	111	61	*Lacuna vincta*	22	22	*Rochefortia tumida*	111	61
	Nephtyidae	44	27	*Macoma* sp.	22	22	*Nephtys cornuta*	67	44
	Spio sp.	22	22	*Nephtys* sp.	22	22	Ampharetidae	44	27
				Polychaeta, unid.	22	22	*Eteone* sp.	44	44
							Ampharete sp.	22	22
							Capitella capitata	22	22
							Gammaropsis sp.	22	22
							Macoma balthica	22	22
							Nephtys caeca	22	22

	2004			2005			2008		
Station	**Taxon**	**#/m²**	**SE**		**#/m²**	**SE**		**#/m²**	**SE**
MBB-Low	*Chaetozone* sp..	489	201	*Polydora* sp.	2,422	2,395	*Nephtys ciliata*	89	22
	Pygospio elegans	489	227	*Pygospio elegans*	822	378	*Aricidea catherinae*	67	44
	Aricidea lopezi	111	50	*Chaetozone* sp.	422	244	*Dipolydora brachycephala*	22	22
	Polychaeta, unid.	111	0	*Capitella capitata*	267	267	*Glycinde picta*	22	22
	Actiniaria	67	67	Oligochaeta	178	178			
	Lacuna sp.	67	67	Gastropoda	133	82			
	Nephtys ciliata	67	27	*Nephtys ciliata*	111	35			
	Nephtys sp.	67	44	Polychaeta, unid.	111	0			
	Rhynchospio glutaea	44	27	Cirratulidae	67	67			
	Echiurus echiurus alaskensis	22	22	*Eteone longa*	67	44			

Notes:
All n = 5
N/A = not available; SE = standard error of the mean; m^2 = square meters

Annelida
Arthropoda
Mollusca
Misc. Taxa

Table 42-21
Ranking of Dominant Intertidal Macroinfaunal Groups by Average Biomass

Station	2004 Group	2004 Biomass (g/m^2)	2004 SE	2005 Group	2005 Biomass (g/m^2)	2005 SE	2008 Group	2008 Biomass (g/m^2)	2008 SE
MPS3-Low	Mollusca	11.4	4.8	Annelida	21.1	5.9	Mollusca	130.8	123.8
	Annelida	8.3	2.3	Mollusca	6.6	4.3	Annelida	1.3	0.4
				Arthropoda	0.1	0.1			
MPS3-Mid	Mollusca	58.7	43.7	N/A			Mollusca	418.7	292.4
	Annelida	20.3	7.9				Annelida	3.6	0.9
	Misc. Taxa	5.8	5.8				Misc. Taxa	0.4	0.2
							Arthropoda	0.1	0.0
MPSE-Mid	Mollusca	90.2	16.1	Mollusca	6.9	3.4	Mollusca	242.5	40.9
	Annelida	7.6	3.5	Annelida	0.1	0.1	Annelida	1.5	0.4
	Misc. Taxa	1.0	1.0				Misc. Taxa	0.4	0.3
							Arthropoda	0.0	0.0
MPSE2-Mid	N/A			N/A			Mollusca	115.9	10.8
							Annelida	0.8	0.4
MBSA1-Mid	N/A			Mollusca	66.0	26.8	Mollusca	457.7	149.4
				Annelida	6.3	2.3	Annelida	1.5	0.8
							Misc. Taxa	0.1	0.1
MPS4-Mid	Mollusca	500.3	496.3	Annelida	8.1	2.6	Annelida	0.2	0.0
	Annelida	12.0	4.5	Mollusca	6.7	4.6	Misc. Taxa	0.0	0.0
MPS1A-Mid	Annelida	0.5	0.2	Mollusca	0.9	0.9	N/A		
	Mollusca	0.1	0.1	Annelida	0.8	0.6			
MPS2-Low	Annelida	8.3	2.8	Annelida	13.2	5.9	Annelida	0.9	0.5
				Mollusca	2.2	2.1	Mollusca	0.6	0.4
MBB-Low	Annelida	18.9	5.1	Annelida	15.1	6.5	Annelida	0.4	0.1
	Misc. Taxa	6.6	6.5	Mollusca	1.6	1.5			
	Mollusca	0.5	0.5						

Notes:
2004 and 2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
All n = 5
N/A = not available; SE = standard error of the mean; m^2 = square meters
g/m^2 = grams per square meters

Annelida
Arthropoda
Mollusca
Misc. Taxa

Table 42-22

Averages of Intertidal Macroinfaunal Measures by Station and Year

		MPS3-Low	MPS3-Mid	MPSE-Mid	MPSE2-Mid	MBSA1-Mid	MPS4-Mid	MPS1A-Mid	MPS2-Low	MBB-Low
Abundance (#/m^2)										
2004	Mean	600.0	844.4	1,133.3	N/A	N/A	2,177.8	222.2	377.8	1,644.4
	SE	143.2	194.4	41.6	N/A	N/A	446.7	121.7	143.2	414.8
2005	Mean	4,244.4	N/A	600.0	N/A	2,844.4	1,888.9	133.3	155.6	4,911.1
	SE	1,138.8	N/A	517.1	N/A	1,196.5	600.4	41.6	27.2	3,551.3
2008	Mean	422.2	8,488.9	2,511.1	3,044.4	5,288.9	2,555.6	N/A	533.3	200.0
	SE	41.6	1,404.8	218.3	259.6	1,102.0	726.1	N/A	196.9	54.4
Biomass (g/m^2)										
2004	Mean	98.1	424.0	494.2	N/A	N/A	2,561.8	3.1	41.7	130.1
	SE	3.5	31.4	22.0	N/A	N/A	391.3	0.2	2.8	6.1
2005	Mean	139.0	N/A	35.1	N/A	361.3	74.0	8.1	76.8	83.5
	SE	5.8	N/A	3.4	N/A	22.8	3.6	0.9	5.3	5.8
2008	Mean	660.3	2,114.0	1,222.3	583.5	2,296.9	1.2	N/A	7.4	2.1
	SE	92.7	161.7	58.3	27.8	131.1	0.0	N/A	0.5	0.1
Number of Taxa (N)										
2004	Mean	3.6	5.6	3.2	N/A	N/A	8.0	1.6	1.6	6.4
	SE	0.7	1.2	0.4	N/A	N/A	1.1	0.7	0.4	1.0
2005	Mean	9.6	N/A	1.2	N/A	6.2	6.6	1.2	1.4	7.4
	SE	0.9	N/A	0.5	N/A	0.6	0.8	0.4	0.2	2.1
2008	Mean	2.8	14.2	5.8	3.8	11.0	2.6	N/A	3.4	1.6
	SE	0.4	1.0	0.7	0.7	0.8	0.6	N/A	1.3	0.4
Simpson Dominance (S_I)										
2004	Mean	0.37	0.26	0.59	N/A	N/A	0.24	0.27	0.84	0.26
	SE	0.07	0.06	0.07	N/A	N/A	0.04	0.11	0.10	0.04
2005	Mean	0.26	N/A	0.94	N/A	0.49	0.30	0.60	0.80	0.36
	SE	0.06	N/A	0.05	N/A	0.08	0.08	0.19	0.12	0.04
2008	Mean	0.43	0.24	0.49	0.74	0.21	0.80	N/A	0.59	0.78
	SE	0.07	0.03	0.07	0.06	0.02	0.09	N/A	0.19	0.14
Shannon Diversity (H)										
2004	Mean	1.13	1.53	0.76	N/A	N/A	1.73	0.53	0.26	1.54
	SE	0.19	0.24	0.13	N/A	N/A	0.15	0.24	0.16	0.17
2005	Mean	1.76	N/A	0.11	N/A	1.12	1.53	0.28	0.28	1.36
	SE	0.15	N/A	0.10	N/A	0.16	0.21	0.17	0.17	0.12
2008	Mean	0.93	1.89	1.09	0.55	1.84	0.37	N/A	0.84	0.35
	SE	0.15	0.12	0.16	0.12	0.09	0.15	N/A	0.41	0.22

Notes:
2004 and 2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
*A few values are not included because we only have the specimens in the voucher collection.
Replicates with no infauna were given a count of 0 and weight of zero.
Diversity values are based on the non-zero replicates only.
N/A = not available; SE = standard error of the mean; m^2 = square meters
#/m^2 = abundance; g/m2 = grams per square meters

Table 42-23
Ranking of Dominant Megainfaunal Groups by Average Biomass

Station	2005 Group	2005 Biomass (g/m²)	2005 SE	2005 Abundance #/m²	2005 SE	2008 Group	2008 Biomass (g/m²)	2008 SE	2008 Abundance #/m²	2008 SE
MPS3-Low	Mollusca	2,281.1	N/A	420	N/A	N/A				
	Annelida	74.3	N/A	164	N/A					
	Arthropoda	8.8	N/A	20	N/A					
	Misc. Taxa	0.3	N/A	8	N/A					
MPS3-Mid	N/A					Mollusca	1147.5	N/A	120	N/A
						Annelida	0.2	N/A	8	N/A
MBSA1-Mid	Annelida	0.4	0.3	16	4.0	Mollusca	223.2	148.7	528	272.0
	Mollusca	0.2	0.2	16	16.0	Misc. Taxa	14.7	14.7	22	14.0
	Arthropoda	0.1	0.1	8	4.0	Annelida	2.1	1.9	30	18.0
MPS2-Low	Misc. Taxa	274.9	N/A	8	N/A	Annelida	1.7	N/A	4	N/A
	Mollusca	50.3	N/A	56	N/A	Mollusca	*	*	12	N/A
	Annelida	11.6	N/A	28	N/A					
	Arthropoda	1.8	N/A	4	N/A					

Notes:
2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
MPS3 and MPS2, n=1; MBSA1, n=2
*Biomass not measured because these specimens are part of our voucher collection.
N/A = not available; SE = standard error of the mean; m^2 = square meters
$\#/m^2$ = abundance; g/m^2 = grams per square meters

Annelida
Arthropoda
Mollusca
Misc. Taxa

Table 42-24
Averages of Subtidal Macroinfaunal Measures by Station and Year

		MPS4-Sub	MPS1-Sub	MPS2-Sub	MOPP1-Sub
Abundance (#/m^2)					
2004	Mean	2,478.0	3,940.0	2,210.0	5,150.0
	SE	745.5	479.6	500.0	N/A
2008	Mean	866.7	1,288.9	N/A	2,244.4
	SE	177.1	108.9	N/A	231.5
Biomass (g/m^2)					
2004	Mean	54.6	298.3	199.7	25.9
	SE	11.7	68.4	51.5	N/A
2008	Mean	1.6	11.7	N/A	5.1
	SE	0.3	4.6	N/A	1.3
Number of Taxa (N)					
2004	Mean	26.0	40.6	35.8	30.0
	SE	3.1	3.4	3.8	N/A
2008	Mean	4.8	8.6	N/A	9.0
	SE	0.7	0.6	N/A	1.3
Simpson Dominance (S_I)					
2004	Mean	0.1	0.1	0.1	0.2
	SE	0.0	0.0	0.0	N/A
2008	Mean	0.3	0.1	N/A	0.2
	SE	0.0	0.0	N/A	0.0
Shannon Diversity (H)					
2004	Mean	2.5	2.7	2.9	2.3
	SE	0.1	0.1	0.1	N/A
2008	Mean	1.4	2.0	N/A	1.9
	SE	0.1	0.1	N/A	0.2

Notes:
2004 and 2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
*A few values are not included because we only have the specimens in the voucher collection
Replicates with no infauna were given a count of 0 and weight of zero.
Diversity values are based on the non-zero replicates only.
N/A = not available; SE = standard error of the mean; m^2 = square meters
#/m^2 = abundance; g/m^2 = grams per square meters

Table 42-25
Ranking of Numerically Dominant Subtidal Macroinfaunal Taxa (first ten) by Average Abundance

Station	Taxon Name (2004)	2004 Abundance $\#/m^2$	2004 SE	Taxon Name (2008)	2008 Abundance $\#/m^2$	2008 SE
MPS4-Sub	*Cossura pygodactylata*	342	271	*Aricidea lopezi*	222	61
	Prionospio steenstrupi	314	127	*Scoloplos armiger armiger*	200	82
	Leitoscoloplos pugettensis	254	104	*Nephtys ciliata*	156	44
	Lumbrineris luti	238	77	*Pygospio elegans*	67	27
	Terebellidae	236	56	*Scoletoma luti*	67	27
	Nephtys sp.	138	35	*Diastylis alaskensis*	44	27
	Orbiniidae	138	56	*Macoma inquinata*	44	44
	Nephtys ciliata	132	50	*Aphelochaeta monilaris*	22	22
	Cirratulidae	82	32	*Chaetozone acuta*	22	22
	Nephtys cornuta	74	50	*Glycinde picta*	22	22
MPS1-Sub	*Lumbrineris luti*	892	166	*Nephtys ciliata*	200	65
	Prionospio steenstrupi	740	82	*Aphelochaeta glandaria* Cmplx	178	67
	Leitoscoloplos pugettensis	336	73	*Scoletoma luti*	133	42
	Cossura sp.	260	73	*Aricidea lopezi*	111	50
	Ennucula tenuis	256	110	*Pholoe minuta*	89	22
	Leitoscoloplos panamensis	112	26	*Scoloplos armiger armiger*	89	22
	Magelona longicornis	100	7	*Cossura pygodactylata*	67	27
	Nephtys ciliata	98	27	*Macoma calcarea*	67	44
	Pholoe minuta	96	26	*Prionospio steenstrupi*	67	44
	Nephtys cornuta	80	36	*Axinopsida serricata*	44	44
MPS2-Sub	*Lumbrineris luti*	290	88	*N/A*		
	Leitoscoloplos pugettensis	280	65			
	Prionospio steenstrupi	216	62			
	Ennucula tenuis	138	60			
	Nephtys ciliata	110	29			
	Terebellidae	102	57			
	Autolytus sp.	82	62			
	Nephtys sp.	82	37			
	Macoma sp.	62	42			
	Cossura pygodactylata	58	36			
MOPP1-Sub	Terebellidae	2,180	436	*Nephtys caeca*	644	54
	Lumbrineris luti	710	142	*Scoletoma luti*	311	119
	Ampharetidae	360	72	*Ampharete* sp.	267	103
	Spiophanes bombyx	290	58	*Scoloplos armiger armiger*	178	44
	Ampharete acutifrons	240	48	*Proclea* sp.	133	82
	Orbiniidae	170	34	*Solariella varicosa*	111	70
	Spiophanes sp.	140	28	*Diastylis alaskensis*	89	65
	Scoloplos armiger	120	24	*Euchone hancocki*	89	65
	Aricidea lopezi	110	22	*Aricidea catherinae*	44	27
	Leitoscoloplos pugettensis	110	22	*Aricidea lopezi*	44	27

Notes:
2004 and 2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
All n = 5
N/A = not available; SE = standard error of the mean; m^2 = square meters
$\#/m^2$ = abundance

