Coastal Marine Institute

University of Alaska

Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet

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Final Report
OCS Study MMS 2010-005

November 2010

Minerals Management Service
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and the

School of Fisheries & Ocean Sciences

University of Alaska Fairbanks

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Abstract

This work describes anomalous occurrences of Arctic epifaunal invertebrates and algae along the western side of Cook Inlet. It also expands the basis for an earlier finding that the biota in upper Cook Inlet belongs to the subpolar Beringian biogeographical subprovince and extends that subprovince into lower Cook Inlet. To address questions of Arctic-affiliated algae and invertebrates, we reviewed previous biological assessments, examined specimens, and considered the geological history and other factors that may explain the disjunct occurrences of algae and invertebrates. We reviewed the distributions of 175 algae of Cook Inlet and 66 algal species from the Arctic and 723 species of marine invertebrates from Point Barrow, both sides of Cook Inlet, and Prince William Sound. Sixty-eight invertebrates (96 percent of the Pt. Barrow species that we considered from those listed by George MacGinitie) have distributions that include the west side of Cook Inlet and the Arctic.

For the invertebrates, we employed multivariate analyses on the full spectrum of invertebrates found on the west side of Cook Inlet as well as just Bryozoa or Mollusca to view relationships among regions and taxa. The distribution of seaweeds in the Arctic, the northeast Pacific, and in Cook Inlet was compared to evaluate what relationship might exist between species occurring in the Cook Inlet and in the Arctic. This assessment used existing algae databases and as yet unpublished molecular data.

We found a strong relationship between Arctic and west-side bryozoan fauna and weaker relationships for other invertebrate groups. Our results suggest that the disjunct distributions of many Arctic-affiliated species, both algae and invertebrates may be due to a contraction in their distributional ranges in the north Pacific from wider distributions occupied before the most recent glacial retreat.

I. Introduction

As early as 1976, scientists noted that a large proportion of the subtidal fauna (mostly epifauna) on the west side of lower Cook Inlet bore a striking resemblance to the fauna reported by MacGinitie (1955) for Point Barrow (Lees 1976). Further studies provided evidence to support the hypothesis that the epifauna in this region are a relict Arctic fauna (Lees *et al.* 1980). Independently, staff at the University of Alaska Fairbanks (UAF) Museum developed a similar opinion based on archived collections of western Cook Inlet invertebrates (collected by Mr. Rae Baxter and Mr. George Mueller). (Figure 1)

We define relict Arctic biota as individual species and communities of plants and animals that have persisted in habitats where conditions have remained relatively unaltered since the retreat of glaciers following the last ice age. According to Ekman (1953), glacial relicts "remained when the arctic region shifted to the north during late-glacial or post glacial periods" In a review of the theory, Holmquist (1962) emphasized that the relict concept is rather loosely defined. Examples of relict fauna include crustaceans in lakes in the Canadian archipelago (Johnson 1964); landlocked Arctic char in Europe (Igoe & Hammar 2004) and North America (Bernatchez *et al*. 2002); and marine brackish water species in the Baltic Sea (Ekman 1953).

While defining biogeographical regions in coastal Alaska, Kelleher *et al.* (1995) placed upper Cook Inlet in the subpolar Beringian Province rather than the Aleutian Province with the adjacent Gulf of Alaska. This classification was based on fish assemblages, the occurrence of an isolated population of beluga whales, and water column characteristics (*i.e.*, water temperature and salinity). They noted that this unique region has not been catalogued as a marine protected area by the United States. Additionally, Piatt & Springer (2007) place the east and west sides of Cook Inlet into separate marine ecoregions.

Given their potential isolation, these western Cook Inlet populations could be at risk from habitat perturbation and may prove to be sensitive indicators of climate change or other ecological shifts. In addition, industrial development could threaten these populations and baseline information is needed to fully evaluate that potential. Monitoring their distributions and abundance could provide insight into changes in marine fauna and flora that may occur with changing physical oceanographic conditions. The persistence of these species in spite of their restricted distributions, relative to the prevailing currents, raises some interesting questions about their reproductive mechanisms and strategies.

An evaluation of the intertidal and shallow subtidal invertebrates and algae in lower and middle western Cook Inlet addresses the Coastal Marine Institute (CMI) framework need for "better understanding marine, coastal or human environments affected or potentially affected by offshore oil and gas or other mineral exploration and extraction on the outer continental shelf."

Figure 1. The study area.

A. Purpose

The principal purposes of this study are to:

1. Conduct a survey of archived specimens from the west side of Cook Inlet, especially from Kamishak Bay, to develop a more complete comprehension of species composition of intertidal and subtidal benthic assemblages on the west side of Cook Inlet;
2. Evaluate the degree of geographic isolation for each potential relict Arctic species by reviewing species lists from previous studies conducted on the east side of Cook Inlet, the Alaska Peninsula, Kodiak, and in Shelikof Strait and the Bering Sea; and

3. Determine the taxonomic status of the species observed in this region by conducting detailed taxonomic evaluations on a wide variety of algae and invertebrates. These include preserved and archived specimens collected during several surveys as early as 1976.

B. Geology

Cook Inlet is a northeast-southwest trending embayment off the Pacific Ocean in the northwestern Gulf of Alaska. This relatively narrow, elongate trough is composed of primarily Mesozoic and Tertiary sedimentary and volcanic rocks. The Bruin Bay Fault runs along the west shore of Cook Inlet and the Seldovia Fault runs along the east side of the inlet through Seldovia and Homer. The similarity of the Jurassic quartz diorite plutons observed on the Kenai Peninsula, the Barren Islands, and the Kodiak Archipelago to those in the Alaska-Aleutian Range suggests that Cook Inlet is part of the Alaska-Aleutian Range continental batholith and is buttressed on the east by the Seldovia Fault (Fisher & Magoon 1978). Thus, Cook Inlet has been a durable geological feature of the landscape since at least the early Mesozoic. However, it has not always been marine in character.

Five Pleistocene glaciations are recognized in the Cook Inlet area. From oldest to youngest, these are: Mount Susitna, Caribou Hills, Eklutna, Knik, and Naptowne (Karlstrom 1964). These are recognized by the distribution of moraines and ice-scoured landforms, by discordant drainage patterns, and by stratigraphic evidence of drift material separated by major unconformities and weathering profiles. During the first three glaciations, Cook Inlet was completely filled with ice to a maximum depth of 1200 m. During the last two glaciations, glacial lobes extended into Cook Inlet but only coalesced across the southern part of the inlet, impounding water in a large proglacial lake (Figure 2, Thurston 1985). This lake persisted from approximately 46,000 - 37,000 BC until its final drainage around 7,000 BC (Karlstrom 1964).

Marine fossil localities from the Gulf of Alaska near Cook Inlet are few. Maelstrom (1964) lists the Bootlegger Cove locality of Eklutna, near present-day Anchorage (age 110,000 - 90,000 years BC). Species identified are the gastropods *Buccinum* cf. *B. physematum*, *Odostomia* sp., and the bivalves *Nuculana fossa*, *Clinocardium ciliatum*, *Macoma* sp., *Hiatella arctica,* and *Mya truncata*. The modern distribution of these species includes Cook Inlet and boreal/Arctic waters.

The surficial sediments of present-day lower Cook Inlet are sands and gravels with small amounts of silts and clays (Sharma & Burrell 1970). They are mostly reworked glacial sediments from the last ice age as well as silts and clays from present-day fluvial deposits. The strong tidal currents and occasional severe storms within the inlet proper preclude the deposition of significant amounts of fine-grained sediments (Hein *et al*. 1977). Existing deposits are characterized by good sorting by size and nature of the rock fragments. The majority of these sediments were initially deposited when the ocean was shallower than it is today, *i.e.*, coastlines were farther offshore (Bouma and Hampton 1976). Along the west side of Cook Inlet, the intertidal zone mostly comprises muddy tidal flats (Sears & Zimmerman 1977), with several areas of bedrock outcrops and gravel beaches occurring at more exposed locations (Lees 1978; Hayes & Michel 1982). Mountains along the west side of Cook Inlet reach heights of up to 3,000 m. Their glaciers feed short, high-gradient rivers that create fan-shaped deltas, often at the base of steep bedrock walls (Michel *et al*. 1978; Hayes & Michel 1982). Aerial videos of the shoreline at low tide can be viewed through the CIRCAC website: http://www.circac.org/.