Annelida
Arthropoda
Mollusca
Misc. Taxa

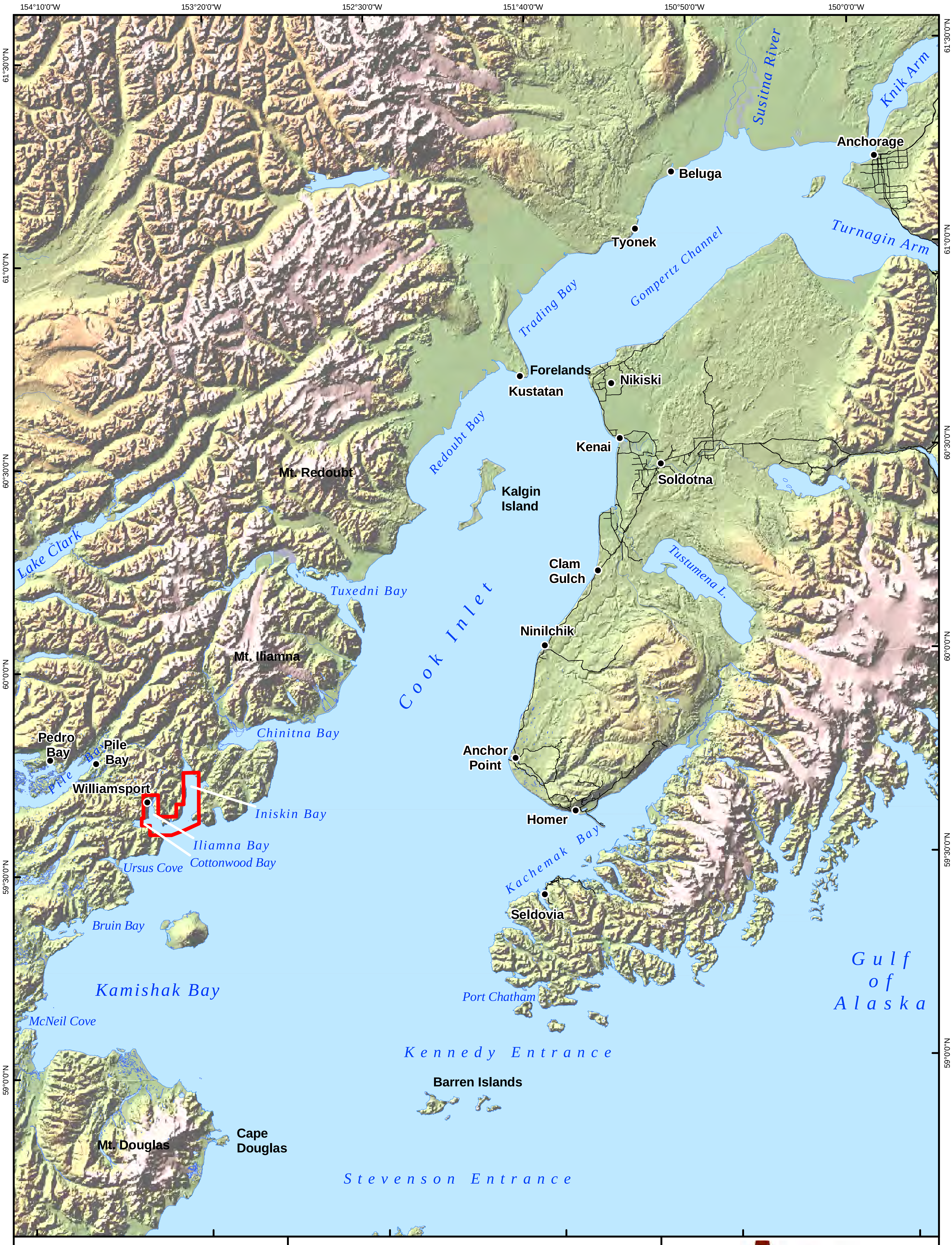
Table 42-26
Ranking of Dominant Subtidal Macroinfaunal Groups by Average Biomass

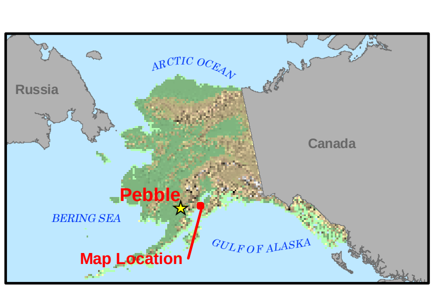
	2004			2008		
Station	Group	Biomass (g/m^2)	SE	Group	Biomass (g/m^2)	SE
MPS4-Sub	Annelida	31.0	13.9	Annelida	1.1	0.2
	Mollusca	23.6	12.4	Arthropoda	0.5	0.3
	Arthropoda	0.1	0.0			
MPS1-Sub	Mollusca	261.4	101.8	Annelida	10.4	6.1
	Annelida	34.4	7.2	Mollusca	1.3	0.8
	Misc. Taxa	2.1	1.5			
	Arthropoda	0.5	0.2			
MPS2-Sub	Mollusca	161.2	81.3	N/A		
	Annelida	25.9	10.6			
	Misc. Taxa	12.6	11.1			
	Arthropoda	0.1	0.0			
MOPP1-Sub	Annelida	23.0	N/A	Mollusca	2.6	1.7
	Mollusca	2.2	N/A	Annelida	2.4	1.0
	Arthropoda	0.8	N/A	Arthropoda	0.02	0.01

Notes:
2004 and 2005 Biomass values are based on wet weight, 2008 values are based on dry weight.
All n = 5
N/A = not available; SE = standard error of the mean; m^2 = square meters
g/m^2 = grams per square meters
Annelida
Arthropoda
Mollusca
Misc. Taxa

FIGURES[1]

[1] A master list of scientific and common names of plants and animals referred to in this report is provided in Appendix 42B.





Miles
0 10 20 30
Kilometers
0 10 20 30 40

N

Scale 1:1,000,000

Alaska State Plane Zone 5 (units feet)

1983 North American Datum

Legend

IIE Study Area

THE pebble PARTNERSHIP

Figure 42-1A

Cook Inlet and Kamishak Bay Region

File: RDI_Pen_Fig42-1A_ 11x17P_1of1_D01.mxd	Date: January 3, 2011
Version: 1	Author: RDI-LS

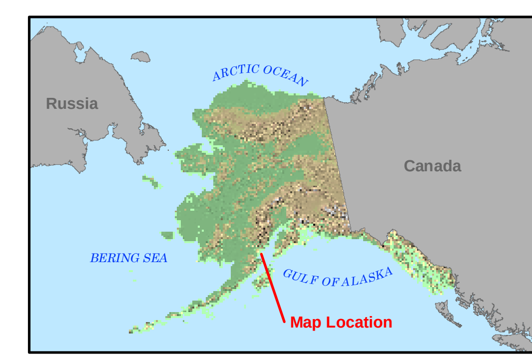
Figure 42-1B
Marine Benthos and Nearshore
Intertidal and Subtidal Sampling Locations

Legend

- Intertidal Infauna and Sediment Stations
- Subtidal Infauna and Sediment Stations
- Megainfauna Stations
- Rocky Intertidal Stations

Dive Transects

- 2008
- 2004



Miles: 0, 0.5, 1, 1.5, 2

Kilometers: 0, 0.5, 1, 1.5, 2

Scale 1:50,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

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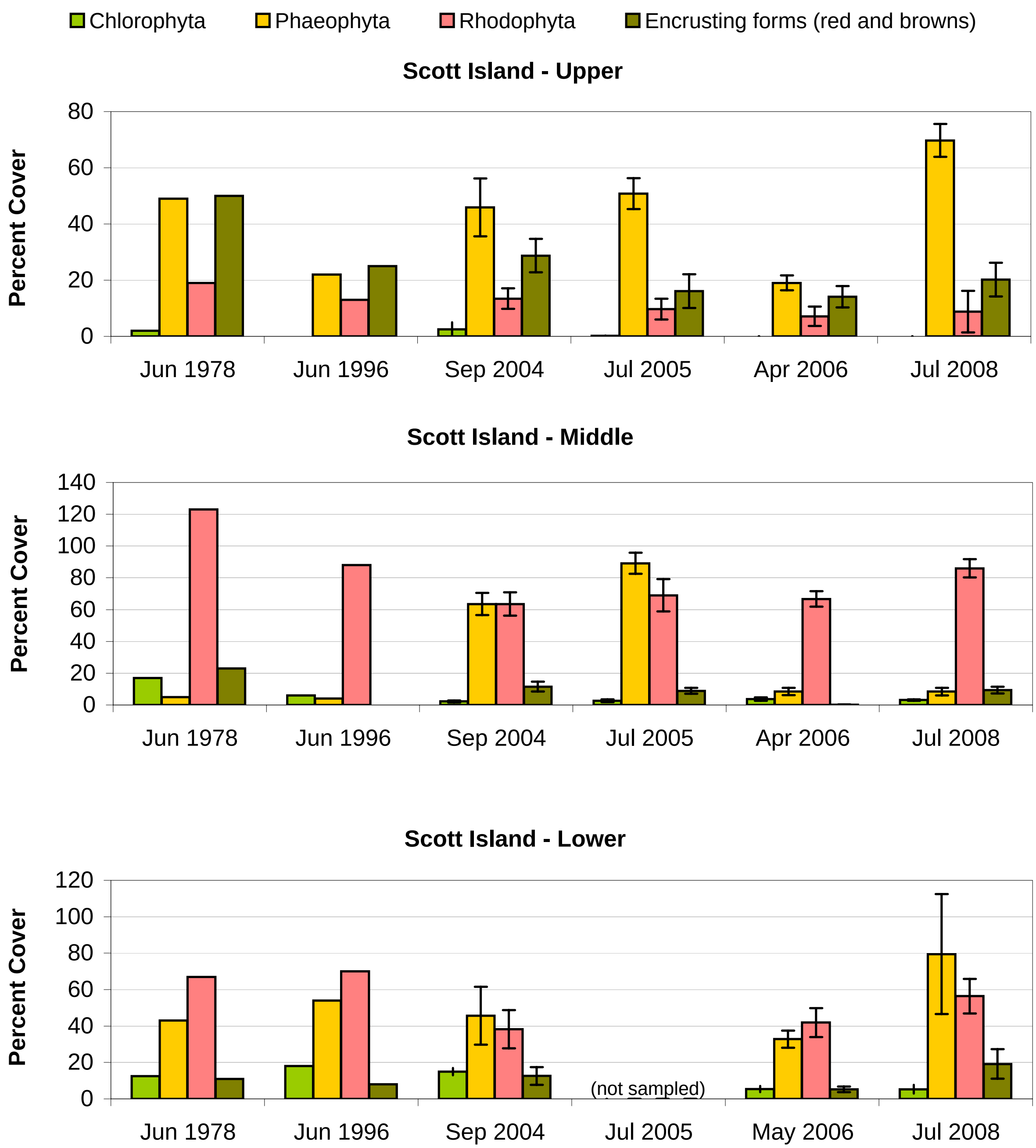


Figure 42-2
Abundance of Major Algal Groups at Scott Island (MSI), 1978 through 2008

Notes:
*Error bars are +/- the standard error of the mean.
1978 data from Lees et al., 1980

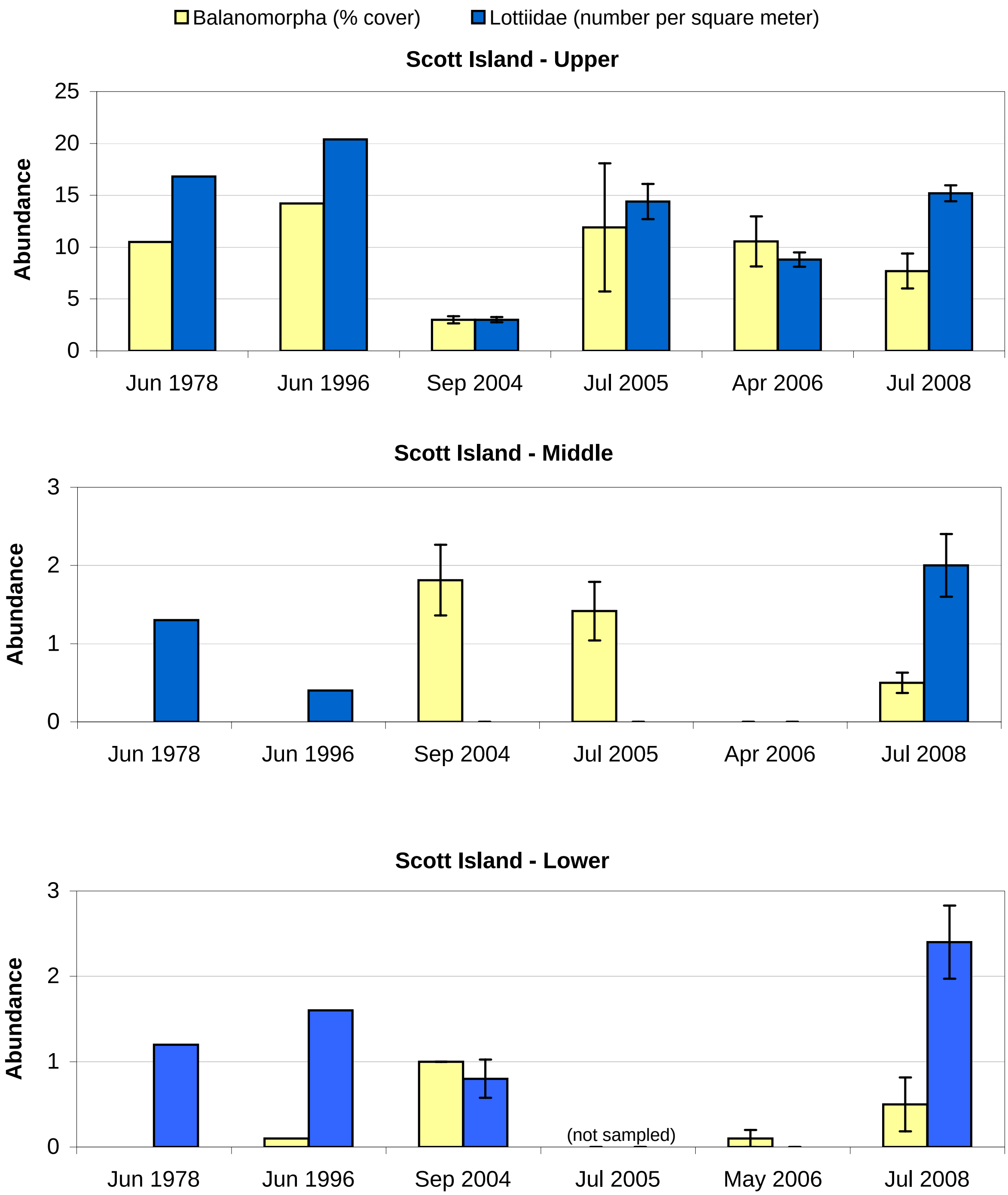


Figure 42-3
Abundance of Barnacles (Balanomorpha) and Limpets (Lottiidae) at Scott Island (MSI), 1978 through 2008

Notes:
*Error bars are +/- the standard error of the mean.
1978 data from Lees et al., 1980