Figure 2. Location and extent of the Pleistocene proglacial lake.

C. Physical Oceanography

The geological history of the northeast Gulf of Alaska, the substrates of the intertidal and nearshore zones of Cook Inlet, and the ocean currents within the Gulf of Alaska and Cook Inlet undoubtedly influence the distribution of Cook Inlet biota but the manner in which these influences have, in the past, or presently operate remains relatively unclear.

Cook Inlet's marine environment varies from north to south and east to west, depending on geomorphology, winds, tides, ocean currents, erosional and depositional patterns, and other factors. Below we describe two of the major physical influences, water circulation and geology, that define biological habitat in Cook Inlet, and what causes their variability within Cook Inlet. Water circulation patterns are especially important for understanding nearshore systems as they describe the transport of food and larvae from areas upstream and to areas downstream of prevailing currents. Cook Inlet's unique physical oceanography influences the distribution of nearshore habitats throughout the Inlet.

Cook Inlet is a roughly 290 km long estuarine embayment extending northward from the Gulf of Alaska from about 59° N at the mouth to about 61°20'N near Anchorage. Cook Inlet ranges from about 20 to 130 km in width – the narrowest part of Cook Inlet proper being the constriction between the East and West Forelands. Cook Inlet also includes several significant water bodies and embayments including Kamishak and Kachemak bays in the lower Inlet, the long and narrow Turnagain and Knik arms that extend east and north from the upper inlet, as well as many smaller bays and coves (Figure 1).

Cook Inlet's widely varied environment is often described as extreme. For example, tidal ranges can exceed 12 m; large freshwater discharges introduce suspended sediment loads that exceed 2 mgl^{-1} in the upper Inlet (Sharma & Burrell 1970); the inlet has a freezing index of 1400° C days per year leading to extensive shorefast and broken sea ice in the winter (Nelson & Whitney 1996); water currents interact with bathymetry creating semi-permanent shear zones or frontal zones called "tide rips"; and huge depositional areas form mud flats and reefs are often several kilometers from low to high tide. All of these factors, and more, influence Cook Inlet's overall circulation patterns on different spatial and temporal scales.

The average depth of the Inlet is 60 m, but ranges up to 100 m near the mouth but is typically 40 m or less at the head of the estuary. Near the mouth of Cook Inlet, the shelf bathymetry shoals to less than 100 m, but a deeper channel extends along the axis of the inlet and into Kachemak Bay and west of Kalgin Island. The gradients in bottom depth associated with these channels are instrumental in forming the Cook Inlet "tide rips" as described below.

Winds in Cook Inlet are seasonally channeled by the inlet due to the northeast-southwest elongation of Cook Inlet with mountain ranges along the perimeter of the Inlet. In the summer, the winds are predominately from the south and southwest, while in the winter the colder, denser air masses from the interior drive winds predominantly out of the north and northeast (Whitney 1999). Given its proximity to the surrounding mountain ranges, Cook Inlet is prone to extreme localized and intense winds manifested as barrier jets, outflow winds, and gap winds (air being funneled through gaps between mountains). These complex interactions between terrain and dynamic weather systems can strongly influence local water circulation (Zingone & Hufford 2006).

The two major sources of water inputs to Cook Inlet are rivers discharging directly into the inlet and transport of the Alaska Coastal Current (ACC) into lower Cook Inlet. The four major river systems that discharge into upper Cook Inlet include the Beluga, Knik, Matanuska, and Susitna Rivers. As w336ell, many smaller freshwater systems also introduce freshwater throughout the inlet. The freshwater discharge rates from these systems vary significantly by season, with the highest flows typically associated with snowmelt in the spring and summer. The four main rivers listed above have peak flows that, combined, represent about 70% of the total freshwater input into the inlet (Nelson &Whitney 1996) and carry tons of suspended sediment into the inlet each year.

Not surprisingly, the salinity of Cook Inlet varies significantly north to south due to the influx of freshwater in the upper inlet. Values as low as 10 ppt have been measured at the surface in upper

Cook Inlet (Smith 1993) and as high as 32 ppt near the mouth of the inlet (Smith 1993, Pegau *et al.* 2009). Recent hydrographic surveys showed that in the central inlet, mean salinities increase from surface to bottom, from north to south, and from west to east, indicating a mean southward baroclinic (density-driven) flow along the west side of Cook Inlet in the upper part of the water column (Pegau *et al.* 2009). Freshwater flowing into upper Cook Inlet can be seen transporting sediments southward along the west side of the inlet in satellite images (http://modis.gsfc.nasa.gov/).

The semi-diurnal tidal cycle dominates the currents in Cook Inlet, with much of the flow following contours of bathymetry and the coastline. The principal velocity component is in the north-south direction (Johnson *et al*. 2000). The shape and bathymetry of Cook Inlet is such that the M2 (principal lunar semidiurnal tide) resonates and this leads to very large tidal amplitudes (Nelson & Whitney 1996, Pegau *et al.* 2009). The tides at the mouth and head of Cook Inlet are almost 180° out of phase, creating an almost standing wave. Local constrictions, such as between the West and East Forelands in upper Cook Inlet, cause the tidal amplitude and subsequent currents to increase, creating areas of greater current velocities. Local areas in Cook Inlet can have currents greater than 10 knots, and Cook Inlet as a whole has an average maximum surface current of 3 knots (Li *et al.* 2004). Tidal excursions, or the maximum distance that a parcel of water would transport over a full tidal cycle, are greatest in the upper inlet (up to 37 km) and decrease in the southern inlet (to less than 18 km, Nelson & Whitney 1996). In the upper and central inlet, tidal excursions are slightly greater on ebb tides than on flood tides due to the addition of freshwater flowing south.

Although the dominant currents in Cook Inlet are tidally driven at any time, the net currents in Cook Inlet are driven by the density differences due to the Alaska Coastal Current (ACC) and the freshwater inputs into the upper inlet flowing down the west side of the inlet. The ACC is a coastal jet extending over 1,000 km along the northern periphery of the Gulf of Alaska just inside of the Alaska Current and Alaska Stream, flows in a counter-clockwise direction. It is driven by the large flux of freshwater from runoff along the coast (*e.g.,* the Copper River; Figure 3, Royer 1982). When the ACC flows past the Kenai Peninsula, a portion of the current swings into Kennedy Entrance, at the eastern side of the mouth of Cook Inlet. In Cook Inlet, the bulk of the current follows the 100-m isobath and exits the inlet along the west side of the mouth at Stevenson Entrance so that the major mean circulation feature in the lower Cook Inlet region is the westerly flow (Muench *et al*. 1981). Several summary reports were produced in the 1970s and early 1980s that describe the circulation patterns in Cook Inlet, with the emphasis placed on lower Cook Inlet due to the proximity to potential offshore lease sale areas (Figure 4, Muench *et al*. 1978, 1981; Burbank 1977).