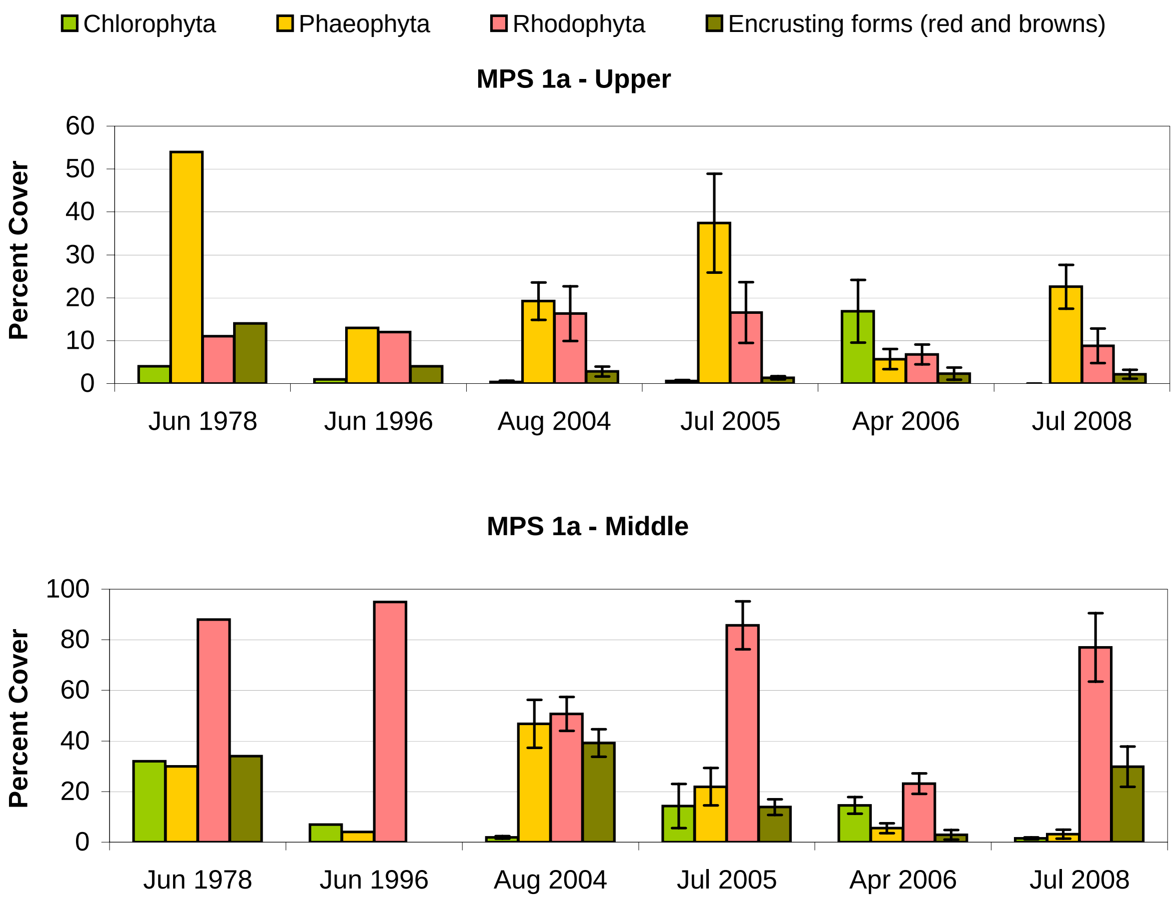


Figure 42-4
Abundance of Major Algal Groups at Knoll Head West (MPS1A), 1978 through 2008

Notes:
*Error bars are +/- the standard error of the mean.
1978 data from Lees et al., 1980

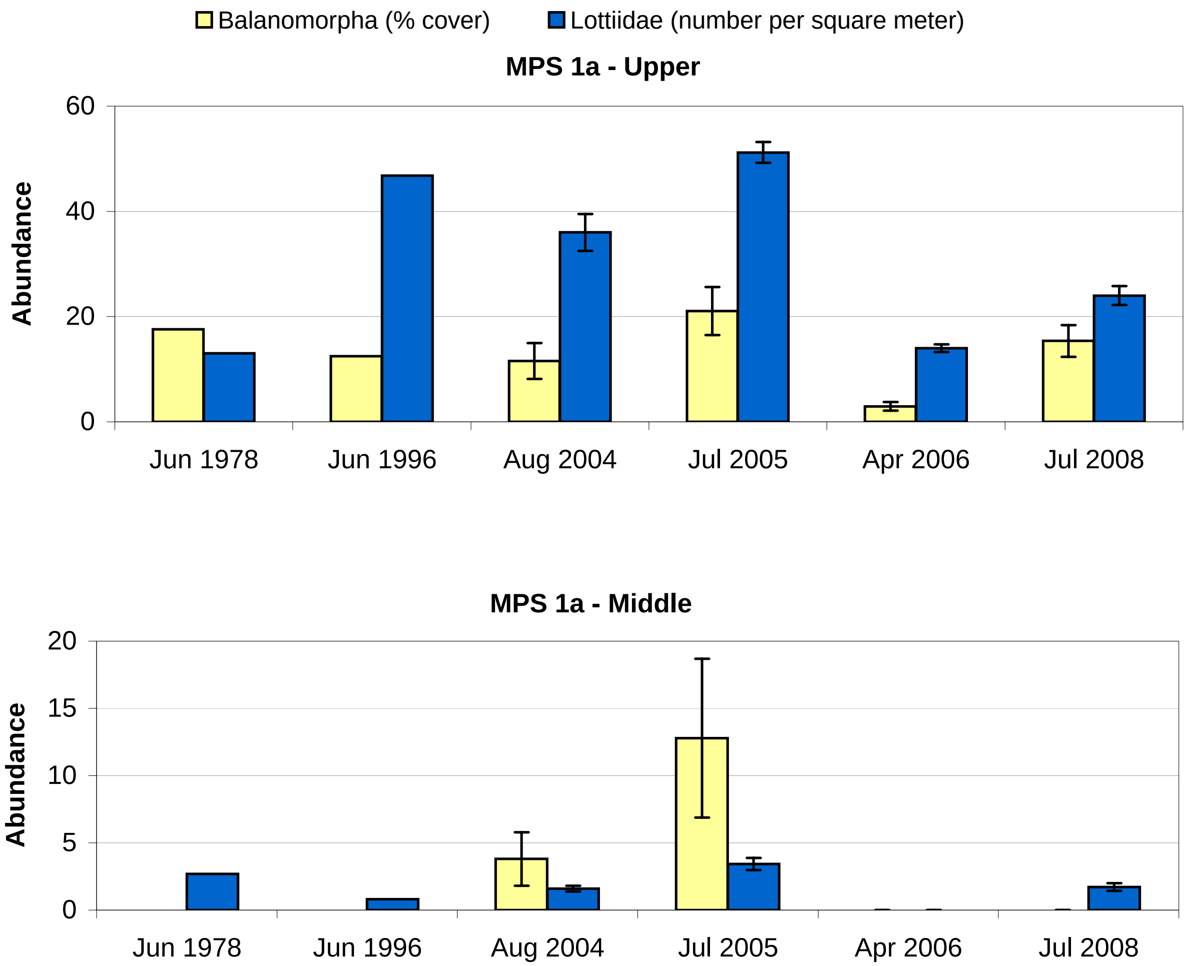


Figure 42-5

Abundance of Barnacles (Balanomorpha) and Limpets (Lottiidae) at Knoll Head West (MPS1A), 1978 through 2008

Notes:
*Error bars are +/- the standard error of the mean.
1978 data from Lees et al., 1980

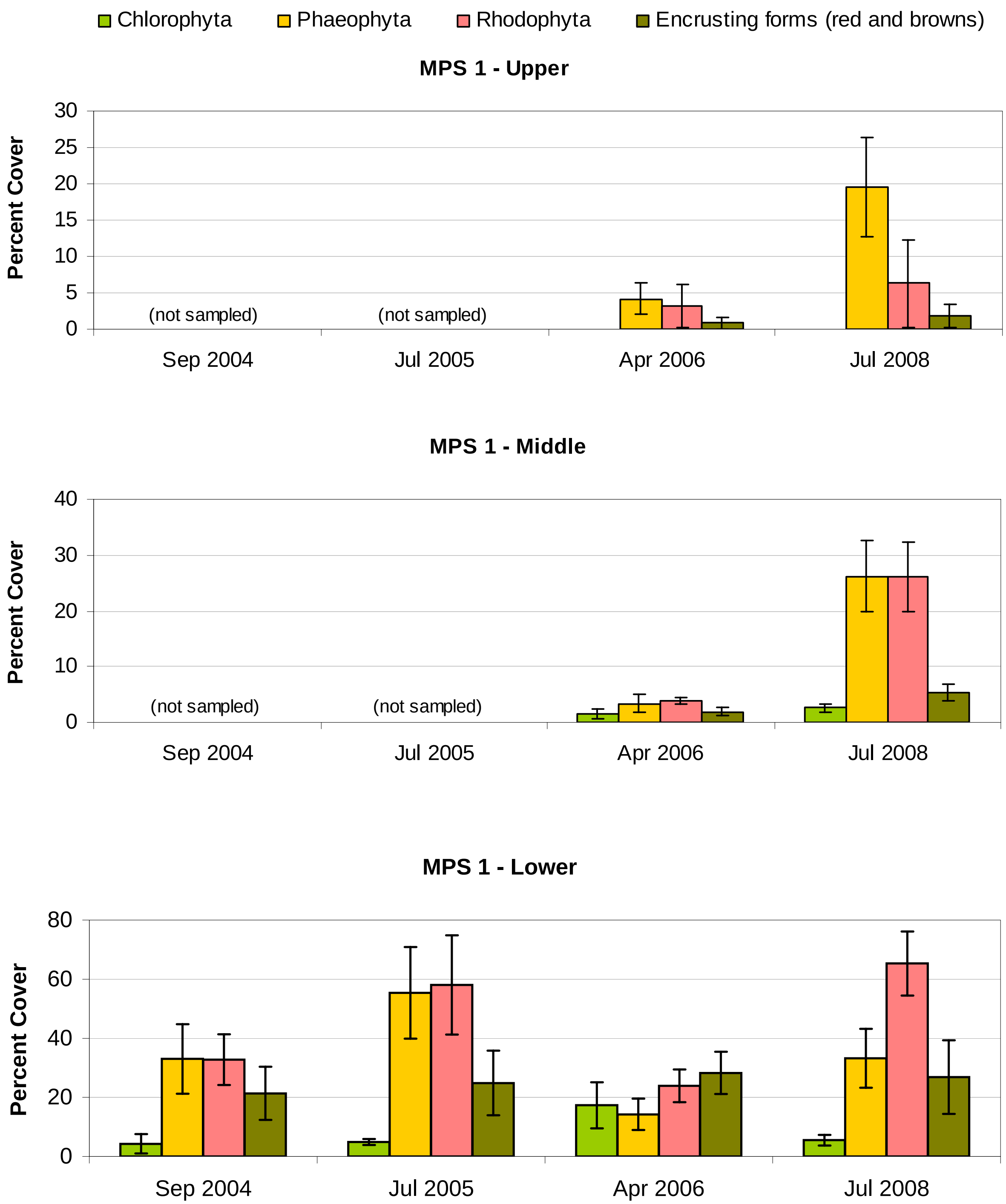


Figure 42-6
Abundance of Major Algal Groups at Knoll Head (MPS1), 1978 through 2008

Notes:

*Error bars are +/- the standard error of the mean.
1978 data from Lees et al., 1980

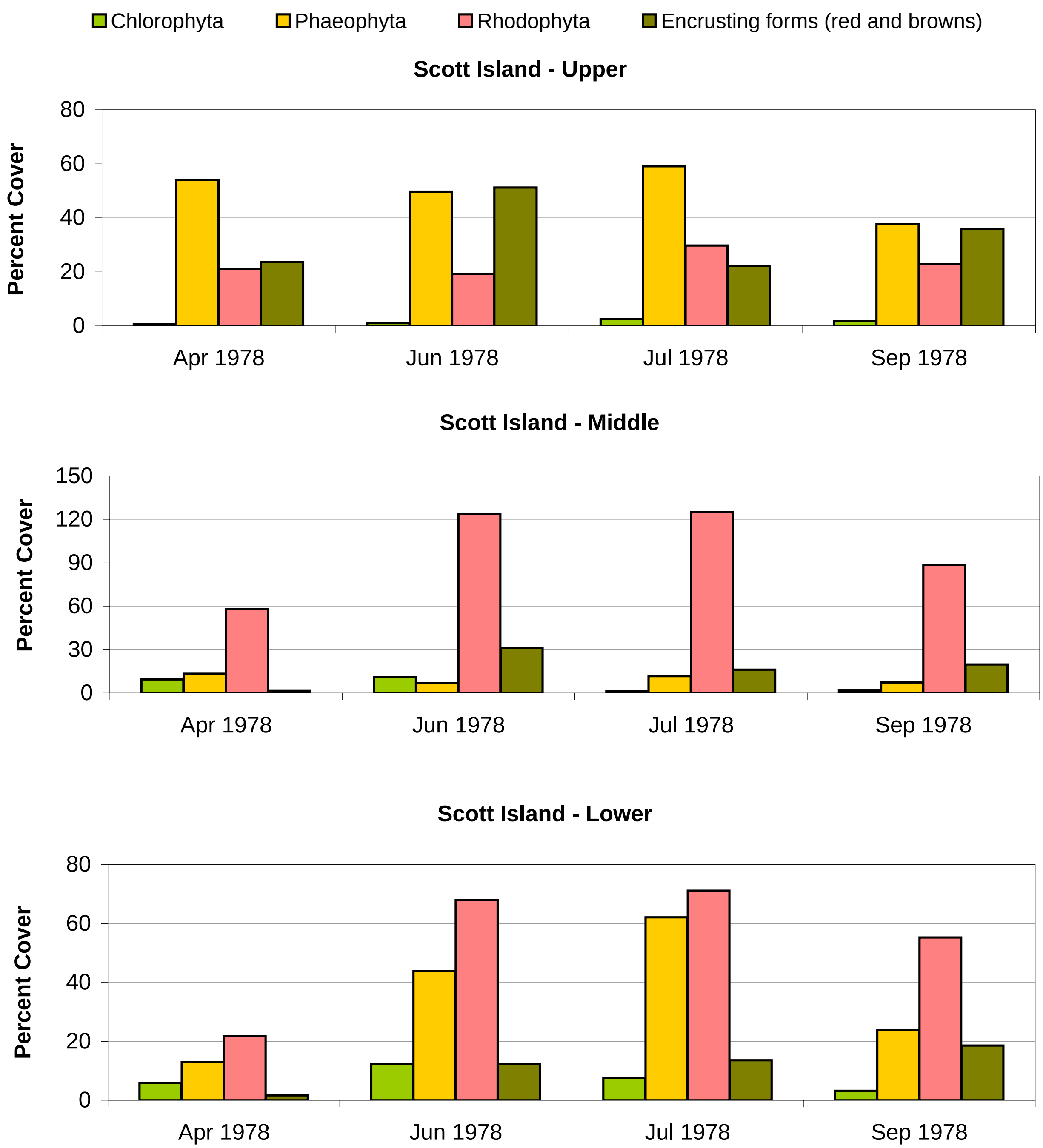
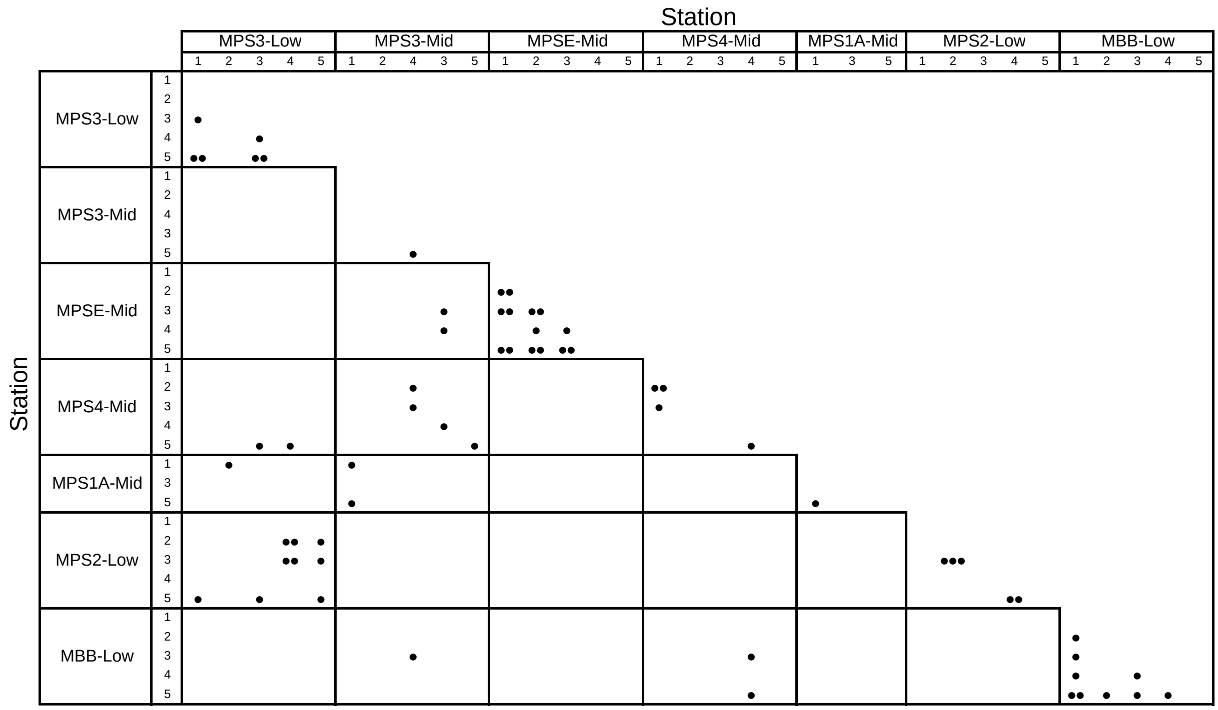
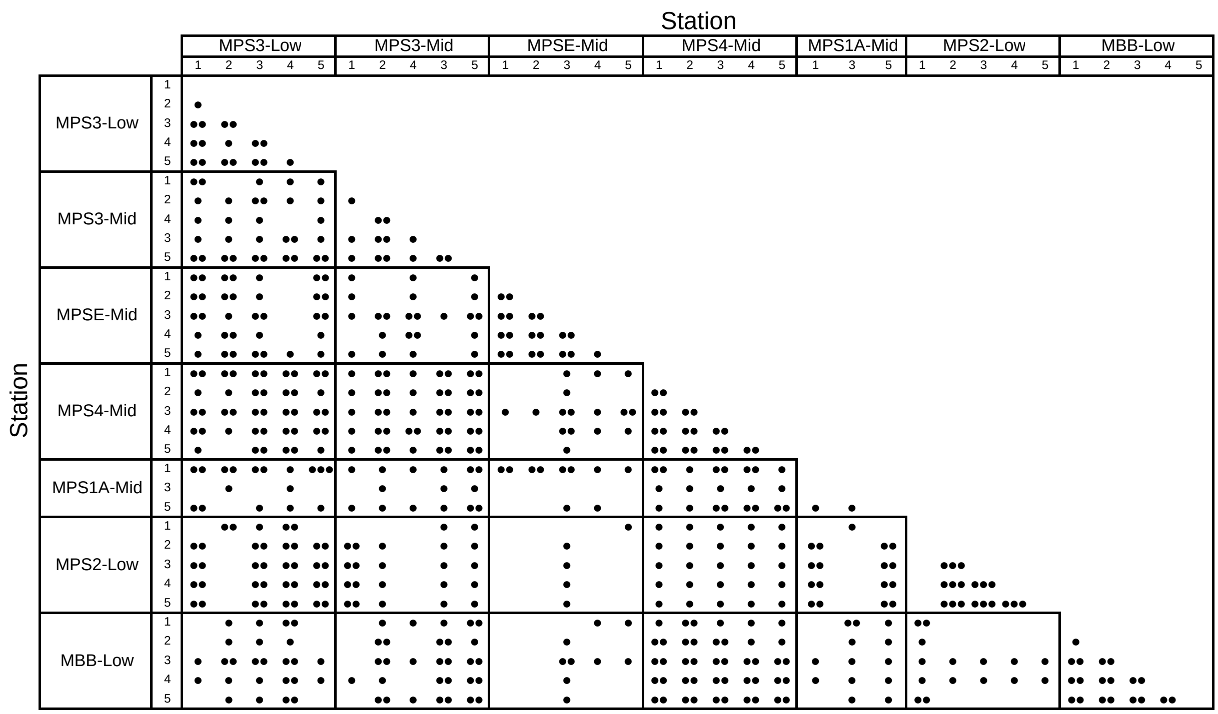


Figure 42-7
Seasonal Changes in Cover of Major Algal Groups at Scott Island (MSI), April to September 1978

Notes:
1978 data from Lees et al., 1980



a) Intertidal Macroinfauna Species Abundance



b) Intertidal Macroinfauna Functional Group Abundance

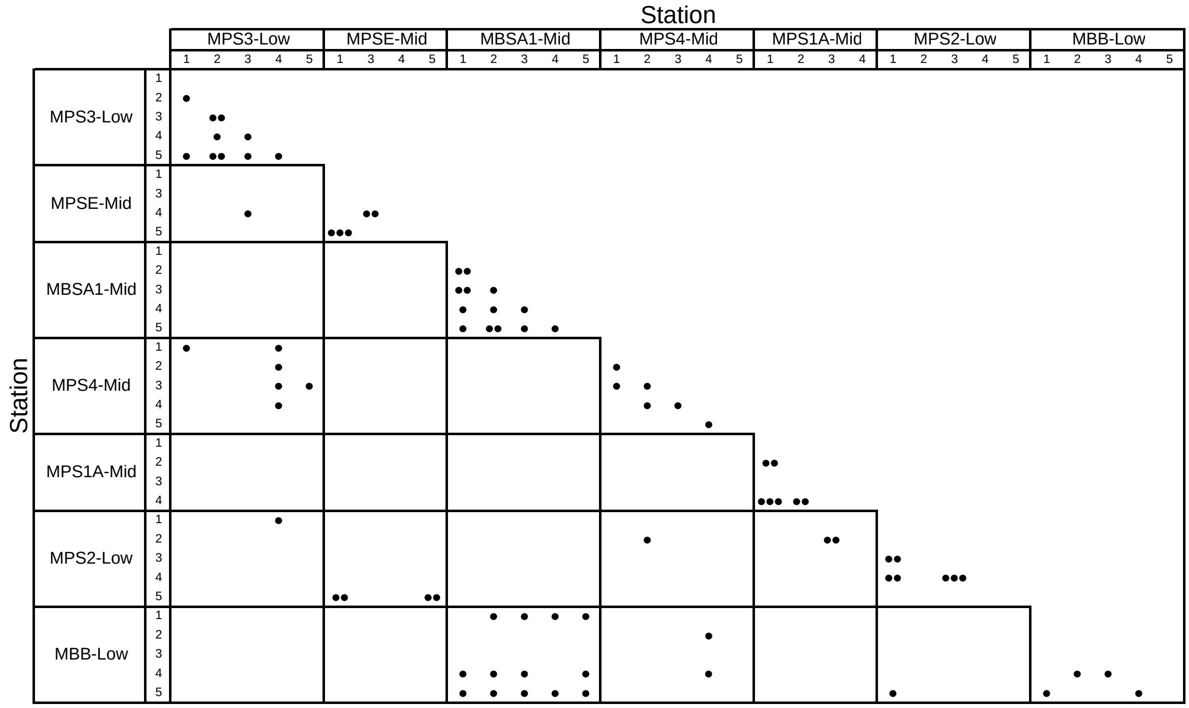
Figure 42-8

Ordination Matrix of Bray-Curtis Similarity Coefficients Calculated for Each Pair of Intertidal Macroinfauna Samples among All Replicates and Stations, 2004

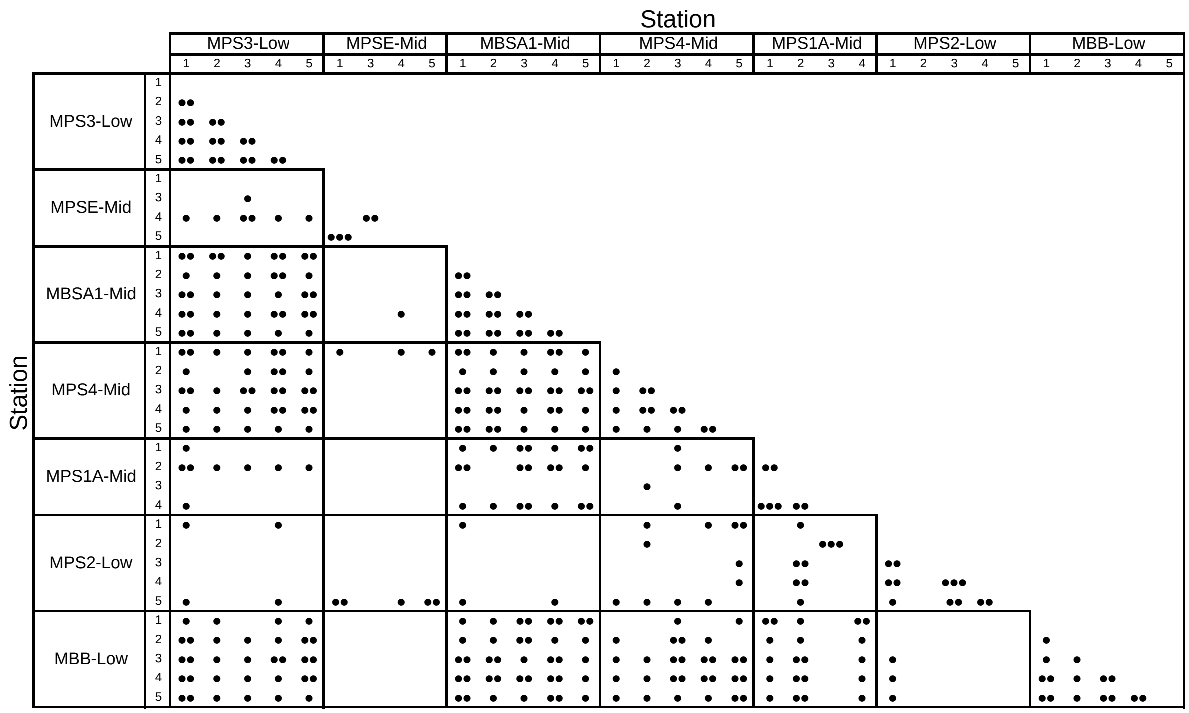
Notes:

Dots represent values of Bray-Curtis coefficients (i.e., percent similarity) calculated for each pair of replicate samples over all stations; • indicates 0-40% similarity in pairwise comparisons, •• indicates 41-60% similarity in pairwise comparisons, ••• indicates 61-100% similarity in pairwise comparisons.

Numbers represent replicate samples taken at each station.



a) Intertidal Macroinfauna Species Abundance

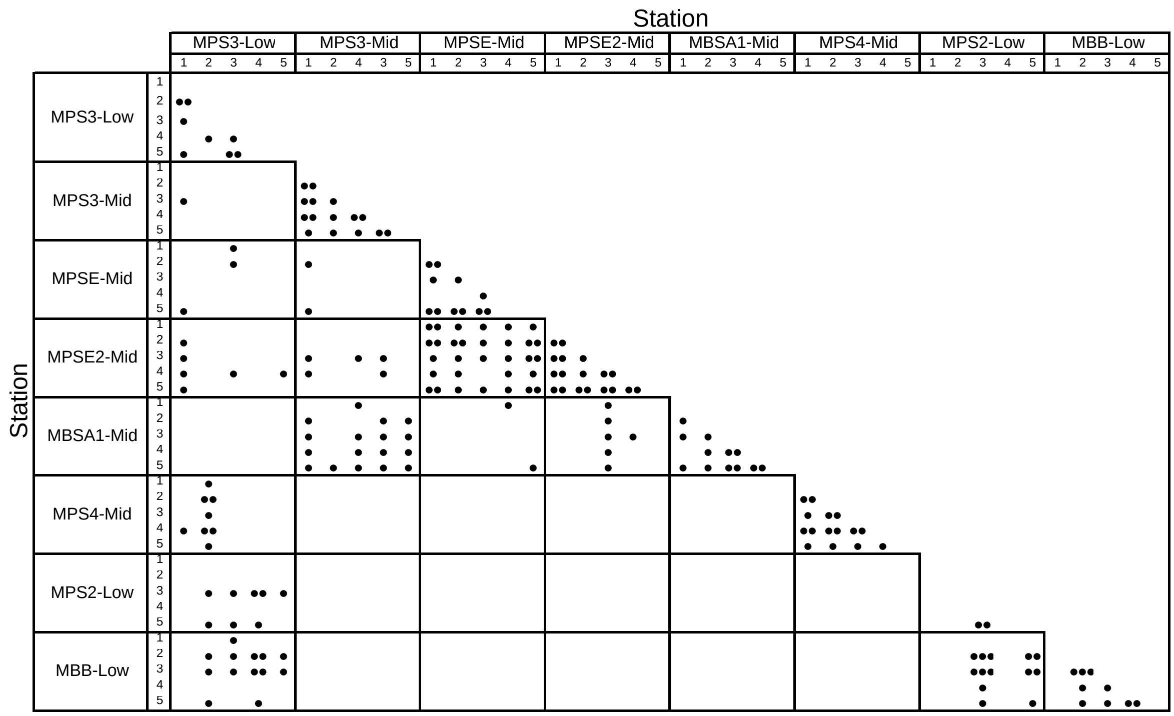


b) Intertidal Macroinfauna Functional Group Abundance

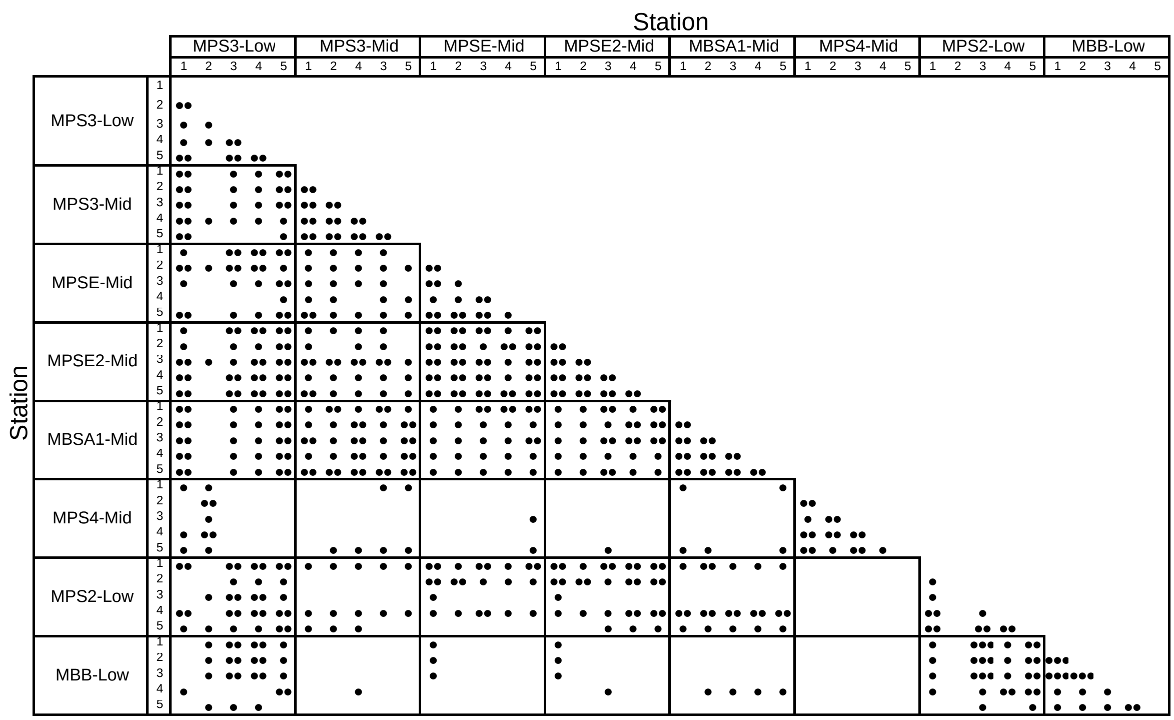
Figure 42-9
Ordination Matrix of Bray-Curtis Similarity Coefficients Calculated for Each Pair of Intertidal Macroinfauna Samples among All Replicates and Stations, 2005

Notes:

Dots represent values of Bray-Curtis coefficients (i.e., percent similarity) calculated for each pair of replicate samples over all stations; • indicates 0-40% similarity in pairwise comparisons, •• indicates 41-60% similarity in pairwise comparisons, ••• indicates 61-100% similarity in pairwise comparisons.
Numbers represent replicate samples taken at each station.