A north-flowing portion of the ACC that enters Cook Inlet follows the eastern shore of the inlet until it joins the freshwater discharge from the upper end of the inlet. It then loops back south and enters Shelikof Strait (Figure 4). A recent study shows that the extent that the ACC enters and mixes in Cook Inlet is highly seasonal (Pegau *et al.* 2009). This study also showed that mixing of the fresher surface waters in Cook Inlet varies with the semidiurnal tidal cycle, as well as the spring neap cycle. Stronger tidal mixing energy can break stratification better during the

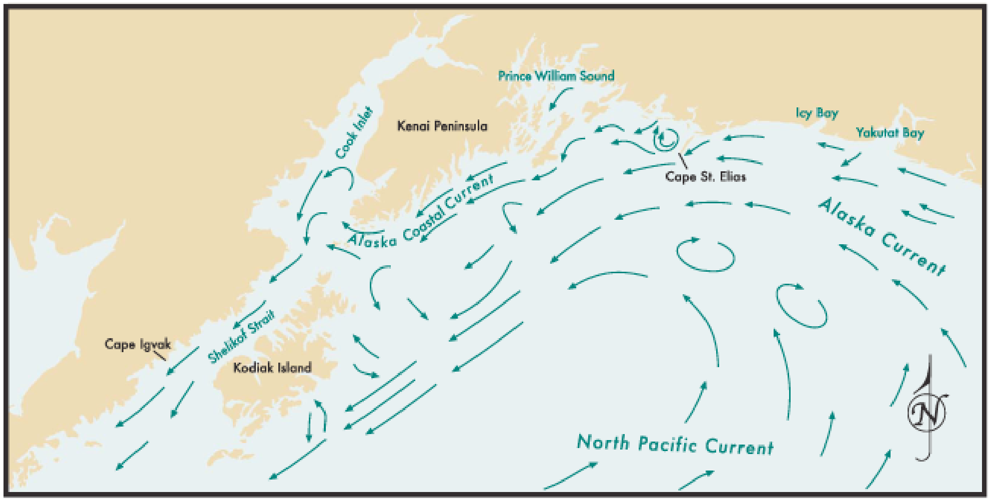


Figure 3. Ocean Currents in the Gulf of Alaska

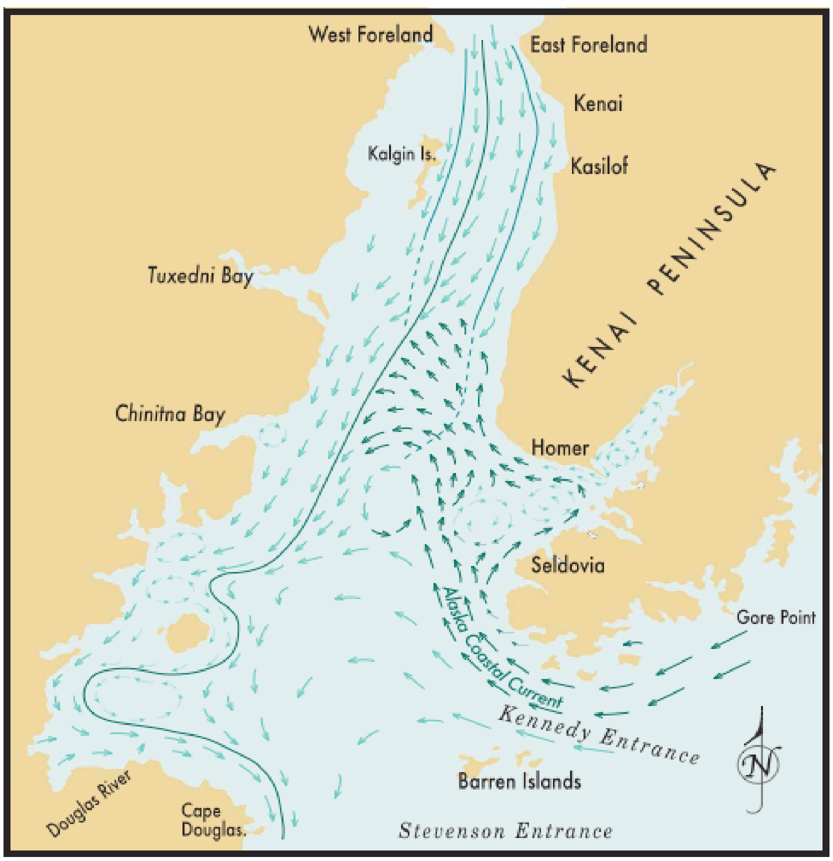


Figure 4. Currents in Cook Inlet.

spring tides of the spring-neap cycles and stronger stratification during the spring season can block mixing. The authors also infer that tidal mixing may block the exchange of waters between areas, which can be important for the exchange of upwelled nutrients or the dispersal of larvae from one area to another.

The interaction between the baroclinic currents (from the ACC and the freshwater current on the west side of the inlet), the barotropic (tidal currents), and bathymetry result in a unique local current regime that includes a series of three main fronts that roughly parallel the shoreline in central Cook Inlet (Burbanks 1977; Okkonen & Howell 2003). These fronts are called tide rips and they vary in form, force, and location. The major rips (frontal zones) are areas of convergence of surface currents and can act as a barrier to transport of surface debris across the front, act as collection zones for debris and seasonal broken ice, and can cause mixing of surface oil by sucking the oil down at the convergence zone until the oil can resurface when its buoyancy allows. Similarly, these features can influence transport of plankton, larvae, sediments, and pollutants within the inlet and seem to confine the lowest salinity and sediment-laden waters to the west side of the inlet. There is evidence, though, that surface currents can overcome the tide rips; drift cards released in the lower eastern inlet have been found on the western inlet shores (Okkonen & Howell 2003) and mixing and subsequent resurfacing of oil has transported spilled oil from the east side of the inlet to the western shores (Whitney 2002).

Cook Inlet's circulation patterns define differences in the physical, chemical, biological, and geological environment in Cook Inlet. As described above, differences in water temperatures and salinities associated with freshwater inputs and upwelling of colder oceanic waters are apparent throughout the inlet, with colder winter temperatures and lower salinities on the west side leading to the formation of more winter ice that can greatly affect survival of species. Tide rips can provide a barrier to transport of food and larvae from the east to the west side of the inlet. High suspended sediment loads that enter upper (northern) Cook Inlet via river discharges are mainly confined to the west side and can influence nearshore geomorphology and the habitats available for nearshore plants and animals. The ACC provides a mechanism for transporting nutrients, food, and larvae to Cook Inlet, but its influence to the western shores is minimized by the frontal zones. Seasonal upwelling of cold, nutrient-rich waters occurs at the mouth of the inlet. This water is transported north and mixes with waters in lower Cook Inlet, greatly influencing productivity in the lower inlet relative to the northern and central inlet. All of these differences can combine to produce differences in habitats and species assemblages from spatially separated areas of the inlet.

D. Marine Invertebrate and Algal Biota

Environmental conditions on the east side of Cook Inlet, especially south of Deep Creek or Ninilchik, are substantially less rigorous than those observed on the west side of the inlet. The physical factors causing the increased rigor for the biota on the west side include: high concentrations of total suspended solids and elevated turbidity; greater deposition rates; more rigorous weather patterns; lower water and air temperatures; lower salinity; and larger quantities of ice and greater ice scour. The biological consequences of these conditions are: a thinner euphotic zone, resulting in far less primary productivity, especially for phytoplankton; low concentrations of phytoplankton, zooplankton, and organics in the water column to support benthic suspension feeders; reduced survival of planktonic larvae due to paucity of phytoplanktonic food and the abrasive and gill-clogging effects of the suspended solids; and poorer conditions for recruiting larvae, especially on rocky substrata (Lees *et al.* 2002). The subtidal benthos in Cook Inlet is described in Feder and Jewett's historical review of previous studies (1987 in Hood & Zimmerman). Assessments of infaunal and epifaunal species were undertaken in 1977 - 1996 to describe species composition, distribution patterns, and biomass in relationship to environmental parameters. The many studies by Feder and his associates of the offshore benthos complement the thorough descriptions of intertidal and subtidal biological assemblages and associated substrata presented by Lees *et al*.

As part of the environmental assessments of the Alaska continental shelf (Outer Continental Shelf Environmental Assessment Program, *i.e.*, OCSEAP), Lees *et al.* (1977) provided reconnaissance-level descriptions the intertidal habitats and intertidal communities on both the eastern and western sides of lower Cook Inlet (Figure 1). Lees *et al.* (1980) described three assemblages of subtidal epifauna and algae on rocky substrata of lower Cook Inlet based on structure and species composition of macrophytes and epifauna. Within outer Kachemak Bay, kelp beds with both dense canopy and understory layers extending to depths of 18 m were widespread and supported well-developed assemblages of sedentary invertebrates. North of Kachemak Bay as far as Anchor Point, on the east side of Cook Inlet, the moderately developed kelp beds extended to shallower depths and displayed a thinner canopy, a more moderate understory, but still well-developed assemblages of sedentary invertebrates. In contrast, in Kamishak Bay, on the west side of Cook Inlet, kelps beds, limited to understory kelps, were rare to absent and restricted to lower intertidal depths. A diverse sedentary invertebrate assemblage covered much of the available rock substrate. Especially below the kelps, the epifauna was dominated by barnacles, encrusting and foliose bryozoans, sponges, and ascidians. Cover by these suspension feeders was relatively high but biomass was only moderate.