a) Intertidal Macroinfauna Species Abundance



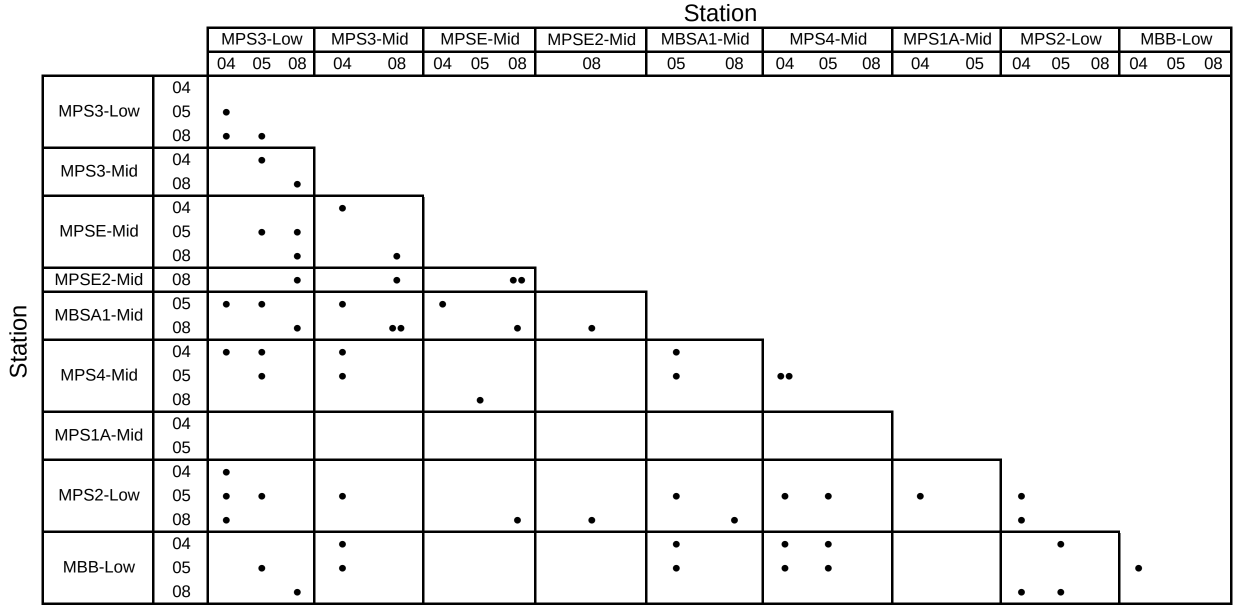
b) Intertidal Macroinfauna Functional Group Abundance

Figure 42-10
Ordination Matrix of Bray-Curtis Similarity Coefficients Calculated for Each Pair of Intertidal Macroinfauna Samples among All Replicates and Stations, 2008

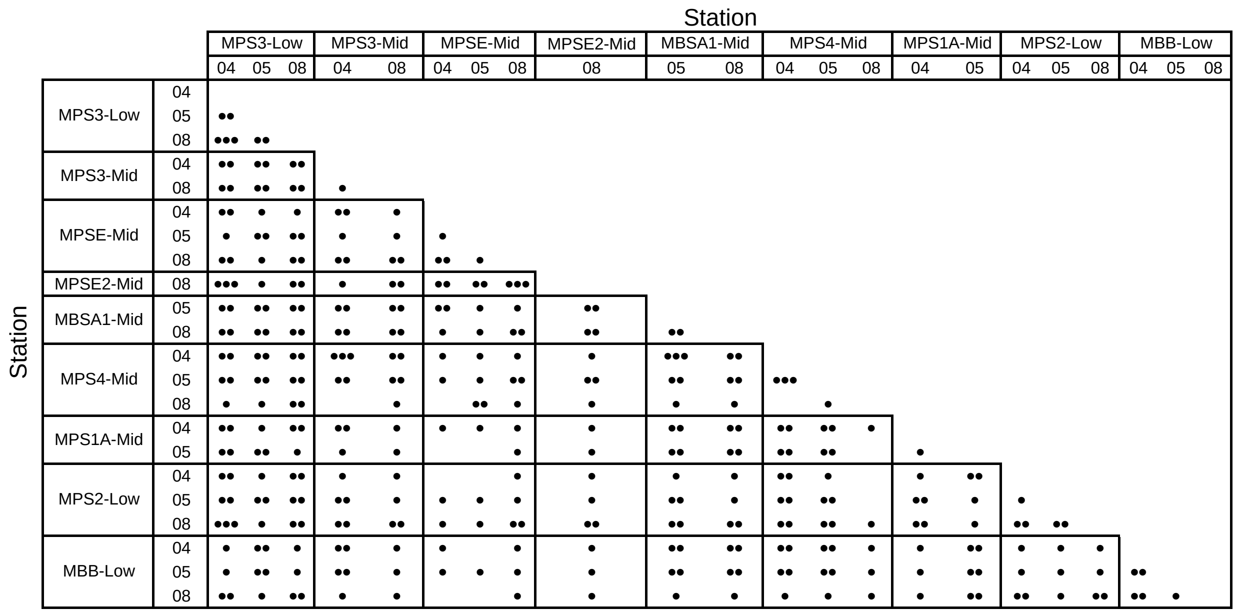
Notes:

Dots represent values of Bray-Curtis coefficients (i.e., percent similarity) calculated for each pair of replicate samples over all stations; • indicates 0-40% similarity in pairwise comparisons, •• indicates 41-60% similarity in pairwise comparisons, ••• indicates 61-100% similarity in pairwise comparisons.

Numbers represent replicate samples taken at each station.



a) Intertidal Macroinfauna Species Abundance



b) Intertidal Macroinfauna Functional Group Abundance

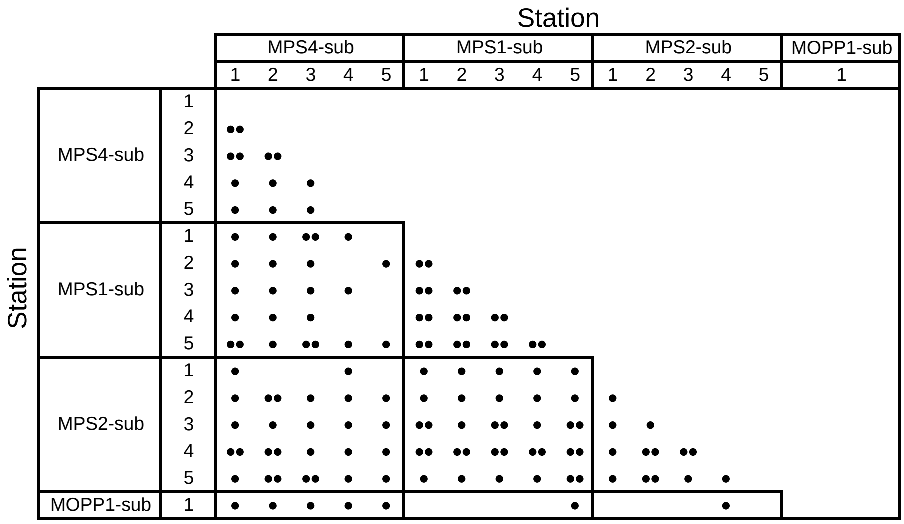
Figure 42-11

Ordination Matrix of Bray-Curtis Similarity Coefficients Calculated for Each Pair of Intertidal Macroinfauna Samples among All Replicates for Those Stations Sampled in All Three Years, 2004, 2005, and 2008

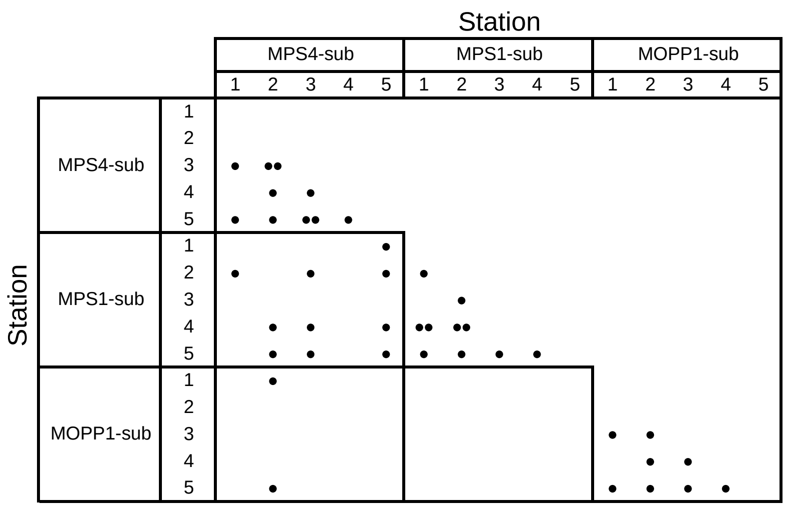
Notes:

Dots represent values of Bray-Curtis coefficients (i.e., percent similarity) calculated for each pair of replicate samples over all stations; • indicates 0-40% similarity in pairwise comparisons, •• indicates 41-60% similarity in pairwise comparisons, ••• indicates 61-100% similarity in pairwise comparisons.

Numbers represent replicate samples taken at each station.



a) Subtidal Macroinfauna Species Abundance



b) Subtidal Macroinfauna Functional Group Abundance

Figure 42-12
Ordination Matrix of Bray-Curtis Similarity Coefficients Calculated for Each Pair of Subtidal Macroinfauna Samples among All Replicates and Stations, 2004 and 2008

Notes:

Dots represent values of Bray-Curtis coefficients (i.e., percent similarity) calculated for each pair of replicate samples over all stations; • indicates 0-40% similarity in pairwise comparisons, •• indicates 41-60% similarity in pairwise comparisons, ••• indicates 61-100% similarity in pairwise comparisons.
Numbers represent replicate samples taken at each station.

PHOTOGRAPHS

PHOTO 42-1

Knoll Head West (MPS1A) mid-elevation transect; May/June 1978 (top left), June 1996 (top right), August 2004 (center), July 2005 (bottom left), and July 2008 (bottom right).

PHOTO 42-2

Knoll Head West (MPS1A), upper elevation transect, Quadrat 1; June 1996 (top left), August 2004 (top right), July 2005 (bottom left), July 2008 (bottom right).

PHOTO 42-3

Blackie Beach (MBB) lower elevation looking south: left side, June 1996 (green is eelgrass); right side, July 2005 (green is *Ulva*).

PHOTO 42-4
Scott Island (MSI) upper transect August 2004, July 2005, and April 2006 (top to bottom).

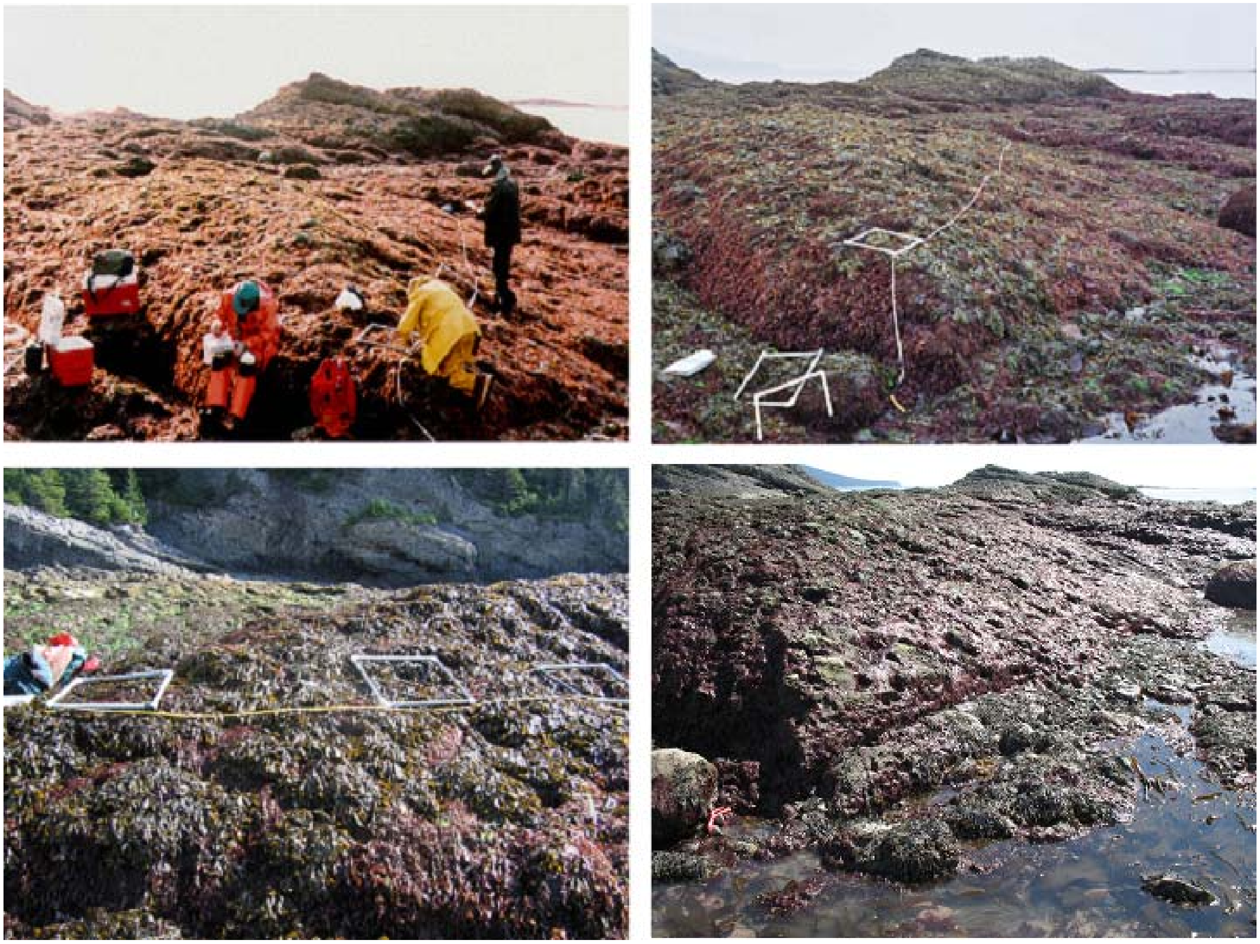


PHOTO 42-5

Scott Island (MSI) mid transect; June 1996 (top left), August 2004 (top right), July 2005 (bottom left), and May 2006 (bottom right).

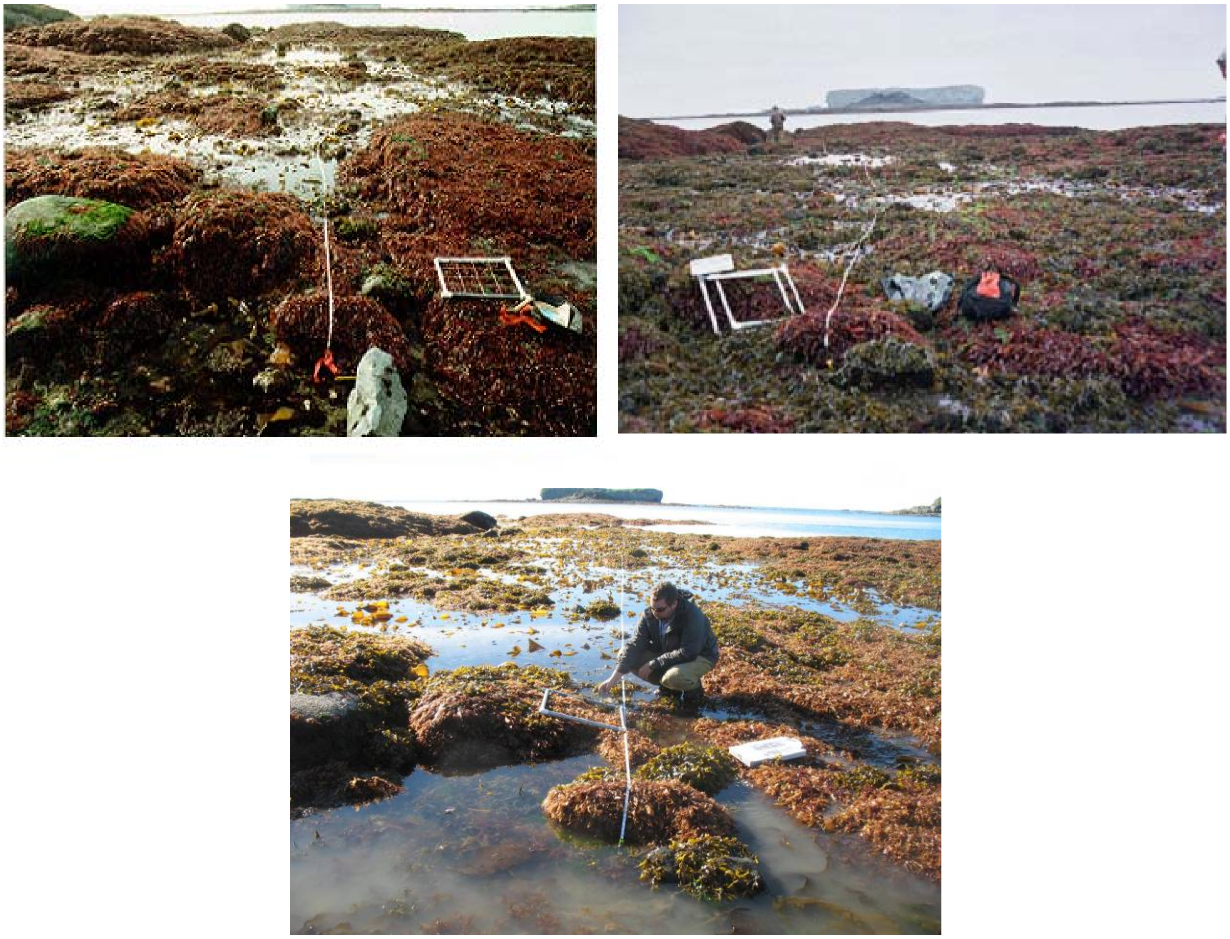


PHOTO 42-6
Scott Island (MSI) low transect; June 1996 (top left), August 2004 (top right), and July 2008 (bottom).

PHOTO 42-7
Knoll Head West (MPS1A), panorama toward Black Reef, August 2004.

PHOTO 42-8
Hand corer used for sampling intertidal infauna (0.009 square meters).

PHOTO 42-9

Excavation of 0.25 square meter quadrats for larger megainfauna.

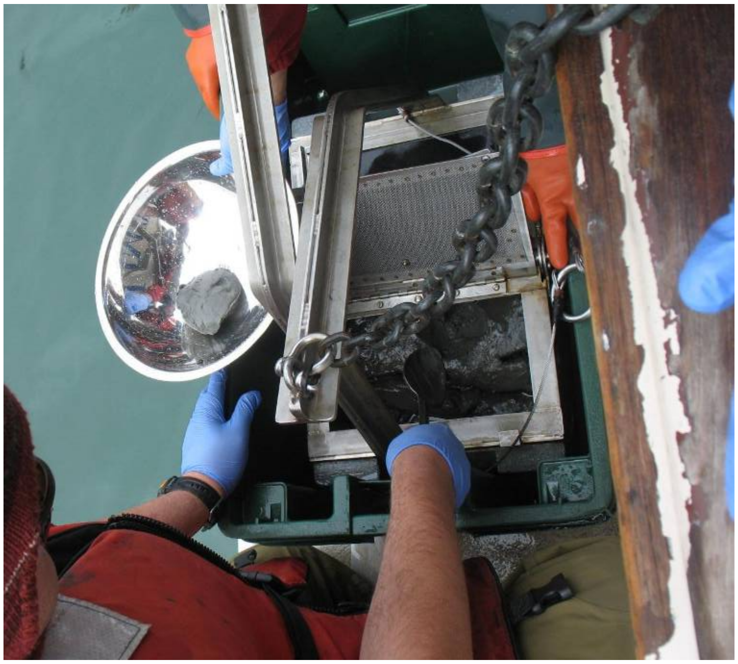


PHOTO 42-10
van Veen grab sampling from M/V Outer Limits, July 2008.

PHOTO 42-11

Knoll Head (MPS1) lower transect looking north toward a series of arches, “the garages,” at the base of Knoll Head, August 2004 (top); upper elevation transect looking west, April 2006 (bottom).

PHOTO 42-12
Knoll Head (MPS1) mid transect; looking south, April 2006 (top) and Quadrat 1, April 2006 (bottom).

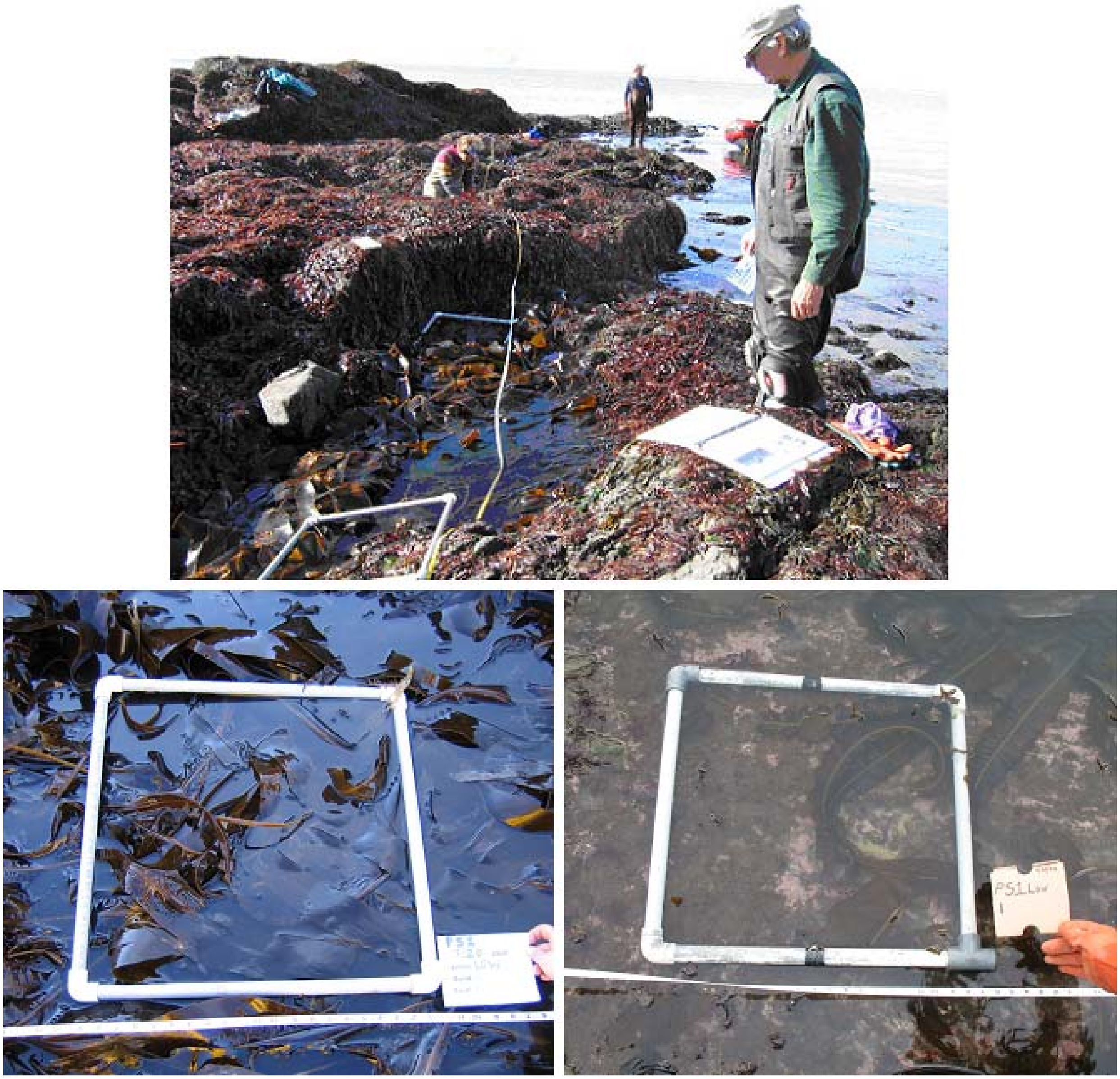


PHOTO 42-13

Knoll Head (MPS1) lower transect, July 2005 (top); Quadrat 1, July 2005 (bottom left) and April 2006 (bottom right).

PHOTO 42-14

Knoll Head West (MPS1A) mid-elevation rocky bench looking northeast at pebble/sand pocket beach, May 2006.

PHOTO 42-15
SW Iniskin Bay (MPS2) upper beach showing cliffs and east slope of Knoll Head, August 2004 (top right); mid transect, July 2005 (left); and lower mudflat extending south (bottom right).

PHOTO 42-16

Diamond Point (MPS3) upper elevation rock outcrop (top); lower elevation bedrock and boulder/cobble habitat, August 2004 (bottom).

PHOTO 42-17

North Head (MPS4) upper gravel beach and rock outcrop, August 2004 (upper); mid elevation boulder/cobble habitat, July 2005 (lower).

PHOTO 42-18

Diamond Head (MPS3); Lower sand/mud flats at entrance to Cottonwood Bay, August 2004 (top); looking northeast past Diamond Head toward head of Illiamna Bay, July 2005 (bottom).

PHOTO 42-19
Eelgrass patch (top) and individual shoots (bottom) in Williamsport (MPSE) area of Iliamna Bay.

PHOTO 42-20

Dense cluster of the sabellid polychaete *Schizobranchia insignis,* typical of the soft, sand/silt substrate present on two diver transects conducted at MPS1 Iniskin Bay, August 2004. (Photograph approximately 1 foot by 1 foot area).

PHOTO 42-21

Hermit crabs (e.g., *Pagurus*) on a boulder covered with pink encrusting coralline algae (Rhodophyta) and an orange sponge (*Esperiopsis* sp.). Typical of the subtidal cobble/boulder habitat present at MPS1, August 2004. (Photograph approx.1 ft by 1 ft area).

PHOTO 42-22

Hermit crab *Elassochirus tenuimanus* amid a patch of tubiculous polychaetes *Schizobranchia insignis,* on sand/silt substrate at MPS1, August 2004.

PHOTO 42-23

Sea anemone *Urticina crassicornis* and typical of the subtidal cobble/boulder habitat at North Head, August 2004. (Photograph approximately 1 foot by 1 foot area).

PHOTO 42-24

Starry flounder *Platichthys stellatus* partially buried in the sand/silt at North Head, August 2004. (Photograph approximately 1 foot by 1 foot area).

PHOTO 42-25

Blood sea star (*Henricia leviuscula*) on course bottom at North Head, August 2004. Laying across the sea star is a single tubiculous anemone *Pachycerianthus fimbriatus.* (Photograph approximately 1 foot by 1 foot area).

PHOTO 42-26

Probable whitespotted greenling *Hexagrammos stelleri* south side of White Gull Island, August 2004. (Photograph approximately 1 foot by 1 foot area).

PHOTO 42-27
Sea anemone *Metridium giganteum* present on south side of White Gull Island, August 2004. (Photograph approximately 1 foot by 1 foot area).

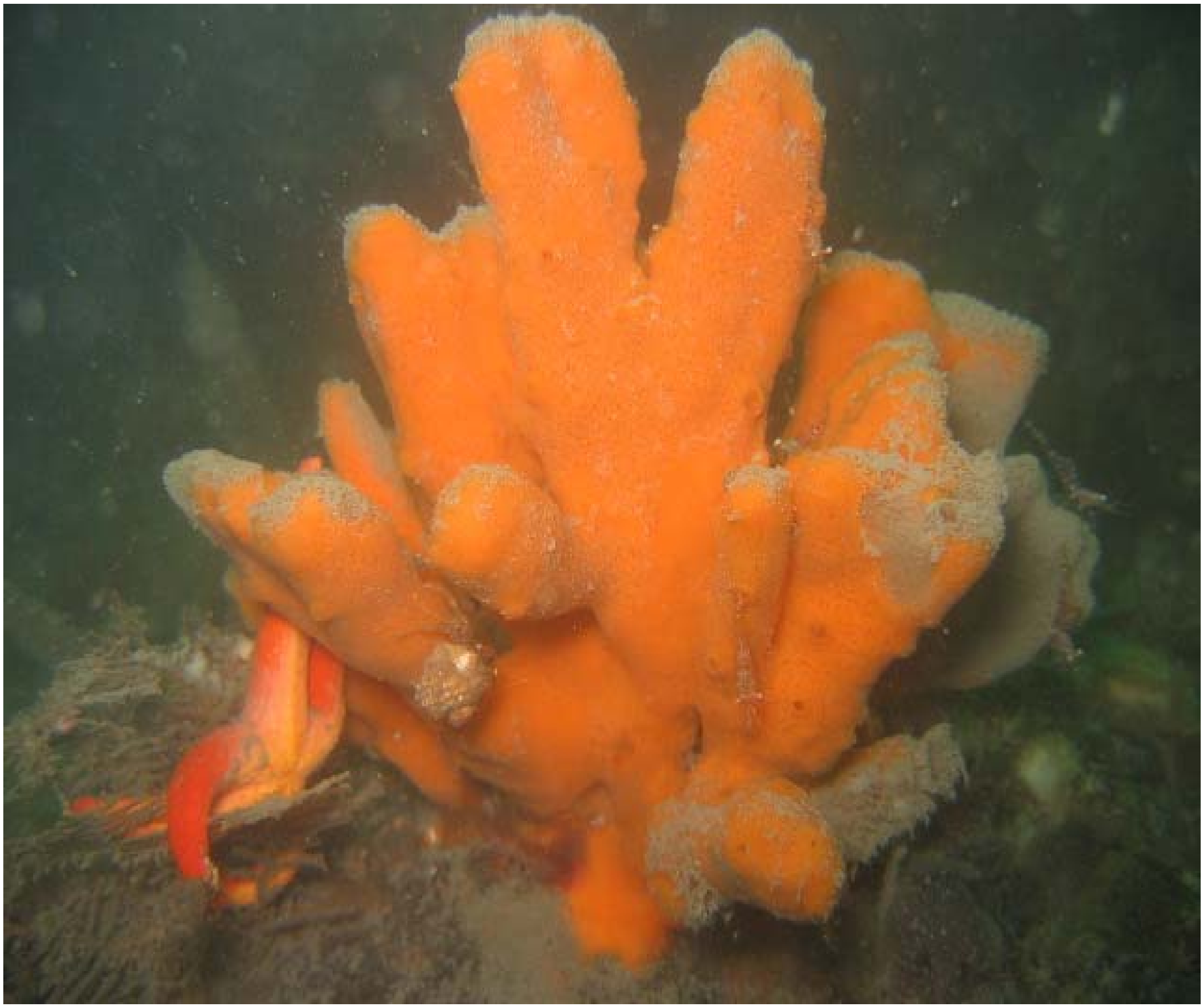


PHOTO 42-28

Sea sponge (*Esperiopsis* sp.*)* on the south side of White Gull Island, August 2004.

APPENDICES

APPENDIX 42A
Sources Consulted for Literature Synthesis

Sources Consulted for Literature Synthesis

Agler, B.A., S.J. Kendall, P.E. Seiser, and D.B. Irons. 1995. Estimates of Marine Bird and Sea Otter Abundance in Lower Cook Inlet, Alaska during Summer 1993 and Winter 1994. Final Report. U.S. Fish and Wildlife Service, Migratory Bird Management. Outer Continental Shelf Study MMS 94-0063. Anchorage, Alaska.