Unconsolidated sediments in deeper waters of lower Cook Inlet are characterized by a relatively smooth bottom and strong tidal currents (Feder & Jewett 1987). Benthic communities are represented by two major infaunal groups. Deposit feeders characterized muddy substrata but suspension feeders dominate on sandy substrata outside Kachemak Bay.

The western side of Cook Inlet is "influenced by freshwater runoff and a high concentration of river-derived sediments carried from the upper inlet" (Feder & Jewett 1987). Moreover, the turbid waters restrict primary productivity especially in the early spring (Feder & Jewett 1987). This pattern of currents and turbidity appears to present a very effective barrier to transport and/or survival of planktonic larvae of marine invertebrates from the east side of the inlet to the west side but possibly, some types of larvae (*e.g.*, razor clams) are able to move successfully across the inlet.

II Methods

A. Sources of information

To address questions of Arctic-affiliated algae and invertebrates, we reviewed previous biological assessments, examined specimens, and considered the geological history and other factors that may explain the disjunct occurrences of algae and invertebrates.

Collections of invertebrates from the west side of Cook Inlet are rare, limited to Lees' surveys done in the 1970s (UA Museum Aquatic Collection Accession 2003-1) and collecting done for the University of Alaska Museum in 1976. Other UA Museum specimens representing approximately fifty-six species from Point Barrow, the Bering/Chukchi Sea, and lower Cook Inlet were examined.

We reviewed species lists from previous studies including the infauna of lower Cook Inlet: Feder, Paul, Hoberg, and Jewett (1981); Shallow subtidal assemblages for Kachemak Bay: Driskell and Lees (1977); Lees and Driskell, 1981. Foster's (2000) list was used for Prince William Sound; MacGinitie (1955) for Point Barrrow.

Additional other invertebrate literature was reviewed to determine distributions of various species. These included: Polyplacophoran Mollusca: Kaas and van Belle (1994); Bivalve Mollusca: Coan *et al.* (2000); Echinodermata: Lambert (1997, 2000); Ascidia: van Name (1945); Bryozoa: Osburn (1950, 1952, 1953); Kluge (1975); and Brachiopoda: Bernard (1971). From these sources we compiled a list of 724 species representing four areas: Point Barrow the east side of Cook Inlet, the east side of Cook Inlet, and Prince William Sound.

We used the species list from the west side as the basis for comparison and included all species that occurred in at least one other region. This list includes all 232 west side taxa, 71 from the Arctic, 143 from Kachemak Bay, and 157 from Prince William Sound.

Two types of multivariate analyses (1) cluster analysis with group averaging using the Bray-Curtis similarity index; and 2) non-metric multidimensional scaling (MDS)) were used to compare relationships among regions and taxa using PRIMER software (Clarke & Warwick 2001).

Where available, we used abundance notes in the various reports to estimate relative abundance for each taxon. The relative abundance codes, adapted from semi-quantitative methods used to examine intertidal biota (see Feder and Kaiser 1980, for example), ranged from 1 through 5 (Table 1).

Table 1. Abundance codes based on reported relative abundance in reports used to build regional faunal tables.

Estimated Relative Abundance	Abundance Code
Rare	1
Sparse/Uncommon	2
Common	3
Abundant	4
Very Abundant	5

Based on impressions regarding possible differences in the proportion of major taxa, trophic structure, and the general size of the animals, we established codes for these factors to assess if potential differences in the faunal composition of the regions were influenced by these factors. These codes were used to weight the codes representing regional abundance for each taxon reported in Appendix A in terms of the three factors. The codes are demonstrated in Tables 2 through 4. The weighting process entails multiplying the relative abundance codes by a specific factor weighting code. For example, the taxon weighted value of a rare (abundance code = 1) sipunculid species (taxon code = 5) would be 5 whereas a common bivalve would be 33.3 (3 X 11.1)

Table 2. Trophic codes for various suspected trophic modes.

Suspected Trophic Mode	Trophic Code
Deposit Feeder	1
Detritivore	2
Suspension/Detritivore	3
Suspension/Filter Feeder	4
Microherbivore	5
Macroherbivore	6
Micropredator/Detritivore	7
Micropredator	8
Mesopredator	9
Macropredator/Detritivore	10
Macropredator	11

Table 3. Taxon codes for major taxonomic designations.

Major Taxon Designation	Taxon Code
Porifera	1
Cnidaria: Hydrozoa: Athecata	2.1
Cnidaria: Hydrozoa: Thecata	2.2
Cnidaria: Hydrozoa	2.3
Cnidaria: Anthozoa	2.4
Annelida: Polychaeta	3
Priapulida	4
Sipuncula	5
Echiura	6
Arthropoda: Crustacea: Cirripedia	7.1
Arthropoda: Crustacea: Decapoda	7.2
Arthropoda: Crustacea: Isopoda	7.3
Brachiopoda	8
Bryozoa: Cheilostomata: Anasca	9.1
Bryozoa: Cheilostomata: Ascophora	9.2
Bryozoa: Ctenostomata	9.3
Entoprocta	10
Mollusca: Bivalvia	11.1
Mollusca: Polyplacophora	11.2
Mollusca: Gastropoda: Opisthobranchia	11.3
Mollusca: Gastropoda: Prosobranchia	11.4
Mollusca: Cephalopoda	11.5
Echinodermata: Asteroidea	12.1
Echinodermata: Echinoidea	12.2
Echinodermata: Holothuroidea	12.3
Echinodermata: Ophiuroidea	12.4
Urochordata: Ascidiacea	13

Table 4. Size codes for relative size categories.

Relative Size (Length or Diameter)	Size Code
Very small (<1 cm)	1
Small (1 cm to 5 cm)	2
>5 cm to 10 cm	3
>10 cm to 20 cm	4
>20 cm	5

c. Expert Identifications

We relied on several taxonomic specialists to provide identifications of taxa that are poorly studied. Twenty-five specimens of gastropods were examined by J. H. McLean, Emeritus Curator of Malacology at the Natural History Museum of Los Angeles County. Forty-six specimens of Bryozoa, as well as shells, pebbles, and algae were examined by Andrei Grischenko of the Perm State Museum from Russia. Thirteen lots of Ascidia from Cook Inlet and adjacent areas were examined by Gretchen Lambert. Igor S. Smirnov, Zoological Institute of Russian Academy of Sciences confirmed the identification of the brittle star *Stegophiura nodosa*.

2. Algae

Known occurrences of seaweed flora of the west side of Cook Inlet were compared with collecting records from the Arctic coast of Alaska developed by Sandra Lindstrom. http://herbarium.botany.ubc.ca/herbarium_database/algae_alaska/search.htm

B. Biogeographical Definitions

We use four biogeographical delineations for the species encountered in this study.
The geographical range of Circumpolar Arctic–Boreal species extends down through the Arctic and southward into temperate waters of both the Pacific (Point Conception in California, and Inubo Strait in the West Pacific [35.7 N] and Atlantic Oceans to Cape Cod and France in the east Atlantic (Golikov *et al.* 1990; Grischenko *et al.* 2007). Arctic–Boreal Pacific species are distributed along the Eurasian and American sectors of the Arctic region and extending southward into temperate waters of the Pacific, but are absent in the Canadian Arctic and northern Atlantic. That is: Bering Strait and the Chukchi Sea to Inubo Strait and Point Conception (Grischenko *et al.* 2007). Amphiboreal species are primarily distributed in temperate waters in both the Pacific and Atlantic Oceans (Ekman 1953). High–Boreal Pacific species are distributed in cool temperate waters of the Pacific Ocean (Sea of Okhotsk, Kuril Islands, Kamchatka Peninsula, Bering Sea, Gulf of Alaska, British Columbia) and present in the Arctic as relict forms (Ekman 1953).

III. Results

A. Invertebrates

1. Major Taxa

The original fauna compiled to compare regions in this study comprises twenty-eight major invertebrate taxa, ranging from Porifera to Urochordata: Ascidiacea, and 723 lower taxa (Table 5). The largest number of lower level taxa observed in the list was for prosobranch gastropods (126 species); bivalves, anascan and ascophoran cheilostome bryozoans, thecate hydroids, ascidians, and opisthobranch gastropods were all represented by at least 40 species. Consequently, we decided to limit the analysis to species that had been reported from the west side of Cook Inlet in order to make the comparisons more relevant (Table 6).

Table 5. Summary by Major Taxononomic Group of Taxa Used for Regional Comparison.

Major Taxon	No. of taxa
Porifera	25
Cnidaria: Hydrozoa: Athecata	12
Cnidaria: Hydrozoa: Thecata	50
Cnidaria: Hydrozoa	1
Cnidaria: Anthozoa	19
Annelida: Polychaeta	15
Priapulida	2
Sipuncula	4
Echiura	2
Arthropoda: Crustacea: Cirripedia	10
Arthropoda: Crustacea: Decapoda	37
Arthropoda: Crustacea: Isopoda	3
Brachiopoda	7
Bryozoa: Cheilostomata: Anasca	49
Bryozoa: Cheilostomata: Ascophora	60
Bryozoa: Ctenostomata & Cyclostomata	33
Entoprocta	2
Mollusca: Bivalvia	85
Mollusca: Polyplacophora	25
Mollusca: Gastropoda: Opisthobranchia	45
Mollusca: Gastropoda: Prosobranchia &Pulmonata	126
Mollusca: Cephalopoda	2
Echinodermata: Asteroidea	32
Echinodermata: Echinoidea	3
Echinodermata: Holothuroidea	13
Echinodermata: Ophiuroidea	13
Urochordata: Ascidiacea	48
Total	723

The fauna examined based on the West-Side Only criterion also comprises twenty-eight major invertebrate taxa, ranging from Porifera to Urochordata: Ascidiacea. The largest number of lower level taxa observed in the list compiled to compare regions with the West-Side Only fauna was for prosobranch gastropods (43 species); bivalves and anascan cheilostome bryozoans were both represented by at least 20 species.

The four regions differed substantially in terms of how many major taxa were reported. Based on the West-Side Only selection method, the largest number of lower level taxa was reported for the west side of Cook Inlet (232; Table 6; Appendix).

The four regions differed somewhat in terms of which major taxa dominated but generally prosobranch gastropods, bivalves, and bryozoans were major components. The dominant major taxa on the west side of Cook Inlet, in decreasing order of abundance, were prosobranch gastropods, bivalves, ascophoran and anascan bryozoans, and decapod crustaceans (Table 7). At Point Barrow in the Arctic, dominant major taxa were ascophoran and anascan bryozoans, bivalves, and prosobranch gastropods. In Kachemak Bay on the east side of lower Cook Inlet and in Prince William Sound, prosobranch gastropods strongly dominated the fauna, followed by bivalves. Decapod crustacean were also well represented in both regions.

Using the list from the west side of Cook Inlet as the guide, the smallest number (71) was reported for the Arctic (Table 6 and 7). This indicates a very strong influence of species from the northeastern Pacific on the faunae of these regions. However, Arctic forms contribute almost one-third of the taxa to the overall list on the west side of Cook Inlet (Table 7) and only slightly less, proportionately, to the faunae of Kachemak Bay and Prince William Sound when the species list from the west side of Cook Inlet is used as the criterion for inclusion on the species lists. This demonstrates an appreciable influence of Arctic species in all the southern regions.

The 68 species found in common between the faunae of the west side of Cook Inlet and the Arctic are dominated by Bryozoa (26 species) and Mollusca (18 species) (Tables 8, 9, and 10). Echinodermata (7 species) and Crustacea (6 species) are represented less frequently. Within west-side species assemblages for these phyla, 59 percent of the bryozoans, 22 percent.

Cook Inlet represents either the southern extent of their geographical ranges or represents disjunct occurrences (*e.g.*, *Saduria entomon,* an estuarine isopod, the limpet *Tectura testudinalis,* and the solitary ascidian, *Pelonaia corrugata*) for 15 species (Table 11).

Table 6. Number of Major Taxa Recorded in Regions Considered in This Study and Taxon Codes Designated for Taxa.

Major Taxon	Taxon Code	Number of Taxa (Regional %)			
		Arctic (Pt. Barrow)	West Side Cook Inlet	Kachemak Bay	Prince William Sound
Porifera	1	1 (1.4)	7 (3.0)	5 (3.5)	6 (3.8)
Cnidaria: Hydrozoa: Athecata	2.1	1 (1.4)	1 (0.4)	0	1 (0.6)
Cnidaria: Hydrozoa: Thecata	2.2	0	15 (6.5)	3 (2.1)	8 (5.1)
Cnidaria: Anthozoa	2.4	0	5 (2.2)	5 (3.5)	3 (1.9)
Annelida: Polychaeta	3	1 (1.4)	3 (1.3)	3 (2.1)	1 (0.6)
Priapulida	4	1 (1.4)	1 (0.4)	0	1 (0.6)
Sipuncula	5	0	1 (0.4)	1 (0.7)	1 (0.6)
Echiura	6	1 (1.4)	2 (0.9)	2 (1.4)	1 (0.6)
Brachiopoda	8	3 (4.2)	4 (1.7)	3 (2.1)	2 (1.3)
Bryozoa: Cheilostomata: Anasca	9.1	12 (16.9)	21 (9.1)	11 (7.7)	13 (8.3)
Bryozoa: Cheilostomata: Ascophora	9.2	12 (16.9)	19 (8.2)	8 (5.6)	8 (5.1)
Bryozoa: Ctenostomata	9.3	3 (4.2)	6 (2.6)	3 (2.1)	2 (1.3)
Entoprocta	10	0	1 (0.4)	0	0
Mollusca: Bivalvia	11.1	9 (12.7)	27 (11.6)	19 (13.3)	25 (15.9)
Mollusca: Polyplacophora	11.2	2 (2.8)	12 (5.2)	7 (4.9)	10 (6.4)
Mollusca: Gastropoda: Opisthobranchia	11.3	0	7 (3.0)	4 (2.8)	6 (3.8)
Mollusca: Gastropoda: Prosobranchia	11.4	8 (11.3)	43 (18.5)	30 (21.0)	34 (21.7)
Mollusca: Cephalopoda	11.5	0	1 (0.4)	1 (0.7)	1 (0.6)
Arthropoda: Crustacea: Cirripedia	7.1	1 (1.4)	7 (3.0)	6 (4.2)	5 (3.2)
Arthropoda: Crustacea: Decapoda	7.2	4 (5.6)	19 (8.2)	14 (9.8)	10 (6.4)
Arthropoda: Crustacea: Isopoda	7.3	1 (1.4)	1 (0.4)	0	0
Echinodermata: Asteroidea	12.1	4 (5.6)	12 (5.2)	9 (6.3)	7 (4.5)
Echinodermata: Echinoidea	12.2	1 (1.4)	2 (0.9)	1 (0.7)	2 (1.3)
Echinodermata: Holothuroidea	12.3	0	6 (2.6)	5 (3.5)	5 (3.2)
Echinodermata: Ophiuroidea	12.4	2 (2.8)	2 (0.9)	1 (0.7)	1 (0.6)
Urochordata: Ascidiacea	13	4 (5.6)	7 (3.0)	2 (1.4)	4 (2.5)
Regional Totals for Species		71	232	143	157

Table 7. Comparison of Species that Southern Regions have in Common with the Arctic* Species Based on Species that Occur on the West Side of Cook Inlet.

Regions Being Compared	Number of Species in Southern Region	Species in Common with Arctic Region	Percent Species in Common
West Side to Arctic	232	71	31
Kachemak Bay to Arctic	143	42	29
Prince William Sound to Arctic	157	43	27

* Based on MacGinitie (1955) for Pt. Barrow.

Table 8. Numbers of Higher Taxa With Arctic Affinities Identified from the West Side of Cook Inlet.

Higher Taxon	Total
Porifera	1
Cnidaria: Hydrozoa	1
Annelida: Polychaeta	1
Echiura	1
Priapulida	1
Brachiopoda	2
Bryozoa: Cheilostoma	23
Bryozoa: Ctenostomata and Cyclostoma	3
Mollusca: Bivalvia	9
Mollusca: Polyplacophora	2
Mollusca: Gastropoda	7
Arthropoda: Crustacea: Cirripedia	1
Arthropoda: Crustacea: Decapoda	4
Arthropoda: Crustacea: Isopoda	1
Echinodermata: Asteroidea	4
Echinodermata: Echinoidea	1
Echinodermata: Ophiuroidea	2
Urochordata: Ascidiacea	4
Grand Total	68

Table 9. Species Found Both in Arctic and on the West Side of Cook Inlet. Sources for Arctic and Cook Inlet records are footnoted.