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APPENDIX 42B
Master Species Lists of Scientific and Common Names

Table 42B-1
Scientific and Common Names of Plants in the Epibenthos

Taxon	Major Group	Common Name
Acrosiphonia arcta	Chlorophyta (non-encrusting)	Green alga
Acrosiphonia coalita	Chlorophyta (non-encrusting)	Green alga
Acrosiphonia duriuscula	Chlorophyta (non-encrusting)	Green alga
Acrosiphonia sp.	Chlorophyta (non-encrusting)	Green alga
Ahnfeltia fastigiata	Rhodophyta (non-encrusting)	Red alga
Alaria marginata	Phaeophyta (non-encrusting)	Brown alga; Kelp
Alaria sp.	Phaeophyta (non-encrusting)	Brown alga; Kelp
Alaria taeniata	Phaeophyta (non-encrusting)	Brown alga; Kelp
Analipus japonicus	Phaeophyta (non-encrusting)	Brown crust
Articulated coralline algae	Rhodophyta (non-encrusting)	Coralline algae
Bangia sp.	Rhodophyta (non-encrusting)	Red crust
Black crust		Black crust
Blidingia minimum	Chlorophyta (non-encrusting)	Red alga
Blue-Black-Green algal crust		Crust
Bosiella cretacea	Rhodophyta (non-encrusting)	Coralline alga
Bosiella plumosa	Rhodophyta (non-encrusting)	Coralline alga
Bosiella sp.	Rhodophyta (non-encrusting)	Coralline alga
Ceramium cimbricum	Rhodophyta (non-encrusting)	Red alga
Chaetomorpha sp.	Chlorophyta (non-encrusting)	Green alga
Clathromorphum reclinatum	Chlorophyta (non-encrusting)	Green alga
Codium sp.	Chlorophyta (non-encrusting)	Green alga
Constantinea subulifera	Rhodophyta (non-encrusting)	Red alga
Corallina frondescens	Rhodophyta (non-encrusting)	Coralline alga
Corallina officinalis	Rhodophyta (non-encrusting)	Coralline alga
Corallina vancouveriensis	Rhodophyta (non-encrusting)	Coralline alga
Cryptoneura sp.	Rhodophyta (non-encrusting)	Red alga
Cryptosiphonia woodii	Rhodophyta (non-encrusting)	Red alga
Desmarestia aculeata	Phaeophyta (non-encrusting)	Brown alga
Diatoms	Chrysophyta	Diatoms
Diatoms, filamentous	Chrysophyta	Diatoms
Dictyosiphon foeniculaceus	Phaeophyta (non-encrusting)	Brown alga
Elachista fucicola	Phaeophyta (non-encrusting)	Brown alga
Elachista lubrica	Phaeophyta (non-encrusting)	Brown alga
Encrusting coralline algae	Rhodophyta (encrusting)	Coralline algae
Encrusting green algae	Chlorophyta (encrusting)	Encrusting green algae
Encrusting red algae	Rhodophyta (encrusting)	Encrusting red algae
Enteromorpha linza	Chlorophyta (non-encrusting)	Green alga
Filamentous brown algae	Phaeophyta (non-encrusting)	Brown algae
Filamentous green algae	Chlorophyta (non-encrusting)	Green algae
Filamentous red algae	Rhodophyta (non-encrusting)	Red algae
Fucus distichus subsp. *evanescens*	Phaeophyta (non-encrusting)	Rock weed
Fucus distichus (germlings)	Phaeophyta (non-encrusting)	Rock weed
Halosaccion firmum	Rhodophyta (non-encrusting)	Red alga
Halosaccion glandiforme	Rhodophyta (non-encrusting)	Red alga
Hildenbrandia rubra	Rhodophyta (encrusting)	Encrusting red alga
Leathesia difformis	Phaeophyta (non-encrusting)	Brown alga
Mastocarpus papillatus	Rhodophyta (non-encrusting)	Red alga
Mastocarpus sp.	Rhodophyta (non-encrusting)	Red alga
Mazzaella parvula	Rhodophyta (non-encrusting)	Red alga
Mazzaella phyllocarpa	Rhodophyta (non-encrusting)	Red alga

Taxon	Major Group	Common Name
Mazzaella sp.	Rhodophyta (non-encrusting)	Red alga
Melanosiphon intestinalis	Phaeophyta (non-encrusting)	Brown alga
Monostroma grevillei	Chlorophyta (non-encrusting)	Green alga
Neodilsea borealis	Rhodophyta (non-encrusting)	Red alga
Neohypophyllum midendorfii	Rhodophyta (non-encrusting)	Red alga
Neorhodomela aculeata	Rhodophyta (non-encrusting)	Red alga
Neorhodomela larix	Rhodophyta (non-encrusting)	Red alga
Neorhodomela oregona	Rhodophyta (non-encrusting)	Red alga
Odonthalia floccosa	Rhodophyta (non-encrusting)	Red alga
Odonthalia kamschatica	Rhodophyta (non-encrusting)	Red alga
Palmaria callophylloides	Rhodophyta (non-encrusting)	Red alga
Palmaria hecatensis	Rhodophyta (non-encrusting)	Red alga
Palmaria mollis	Rhodophyta (non-encrusting)	Red alga
Petalonia fascia	Phaeophyta (non-encrusting)	Brown alga
Petalonia sp.	Phaeophyta (non-encrusting)	Brown alga
Petrocelis sp.	Rhodophyta (encrusting)	Encrusting red alga
Phycodrys riggii	Rhodophyta (non-encrusting)	Red alga
Phyllophoraceae, unid.	Rhodophyta (non-encrusting)	Red algae
Pilayella littoralis	Rhodophyta (non-encrusting)	Red alga
Polysiphonia pacifica	Rhodophyta (non-encrusting)	Red alga
Polysiphonia sp.	Rhodophyta (non-encrusting)	Red alga
Porphyra aestivalis	Rhodophyta (non-encrusting)	Red alga
Porphyra cuneiformis	Rhodophyta (non-encrusting)	Red alga
Porphyra sp.	Rhodophyta (non-encrusting)	Red alga
Porphyra variegata	Rhodophyta (non-encrusting)	Red alga
Protomonostoma undulatum	Chlorophyta (non-encrusting)	Green alga
Pterosiphonia bipinnata	Rhodophyta (non-encrusting)	Red alga
Ralfsia fungiformis	Phaeophyta (encrusting)	Encrusting brown alga
Ralfsia sp.	Phaeophyta (encrusting)	Encrusting brown alga
Rhodochorton purpureum	Rhodophyta (encrusting)	Encrusting red alga
Rhodomela sp.	Rhodophyta (non-encrusting)	Red alga
Rhodomela tenuissima	Rhodophyta (non-encrusting)	Red alga
Saccharina latissima	Phaeophyta (non-encrusting)	Brown alga; Kelp
Saccharina sp.	Phaeophyta (non-encrusting)	Brown alga; Kelp
Saccharina subsimplex	Phaeophyta (non-encrusting)	Brown alga; Kelp
Scytosiphon lomentaria	Phaeophyta (non-encrusting)	Brown alga; Kelp
Scytosiphon sp.	Phaeophyta (non-encrusting)	Brown alga
Soranthera ulvoidea	Phaeophyta (non-encrusting)	Brown alga
Sphacelaria rigidula	Phaeophyta (non-encrusting)	Brown alga
Sphacelaria sp.	Phaeophyta (non-encrusting)	Brown alga
Tokidadendron ambigua	Rhodophyta (non-encrusting)	Red alga
Ulothrix sp.	Chlorophyta (non-encrusting)	Green alga
Ulva intestinalis	Chlorophyta (non-encrusting)	Green alga
Ulva linza	Chlorophyta (non-encrusting)	Green alga
Ulva sp.	Chlorophyta (non-encrusting)	Green alga
Ulva/Ulvaria sp.	Chlorophyta (non-encrusting)	Green alga
Ulvaria sp.	Chlorophyta (non-encrusting)	Green alga
Urospora sp.	Chlorophyta (non-encrusting)	Green alga
Verrucaria sp.	Verrucariaceae	Black lichen
Zostera marina	Angiosperm	Eelgrass

Table 42B-2
Scientific and Common Names of Animals in the Epibenthos

Taxon	Major Group	Common Name
Abarenicola sp. (casts)	Polychaeta	Lug worm
Abietinaria sp.	Hydrozoa	Hydrozoan
Amphiporus sp.	Nemertea	Ribbon worm
Anemone, orange (Urticina?)	Anthozoa	Anemone
Anemone, unid.	Anthozoa	Anemone
Anemone, white (Cnidopus?)	Anthozoa	Anemone
Anthophleura artemisia	Anthozoa	Anemone
Anthophleura sp.	Anthozoa	Anemone
Ascidian, colonial	Ascidiacea	Sea squirt
Balanus crenatus	Balanomorpha	Barnacle
Balanus glandula	Balanomorpha	Barnacle
Balanus rostratus	Balanomorpha	Barnacle
Balanus rostratus (juvenile)	Balanomorpha	Barnacle
Balanus sp.	Balanomorpha	Barnacle
Balanus/Semibalanus (set)	Balanomorpha	Barnacle
Balanus/Semibalanus spp.	Balanomorpha	Barnacle
Bryozoan, arborescent	Bryozoa	Moss animal
Bryozoan, encrusting	Bryozoa	Moss animal
Bryozoan, plunoa	Bryozoa	Moss animal
Buccinum baeri	Gastropoda	Snail
Cancer oregonensis	Decapoda	Cancer crab
Caulibugula sp.	Bryozoa	Moss animal
Chiton unid. *Cyanoplax?*	Polyplacophora	Chiton
Chthamalus dalli	Balanomorpha	Barnacle
Chthamalus dalli (set)	Balanomorpha	Barnacle
Clam shows / siphons	Bivalvia	Clam
Clinocardium nutalli	Bivalvia	Cockle
Colonial fleshy tunicate, unid.	Tunicata	Tunicate
Cucumber, unid.	Echinodermata	Sea cucumber
Gammaridea sp.	Gammaridea	Amphipod
Garveia sp.	Hydroidea	Hydroid
Halichondria panicea	Porifera	Green sponge
Halichondria sp.	Porifera	Green sponge
Haliclona sp.	Porifera	Purple sponge
Haliclystus sp.	Cnidaria	Stalked jellyfish
Henricia leviuscula	Echinodermata	Blood star
Henricia sp.	Echinodermata	Blood star
Henricia tumida	Echinodermata	Blood star
Hiatella arctica	Bivalvia	Nestling clam
Hydroidea sp.	Hydroidea	Hydroid
Hydroids campanulariid	Hydroidea	Hydroid
Insect larvae	Insecta	Insect
Lacuna sp.	Gastropoda	Snail
Leptasterias hexactis	Echinodermata	6-rayed sea star
Leptasterias sp.	Echinodermata	6-rayed sea star
Littorina sitkana	Gastropoda	Periwinkle, littorine snail
Littorina sitkana egg cases	Gastropoda	Periwinkle, littorine snail
Lottia pelta	Lottiidae	Limpet
Lottia strigatella	Lottiidae	Limpet
Lottiidae spp.	Lottiidae	Limpet

Taxon	Major Group	Common Name
Lottiidae spp. (juvenile)	Lottiidae	Limpet
Margarites pupillus	Gastropoda	Snail
Margarites (set)	Gastropoda	Snail
Metridium senile	Anthozoa	Anemone
Metridium sp.	Anthozoa	Anemone
Modiolus modiolus	Bivalvia	Mussel
Mopalia sp.	Polyplacophora	Chiton
Mya sp.	Bivalvia	Soft shell clam
Mytilus trossulus	Bivalvia	Mussel
Mytilus trossulus (spat)	Bivalvia	Mussel
Nucella eggs	Gastropoda	Snail, drill
Nucella lamellosa	Gastropoda	Snail, drill
Nucella lima	Gastropoda	Snail, drill
Onchidella borealis	Nudibranchea	Nudibranch
Pagurus beringanus	Decapoda	Hermit crab
Pagurus granosimanus	Decapoda	Hermit crab
Pagurus hirsutiusculus	Decapoda	Hairy hermit crab
Pagurus sp.	Decapoda	Hermit crab
Paranemertes peregrina	Nemertea	Ribbon worm
Pholidae sp.	Pices	Gunnel
Pholidae sp. (juvenile)	Pices	Gunnel
Pholis laeta	Pices	Gunnel
Polychaete, white	Polychaeta	Worm
Polyclad worm	Polychaeta	Worm
Porifera, orange	Porifera	Sponge
Pugettia dalli	Decapoda	Decorator crab
Pugettia gracilis	Decapoda	Decorator crab
Red mites	Acari	Red mites
Rhynchozoan bispinosum	Bryozoa	Moss animal
Scrupocellaria californica	Bryozoa	Moss animal
Scrupocellaria sp.	Bryozoa	Moss animal
Semibalanus balanoides	Balanomorpha	Barnacle
Semibalanus balanoides (set)	Balanomorpha	Barnacle
Semibalanus cariosus	Balanomorpha	Barnacle
Semibalanus cariosus (set)	Balanomorpha	Barnacle
Serpula vermicularis	Polychaeta	Worm
Serpulidae sp.	Polychaeta	Worm
Sertularidae sp.	Hydrozoa	Hydroid
Shrimp	Caridea	Shrimp
Solitary tunicate, orange	Tunicata	Tunicate
Spirobidae, unid.	Polychaeta	Worm
Suberites sp.	Porifera	Sponge
Tectura persona	Lottiidae	Limpet
Tectura scutum	Lottiidae	Limpet
Telmessus cheiragonus	Decapoda	Helmit crab
Tonicella lineata	Polyplacophora	Lined chiton
Trichotropis insignis	Gastropoda	Snail
Urticina crassicornis	Anthozoa	Anemone

Table 42B-3
Scientific and Common Names of Infauna

Taxon	Major Group	Lower Taxon	Common Name
Abarenicola pacifica	Annelida	Polychaeta	Lugworm
Actiniaria	Misc. Taxa	Actiniaria	Anemone
Ampharete acutifrons	Annelida	Polychaeta	Worm
Ampharete crassiseta	Annelida	Polychaeta	Worm
Ampharete sp.	Annelida	Polychaeta	Worm
Ampharetidae	Annelida	Polychaeta	Worm
Amphiporus sp.	Misc. Taxa	Nemertea	White ribbon worm
Aphelochaeta glandaria Cmplx	Annelida	Polychaeta	Worm
Aphelochaeta monilaris	Annelida	Polychaeta	Worm
Arenicolidae	Annelida	Polychaeta	Worm
Aricidea catherinae	Annelida	Polychaeta	Worm
Aricidea lopezi	Annelida	Polychaeta	Worm
Autolytus sp.	Annelida	Polychaeta	Worm
Axinopsida serricata	Mollusca	Bivalvia	Clam
Bivalvia	Mollusca	Bivalvia	Clam
Capitella capitata	Annelida	Polychaeta	Worm
Capitellidae	Annelida	Polychaeta	Worm
Chaetozone acuta	Annelida	Polychaeta	Worm
Chaetozone sp.	Annelida	Polychaeta	Worm
Cirratulidae	Annelida	Polychaeta	Worm
Clinocardium nuttallii	Mollusca	Bivalvia	Cockle
Cossura pygodactylata	Annelida	Polychaeta	Worm
Cossura sp.	Annelida	Polychaeta	Worm
Cumella vulgaris	Arthropoda	Cumacea	Cumacean
Diastylis alaskensis	Arthropoda	Cumacea	Cumacean
Dipolydora brachycephala	Annelida	Polychaeta	Worm
Echiurus echiurus	Misc. Taxa	Echiuridea	Spoon worm
Echiurus echiurus alaskanus	Misc. Taxa	Echiuridea	Spoon worm
Ennucula tenuis	Mollusca	Bivalvia	Clam
Eteone longa	Annelida	Polychaeta	Worm
Eteone sp.	Annelida	Polychaeta	Worm
Euchone hancocki	Annelida	Polychaeta	Worm
Gammaropsis sp.	Arthropoda	Gammaridae	Amphipod
Gastropoda	Mollusca	Gastropoda	Snail
Glycinde picta	Annelida	Polychaeta	Worm
Harpacticoida	Arthropoda	Copepoda	Harpacticoid copepod
Hoplonemertea	Misc. Taxa	Nemertea	Ribbon worm
Lacuna sp.	Mollusca	Gastropoda	Snail
Lacuna vincta	Mollusca	Gastropoda	Snail
Laonome kroeyeri	Annelida	Polychaeta	Worm
Leitoscoloplos panamensis	Annelida	Polychaeta	Worm
Leitoscoloplos pugettensis	Annelida	Polychaeta	Worm
Littorina sitkana	Mollusca	Gastropoda	Periwinkle; littorine snail
Lumbrineris luti	Annelida	Polychaeta	Worm
Macoma balthica	Mollusca	Bivalvia	Balthic macoma
Macoma calcarea	Mollusca	Bivalvia	Macoma clam
Macoma inquinata	Mollusca	Bivalvia	Macoma clam
Macoma sp.	Mollusca	Bivalvia	Macoma clam
Magelona longicornis	Annelida	Polychaeta	Worm
Mya arenaria	Mollusca	Bivalvia	Eastern soft shell clam