Genus/Species	Biogeographical Pattern
PORIFERA	
Myxilla incrustans [a, e]	Circumpolar Arctic-Boreal
CNIDARIA: Hydrozoa – Hydroida	
Hybocodon prolifera [a, b, f]	Circumpolar Arctic-Boreal
ANNELIDA - Polychaeta	
Pectinaria brevicoma [a, e]	Circumpolar Arctic-Boreal
ECHIURA	
Echiurus echiurus alaskanus [a, e, f]	Circumpolar Arctic-Boreal
PRIAPULIDA	
Priapulus caudatus [a, f]	Circumpolar Arctic-Boreal
MOLLUSCA - Bivalvia	
Diplodonta aleutica	High-Boreal Pacific
Hiatella arctica	Circumpolar Arctic-Boreal
Liocyma fluctuosum	Arctic-Boreal Pacific
Macoma balthica	Circumpolar Arctic-Boreal
Musculus discors	Circumpolar Arctic-Boreal
Musculus niger	Circumpolar Arctic-Boreal
Mya pseudoarenaria	Circumpolar Arctic-Boreal
Mya truncata	Circumpolar Arctic-Boreal
Panomya ampla	High-Boreal Pacific
MOLLUSCA - Polyplacophora	
Amicula vestita [a, e]	Amphiboreal
Stenosemus albus [a, e]	Circumpolar Arctic-Boreal
MOLLUSCA - Gastropoda	
Aquilonaria turneri	Arctic-Pacific-Boreal
Boreoscala groenlandica	Circumpolar Arctic-Boreal
Boreotrophon clathratus	Circumpolar Arctic-Boreal
Cryptonatica affinis	Circumpolar Arctic-Boreal
Piliscus commodus [a, c]	Circumpolar Arctic-Boreal
Tectura testudinalis	Circumpolar Arctic-Boreal
Velutina velutina	Circumpolar Arctic-Boreal
CRUSTACEA: CIRREPEDIA	
Balanus crenatus[a, e, f]	Circumpolar Arctic-Boreal
CRUSTACEA: ISOPODA	
Saduria entomon [a, e, f]	Circumpolar Arctic-Boreal
CRUSTACEA: DECAPODA	

Genus/Species	Biogeographical Pattern
Lebbeus polaris	Circumpolar Arctic-Boreal
Pandalus goniurus	Circumpolar Arctic-Boreal
Paralithodes camtschaticus	Circumpolar Arctic-Boreal
Sclerocrangon boreas	Circumpolar Arctic-Boreal
BRYOZOA - Cheilostomata	
Arctonula arctica	Circumpolar Arctic-Boreal
Bidenkapia spitzbergensis	Circumpolar Arctic-Boreal
Callopora lineata	Circumpolar Arctic-Boreal
Carbasea carbasea	Circumpolar Arctic-Boreal
Celleporella hyalina species complex	Circumpolar Arctic-Boreal
Celleporina aspera	Circumpolar Arctic-Boreal
Celleporina surcularis	Circumpolar Arctic-Boreal
Cystisella beringiana	Arctic-Boreal Pacific
Dendrobeania murrayana	Circumpolar Arctic-Boreal
Electra arctica	Circumpolar Arctic-Boreal
Eucratea loricata	Circumpolar Arctic-Boreal
Flustra foliacea	Amphiboreal
Flustrellidra corniculata	Circumpolar Arctic-Boreal
Flustrellidra gigantea	Circumpolar Arctic-Boreal
Myriozoella plana	Circumpolar Arctic-Boreal
Pachyegis princeps	Circumpolar Arctic-Boreal
Porella acutirostris species complex	Circumpolar Arctic-Boreal
Porella compressa	Circumpolar Arctic-Boreal
Raymondia rigida	Circumpolar Arctic-Boreal
Rhamphostomella costata	Circumpolar Arctic-Boreal
Rhamphostomella spinigera	Circumpolar Arctic-Boreal
Tegella arctica	Circumpolar Arctic-Boreal
Tegella armifera	Circumpolar Arctic-Boreal
BRYOZOA – Ctenostomata & Cyclostomata	
Alcyonidium mytili	Circumpolar Arctic-Boreal
Alcyonidium pedunculatum	Circumpolar Arctic-Boreal
Diplosolen arctica	Circumpolar Arctic-Boreal
BRACHIOPODA	
Hemithyrus psittacea [a, e]	Circumpolar Arctic-Boreal
Diestothyris ?frontalis [a, e] (?=*D. spitsbergensis)*	Circumpolar Arctic-Boreal
ECHINODERMATA - Asteroidea	
Crossaster papposus	Circumpolar Arctic-Boreal
Henricia sanguinolenta	Circumpolar Arctic-Boreal

Genus/Species	Biogeographical Pattern
Leptasterias polaris acervata	Arctic-Boreal Pacific
Solaster endeca	Amphiboreal
ECHINODERMATA - Echinoidea	
Strongylocentrotus droebachiensis	Circumpolar Arctic-Boreal
ECHINODERMATA - Ophiuroidea	
Ophiopholis aculeata	Amphiboreal
Stegophiura nodosa [a, f]	Circumpolar Arctic-Boreal
TUNICATA	
Boltenia echinata	Circumpolar Arctic-Boreal
Dendrodoa pulchella [a, e]	Circumpolar Arctic-Boreal
Halocynthia aurantia	Circumpolar Arctic-Boreal
Pelonaia corrugata [a, e]	Circumpolar Arctic-Boreal
OVERALL TOTAL	68

[a] MacGinitie (1955)
[b] Naumov (1960)
[c] University of Alaska Fairbanks Museum Aquatic Collection accessions
[d] Dr. Andrei Gryshenko, Perm University, Russia
[e] Lees et al. (1980)
[f] Pebble Mine marine biological survey

Table 10.Biogeographical Affinities for Invertebrates with Distributions Including Western Cook Inlet and the Arctic.

Distribution	**Total**
Amphiboreal	4
Arctic-Boreal Pacific	4
Circumpolar Arctic-Boreal	56
High-Boreal Pacific	4
Grand Total	68

Table 11. Species with isolated occurrences on west side of Cook Inlet.

Major Taxon	Species
Brachiopoda	*?Diestothyris spitzbergensis*
Bryozoa: Cheilostomata: Anasca	*Bidenkapia spitzbergensis*
Bryozoa: Cheilostomata: Ascophora	*Porella compressa*
Bryozoa: Cheilostomata: Ascophora	*Raymondia rigida*
Bryozoa: Cheilostomata: Ascophora	*Rhamphostomella spinigera*
Bryozoa: Cyclostomata	*Entalophoroecia vancouverensis*
Arthropoda: Crustacea: Decapoda	*Lebbeus polaris*
Arthropoda: Crustacea: Isopoda	*Saduria entomon*
Mollusca: Gastropoda: Prosobranchia	*Aquilonaria turneri*
Mollusca: Gastropoda: Prosobranchia	*Piliscus commodus*
Mollusca: Gastropoda: Prosobranchia	*Tectura testudinalis*
Mollusca: Polyplacophora	*Amicula vestita*
Echinodermata: Ophiuroidea	*Stegophiura nodosa*
Urochordata: Ascidiacea	*Dendrodoa pulchella*
Urochordata: Ascidiacea	*Pelonaia corrugata*

2. Multivariate Analysis

We conducted multivariate analyses to assess the resemblance in taxonomic composition among regions and in resemblance in regional distribution among taxa. While the resemblance patterns among regions were consistent, the patterns observed in groupings of the full suite of taxa were not meaningful and are not presented. The likely cause for this lack of meaning is that because we are dealing with only four regions, many of the taxa have very similar distribution patterns. In contrast, patterns were more obvious and interpretable when the species lists were restricted to just the Bryozoa or Mollusca and excluded Opisthobranchia and Cephalopoda.

a. Overall West-Side Only Species List

Regional relationships are very similar whether or not the relative abundance data are weighted (Figure 5 a-d). In all cases, the strongest linkage in both the dendrograms and the 2-dimensional non-metric multidimensional scaling (non-MDA) is between Kachemak Bay and Prince William Sound. This core grouping is closely linked to the west side of Cook Inlet; in all cases, the species assemblage on the west side of Cook Inlet is closely related to that in Kachemak Bay and Prince William Sound. The species assemblages for these regions exhibit significant similarity at the 10-percent level. Finally, the Arctic species assemblage joins the other three regions at a substantially lower level of similarity.

Weighting by taxonomic, trophic, or size codes has only a very small effect on the linkages in the dendrograms (Table 12). Except for the effect of trophic structure at the weakest node, the nodes at each level (strongest, moderate, and weakest) are all within a percent of one another.

Table 12.Comparison of nodes linking the regions and weighting options.

	Level of Similarity (%)		
Weighting	Strongest Linkage	Moderate Linkage	Weakest Linkage
Unweighted	76	73	35
Taxon Code Weighted	76	74	36
Trophic Code Weighted	77	74	29
Size Code Weighted	76	74	35

All of the 2-dimensional ordinations produced by MDA illustrate the strong degree of separation of the Arctic species assemblage from those in the southern regions as well as the close similarity of the assemblages in Kachemak Bay, Prince William Sound, and the west side of Cook Inlet (Figure 6 a - d). The clumping of the southern regions inside the higher similarity contours clearly demonstrates this pattern. The assemblages in these three regions average 75 percent similarity (Table 12). In contrast, the Arctic assemblage averages only 34 percent similarity with the southern group of regions. That stress levels in these ordinations are zero in all cases, indicates that the graphics are excellent representations of the regional relationships.

In the cases of trophic structure and size (Figures 6c and 6d), the effect of weighting is the same, *i.e.*, the trajectory for weighting values progressed (values increase) from the Arctic to the west side to Prince William Sound to Kachemak Bay (Table 13). This can be interpreted to mean that the Arctic fauna is skewed toward lower trophic levels and smaller animals than found in the southern regions, especially Kachemak Bay. However, the differences in magnitude of the codes are quite small and have no statistical significance.

Table 13.Differences in weighting due to taxonomic level, trophic structure, and size codes.

Region	**Taxon Groups***	**Trophic Structure***	**Sizea***
Arctic (Pt. Barrow)			
Average	9.60	4.46	2.52
Std Dev	2.42	2.82	0.91
West Side of Cook Inlet			
Mean	9.12	5.54	2.56
Std Dev	3.27	3.26	0.94
Kachemak Bay			
Mean	9.29	5.93	2.68
Std Dev	3.14	3.51	0.99
Prince William Sound			
Mean	9.41	5.65	2.59
Std Dev	3.28	3.29	0.95

* Ranges for codes: Taxon: 1 – 11; Trophic: 1 - 11; Size: 1 - 5

In the case of taxon weighting (Figure 6b), the trajectory increases from the west-side species assemblage progressively to Kachemak Bay, Prince William Sound, and Arctic assemblages. This suggests that less advanced major taxa are better represented in the west-side assemblage than in the other regions and that the Arctic assemblage is skewed toward more advanced major taxa. However, again, the differences are quite small with all regions having an average value approximating the general code for Bryozoa (≈9; Table 13).

b. Bryozoa-Only Species List

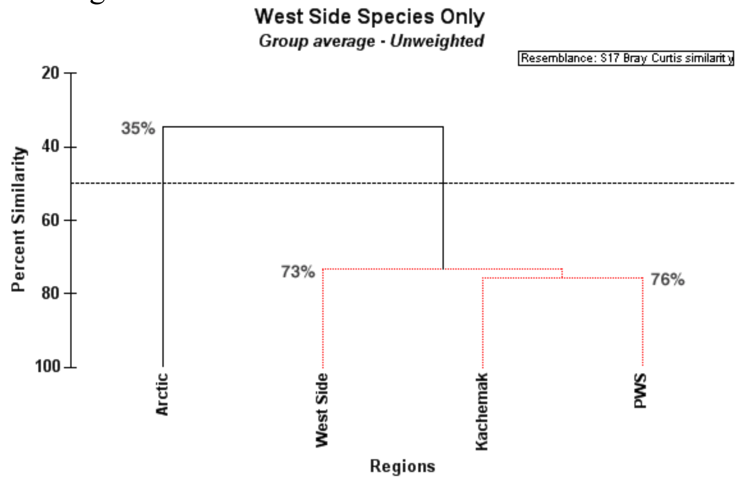
Limiting the faunal assemblage examined to Bryozoa demonstrates that this group is quite important in establishing the strong relationship between Arctic and west-side faunal assemblages versus the Kachemak Bay or Prince William Sound assemblages (Figure 7). The analysis of only bryozoans (46 species, 27 [59%] of which are found in the Arctic) suggests that the strongest linkage is between the Kachemak Bay and Prince William Sound assemblages but the next strongest linkage is between the west side and Arctic assemblages. These two groupings are also linked at a much higher level that is seen for the full West-Side Only assemblage (Figure 5). The similarity among these linkages is statistically significant at the 10-percent level.

The clustering of bryozoan species among these regions splits the species into two major groups comprising five notable subgroups (Figure 8). The two major groups are linked at the 49 percent level of similarity. Ten species in one subgroup have 100 percent similarity, *i.e.* they are identically distributed among the four regions. This group and another group including nine species with more varied distribution and abundance patterns (Table 14) are statistically similar at the 10-percent significance level. Several smaller groups, especially species pairings, also demonstrate statistically significant similarity.

To examine the distribution patterns behind these dendrograms, we constructed a nodal table where the regions are aligned along one axis in the order shown in Figure 7 and the species are aligned along the other axis in the order shown in Figure 8 The major and subordinate divisions shown in Figures 7 and 8 are indicated in Table 14 by triple and double lines, respectively. Underlined species within groupings have statistically similar distributions.

As indicated, cluster analysis divides the species assemblages into two major groups (Figure 8 and Table 14). It is clear from an inspection of Table 14 that this division is based on the occurrence of a species in Kachemak Bay; none of the species in Group A occurred in Kachemak Bay whereas all but one of the species in Group B occurred there. Group A includes 24 species, 11 of which occurred in the Arctic region. Within this group, the largest subgroup, ten species with 100 percent similarity, occurred only in the west-side region. The next largest subgroup, with seven species, occurred in only the west-side and the Arctic regions. A third subgroup, also with seven species, splits into two minor subgroups; one subgroup includes species that occurred in the west-side and Prince William Sound regions and the other has species in those regions as well as in the Arctic region. All of the species with High Boreal and High Boreal Arctic biogeographical affinities occur in Group A (Table 14).

5a. Unweighted



5b. Taxon Code Weighting

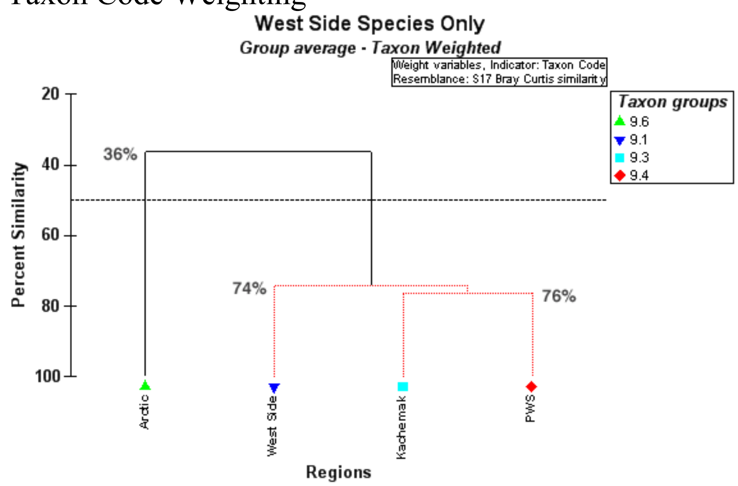
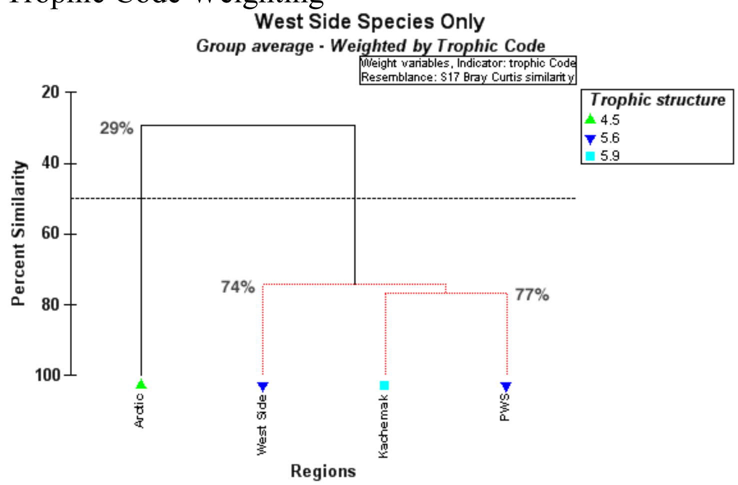