APPENDIX 42C
Subtidal Diver Transect Data

TABLE 42C-1
Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at MPS1 (Knoll Head), August 29, 2004, Transect 1 of 2

Site Transect Name:	MPS1, Transect 1 of 2
Time:	1008 to 1100
Tidal Height:	–1.2 to –1.4 feet MLLW
Actual Depth:	10 to 51 feet
Adjusted Depth:	–11.2 to –49.6 feet MLLW
Transect Distance:	777 feet
Substrate:	Mixed sand/silt over gravel
Visibility:	4-5 feet @ 10 feet deep to 2 feet @ 51
Tidal state:	Slight flood
Divers:	S. Jewett/H. Chenelot

TAXON	**COMMON NAME**
PORIFERA	
Suberites sp.	Sponge
CNIDARIA	
Hydrozoa—*Sertulariidae*	Hydroid
Anthozoa—*Urticina crassicornis*	Sea anemone
ANNELIDA—Polychaeta	
Potamilla sp.	Polychaete
Schizobranchia insignis	Polychaete
MOLLUSCA—Gastropoda	
Margarites pupillus	Snail
Fusitriton oregonensis	Snail
Neptunea lyrata	Snail
Nucella lamellosa	Snail
Onchidoris bilamellata	Nudibranch
MOLLUSCA—Polyplacophora	
Molpadia sp.	Chiton
Cryptochiton stelleri	Chiton
Ischnochiton sp.	Chiton
ARTHROPODA—Crustacea	
Unidentified shrimp	Shrimp
Pagurus beringanus	Hermit crab
Elassochirus tenuimanus	Hermit crab
E. gilli	Hermit crab

TAXON	COMMON NAME
ARTHROPODA—Crustacea (Cont'd)	
Rhinolithodes wosnessenskii	Umbrella crab
Telmessus cheiragonus	Helmet crab
Hyas lyratus	Lyre crab
Oregonia gracilis	Decorator crab
Pugettia gracilis	Kelp crab
ECTOPROCTA	
Flustrellidae	Bryozoan
ECHINODERMATA—Asteroidea	
Henricia leviuscula	Blood sea star
Leptasterias sp.	Sea star
Leptasterias polaris acervata	Sea star
Leptasterias alaskensis	Sea star
Crossaster papposus	Sea star
CHORDATA—Pisces	
Hexagrammos stelleri	Whitespotted greenling
Stichaeus punctatus	Arctic shanny
Pleuronectidae (juvenile.)	Flatfish

TABLE 42C-2
Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at MPS1 (Knoll Head), August 29, 2004, Transect 2 of 2

Site Transect Name:	MPS1, Transect 2 of 2
Time:	1435 to 1509
Tidal Height:	+15.1 to +15.8 feet MLLW
Actual Depth:	32 to 31 feet
Adjusted Depth:	–16.9 - –15.2 feet MLLW
Transect Distance:	437 feet
Substrate:	Gravel
Visibility:	2 feet
Tidal state:	Strong flood
Divers:	S. Jewett/H. Chenelot

TAXON	**COMMON NAME**
ALGAE—Rhodophyta	Red algae
Coralline	Encrusting coralline algae
PORIFERA	
Suberites sp.	Sponge
ANNELIDA—Polychaeta	
Schizobranchia insignis	Polychaete
MOLLUSCA—Pelecypoda	
Pododesmus macroschisma	Rock jingle
MOLLUSCA—Gastropoda	
Fusitriton oregonensis	Snail
Neptunea lyrata	Snail
MOLLUSCA—Polyplacophora	
Cryptochiton stelleri	Chiton
Tonicella lineata	Chiton
Tonicella insignis	Chiton
Mopalia ciliata	Chiton
ARTHROPODA—Crustacea	
Balanus glandula	Barnacle
Pagurus sp.	Hermit crab
Cancer oregonensis	Cancer crab
Hyas lyratus	Lyre crab
Pugettia gracilis	Kelp crab
ECTOPROCTA	
Flustrellidae	Bryozoan
ECHINODERMATA—Asteroidea	
Lepasterias sp.	Sea star
Henricia leviuscula	Blood sea star

TABLE 42C-3
Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at MPS1B
(midway between MPS1 and MPS2), August 31, 2004

Site Transect Name:	MPS1B
Time:	1255 to 1314
Tidal Height:	+4.6 to +6.2 feet MLLW
Actual Depth:	3 to 17 feet
Adjusted Depth:	+1.6 to -10.8 feet MLLW
Transect Distance:	667 feet
Substrate:	Sand/silt/gravel throughout
Visibility:	3 feet @ shallow; 1 feet @ deep
Tidal state:	Very strong flood
Divers:	S. Jewett/S. Harper

TAXON	**COMMON NAME**
ALGAE—Chlorophyta	Green algae
Ulva sp.	Sea lettuce
ALGAE—Phaeophyta	Brown algae
	Split kelp
Fucus distichus subsp. *evanescens*	Rockweed
ALGAE—Rhodophyta	Red algae
PORIFERA	
Suberites sp.	Sponge
Esperiopsis sp.	Yellow sponge
ANNELIDA—Polychaeta	
Schizobranchia insignis	Polychaete
MOLLUSCA—Pelecypoda	
Mytilus trossulus	Blue mussel
Mactromerus polynyma	Arctic Surf Clam
Clinocardium nuttallii	Cockle
MOLLUSCA—Gastropoda	
Tectura scutum	Snail
Nucella lima	Snail
Onchidoris bilamellata	Nudibranch
ARTHROPODA—Crustacea	
Pagurus sp.	Hermit crab
Pagurus ochotensis	Hermit crab
P. hirsutiusculus	Hermit crab
P. aleuticus	Hermit crab
P. beringanus	Hermit crab
Telmessus cheiragonus	Helmet crab
ECTOPROCTA—Flustrellidae	Bryozoan
ECHINODERMATA—Asteroidea	
Leptasterias alaskensis	Sea star

TABLE 42C-4

Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at MPS2,
Iniskin Bay, August 31, 2004

Site Transect Name:	Port Site 2
Time:	1015 to 1032
Tidal Height:	–2.6 to –2.5 feet MLLW
Actual Depth:	8 to 31 feet
Adjusted Depth:	–10.6 to –33.5 feet MLLW
Transect Distance:	307 feet
Substrate:	Sand/silt/gravel throughout
Visibility:	1 to 2 feet
Tidal state:	Slight ebb tide
Divers:	S. Jewett/S. Harper
TAXON	**COMMON NAME**
ARTHROPODA—Crustacea	
Balanus sp.	Barnacle
ECTOPROCTA—Flustrellidae	Bryozoan

TABLE 42C-5

Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at MPS4 (North Head), August 30, 2004

Site Transect Name:	MPS4
Time:	1000 to 1105
Tidal Height:	–2.8 to –0.6 feet MLLW
Actual Depth:	5 to 19 feet
Adjusted Depth:	–7.8 to –19.6 feet MLLW
Transect Distance:	1214 feet
Substrate:	Boulder @ 5 feet deep; sand @ 19 feet deep
Visibility:	2 feet @ 5 feet deep; 10 feet @ 19 feet deep
Tidal state:	Strong flood
Divers:	S. Jewett/S. Harper

TAXON	COMMON NAME
ALGAE—Chlorophyta	Green algae
Ulva sp.	Sea Lettuce
ALGAE—Phaeophyta	Brown algae
Desmarestia aculeata	Witch's Hair
Agarum clathratum	Shotgun kelp
Saccharina subsimplex	Split kelp
Fucus distichus subsp. *evanescens*	Rockweed
ALGAE—Rhodophyta	Red algae
Constantinea sp.	Cup and Saucer
Neodilsea borealis	Northern Red Blade
PORIFERA	
Suberites sp.	Sponge
CNIDARIA—Hydrozoa	
Sertulariidae	Hydroid
Campanularidae	Hydroid
CNIDARIA—Anthozoa	
Unid. White/yellow anemone	Sea anemone
Urticina crassicornis	Christmas sea anemone
Pachycerianthus fimbriatus	Tubiculous anemone
ANNELIDA—Polychaeta	
Schizobranchia insignis	Polychaete
Potamilla sp.	Polychaete

TAXON	COMMON NAME
MOLLUSCA—Gastropoda	
Lacuna vincta	Snail
Neptunea lyrata	Snail
Hermissenda crassicornis	Nudibranch
Onchidoris bilamellata	Nudibranch
MOLLUSCA—Polyplacophora	
Ischnochiton sp.	Chiton
Tonicella lineata	Chiton
T. insignis	Chiton
ARTHROPODA—Crustacea	
Balanus sp.	Barnacle
Pagurus beringanus	Hermit crab
Pagurus ochotensis	Hermit crab
Elassochirus tenuimanus	Hermit crab
E. gilli	Hermit crab
Oregonia gracilis	Decorator crab
Pugettia gracilis	Kelp crab
ECTOPROCTA	
Flustrellidae	Bryozoan
Membraniporidae	Bryozoan
ECHINODERMATA—Asteroidea	
Henricia leviuscula	Blood sea star
Leptasterias spp.	Sea star
Leptasterias alaskensis	Sea star
Crossaster papposus	Sea star
ECHINODERMATA—Echinoidea	
Echinarachnius parma	Sand dollar
ECHINODERMATA—Holothuroidea	
Cucumaria fallax	Sea cucumber
CHORDATA—Pisces	
Unid. Flatfish	Flatfish
Platichthys stellatus	Starry Flounder

TABLE 42C-6
Benthic Reconnaissance Dive Survey of Algae, Epifaunal Invertebrates, and Fishes at White Gull Island, August 30, 2004

Site Transect Name:	White Gull Island
Time:	1775 to 1837
Tidal Height:	+12.5 to +9.7 feet MLLW
Actual Depth:	16 to 37 feet
Adjusted Depth:	–3.5 to –27.3 feet MLLW
Transect Distance:	402 feet
Substrate:	Boulder @ 16 feet deep; gravel @ 37 feet deep
Visibility:	4 to 6 feet
Tidal state:	Slight ebb tide
Divers:	S. Jewett/H. Chenelot/S. Harper

TAXON	**COMMON NAME**
ALGAE—Chlorophyta	Green algae
Acrosiphonia arcta	Arctic Sea Moss
ALGAE—Phaeophyta	Brown algae
Desmarestia aculeata	Witch's Hair
Alaria sp.	
Agarum clathratum	Shotgun kelp
Saccharina subsimplex	Split kelp
Fucus distichus subsp. *evanescens*	Rockweed
ALGAE—Rhodophyta	Red algae
Constantinea sp.	Cup and Saucer
Opuntiella californica	Red Opuntia
Phycodrys riggii	Red alga
Scagelia sp.	Red alga
Sparlingla pertusa	Red alga
PORIFERA	
Suberites sp.	Sponge
Esperiopsis sp.	Sponge
CNIDARIA—Hydrozoa	Hydroid
CNIDARIA—Anthozoa	
Urticina crassicornis	Sea anemone
Metridium giganteum	Sea anemone
MOLLUSCA—Gastropoda	
Tectura scutum	Snail
Lacuna vincta	Snail

TAXON	COMMON NAME
MOLLUSCA—Gastropoda (Cont'd)	
Margarites pupillus	Snail
Neptunea lyrata	Snail
Fusitriton oregonensis	Snail
Hermissenda crassicornis	Nudibranch
Onchidoris bilamellata	Nudibranch
MOLLUSCA—Polyplacophora	
Ischnochiton sp.	Chiton
Mopalia ciliata	Chiton
Tonicella lineata	Chiton
T. insignis	Chiton
BRYOZOA	
Carbasea sp.	Bryozoan
ARTHROPODA—Crustacea	
Balanus glandula	Barnacle
Heptacarpus brevirostris	Shrimp
Pagurus beringanus	Hermit crab
P. hirsutiusculus	Hermit crab
Elassochirus tenuimanus	Hermit crab
E. gilli	Hermit crab
ECTOPROCTA	Bryozoan
ECHINODERMATA—Asteroidea	
Henricia leviuscula	Blood sea star
Pteraster sp.	Sea star
Leptasterias spp.	Sea star
Crossaster papposus	Sea star
ECHINODERMATA—Ophiuroidea	
Ophiopholus aculeata	Brittle star
ECHINODERMATA—Holothuroidea	
Eupentacta pseudoquinquesemita	Sea cucumber
UROCHORDATA—Tunicata	
Psolus chitonoides	Tunicate
CHORDATA—Pisces	
Hexagrammos stelleri	Whitespotted greenling

Taxon	Major Group	Lower Taxon	Common Name
Mya sp.	Mollusca	Bivalvia	Soft shell clam
Mysella planata	Mollusca	Bivalvia	Clam
Nemertea	Misc. Taxa	Nemertea	Ribbon worm
Nephtyidae	Annelida	Polychaeta	Worm
Nephtys caeca	Annelida	Polychaeta	Worm
Nephtys ciliata	Annelida	Polychaeta	Worm
Nephtys cornuta	Annelida	Polychaeta	Worm
Nephtys longosetosa	Annelida	Polychaeta	Worm
Nephtys sp.	Annelida	Polychaeta	Worm
Oligochaeta	Annelida	Oligochaete	Worm
Orbiniidae	Annelida	Polychaeta	Worm
Paramoera sp.	Arthropoda	Gammaridea	Amphipod
Pholoe minuta	Annelida	Polychaeta	Worm
Polychaeta, unid.	Annelida	Polychaeta	Worm
Polydora sp.	Annelida	Polychaeta	Worm
Pontoporeia femorata	Arthropoda	Gammaridea	Amphipod
Priapulidae	Misc. Taxa	Priapulidae	Priapulid
Prionospio sp.	Annelida	Polychaeta	Worm
Prionospio steenstrupi	Annelida	Polychaeta	Worm
Proclea sp.	Annelida	Polychaeta	Worm
Protodriloides chaetifer	Annelida	Polychaeta	Worm
Pygospio elegans	Annelida	Polychaeta	Worm
Rhynchospio glutaea	Annelida	Polychaeta	Worm
Rochefortia tumida	Mollusca	Bivalvia	Clam
Sabellidae	Annelida	Polychaeta	Worm
Scoletoma luti	Annelida	Polychaeta	Worm
Scoloplos armiger	Annelida	Polychaeta	Worm
Scoloplos armiger armiger	Annelida	Polychaeta	Worm
Solariella varicosa	Mollusca	Gastropoda	Clam
Sphaerosyllis sp. N1	Annelida	Polychaeta	Worm
Spio filicornis	Annelida	Polychaeta	Worm
Spio sp.	Annelida	Polychaeta	Worm
Spiophanes bombyx	Annelida	Polychaeta	Worm
Spiophanes sp.	Annelida	Polychaeta	Worm
Terebellidae	Annelida	Polychaeta	Worm
Tetrastemma sp.	Nemertea	Nemertea	Ribbon worm
Tubulanus sp. A	Nemertea	Nemertea	Ribbon worm