Figure 5. **Comparison of regional similarity in dendrograms differing by type of weighting. The red shading of branches indicates the linked regions are statistically similar at the 10-percent significance level based on permutation testing.**

5c. Trophic Code Weighting



5d. Size Code Weighting

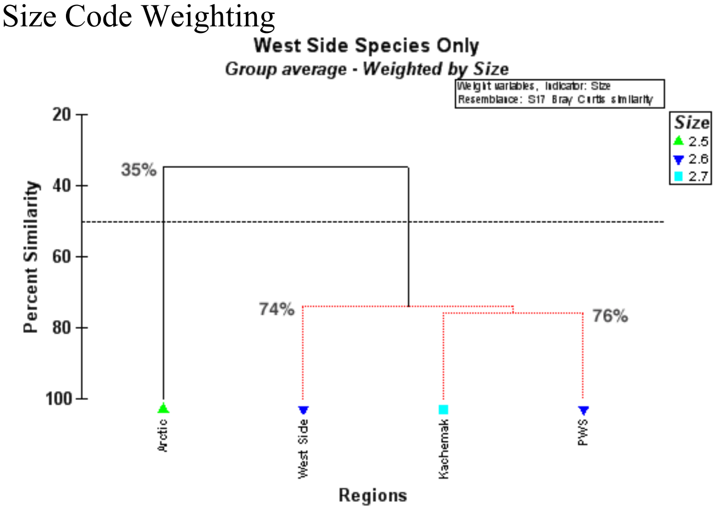
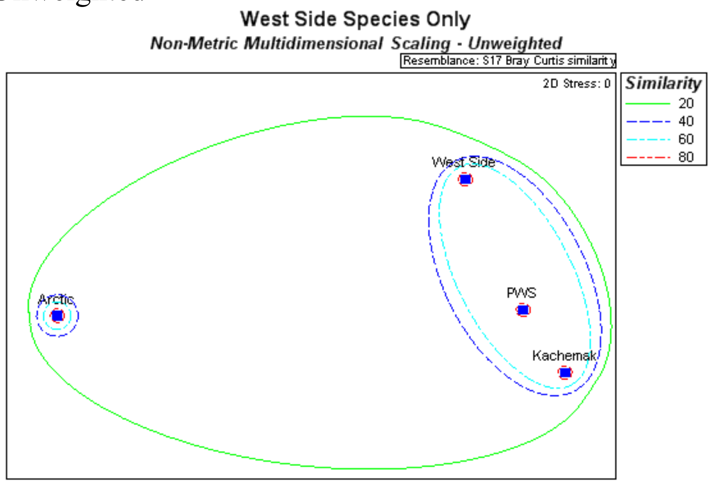


Figure 5 Cont. **Comparison of regional similarity in dendrograms differing by type of weighting. The red shading of branches indicates the linked regions are statistically similar at the 10-percent significance level based on permutation testing.**

6a. Unweighted



6b. Taxon Code Weighting

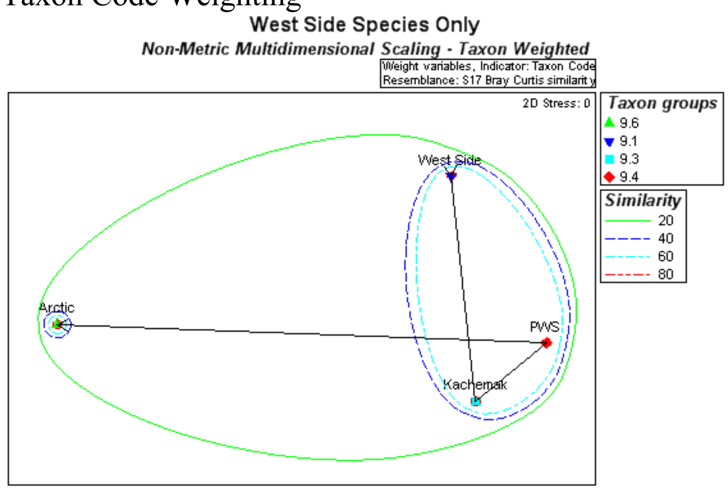
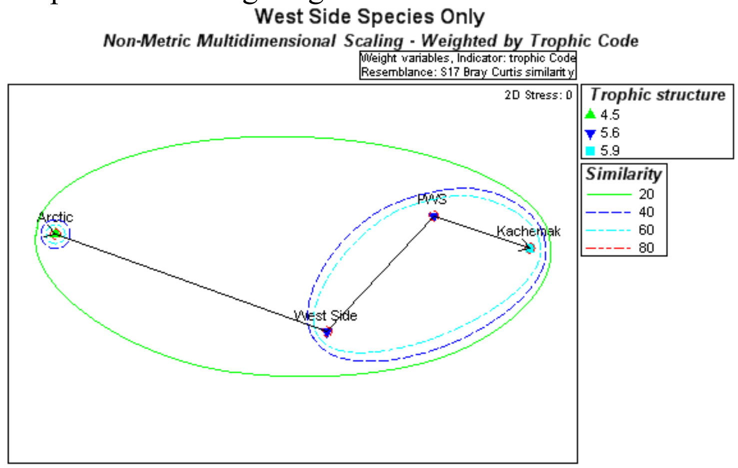


Figure 6. **Comparison of regional similarity in 2-dimensional spaces that differ by type of weighting. Arrows connecting the regional symbols in Figures 5b-d indicate the trajectory for the specified weighting factor, from low to high.**

6c. Trophic Code Weighting



6d. Size Code Weighting

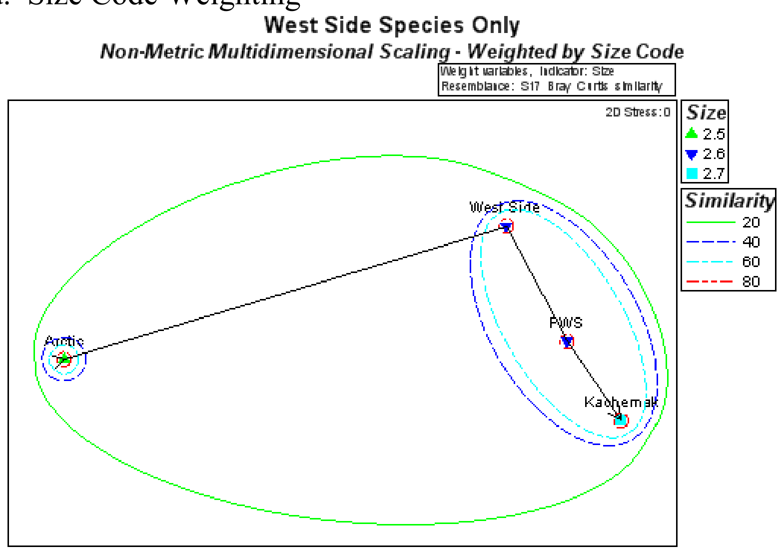


Figure 6 Cont. **Comparison of regional similarity in 2-dimensional spaces that differ by type of weighting. Arrows connecting the regional symbols in Figures 5b-d indicate the trajectory for the specified weighting factor, from low to high.**

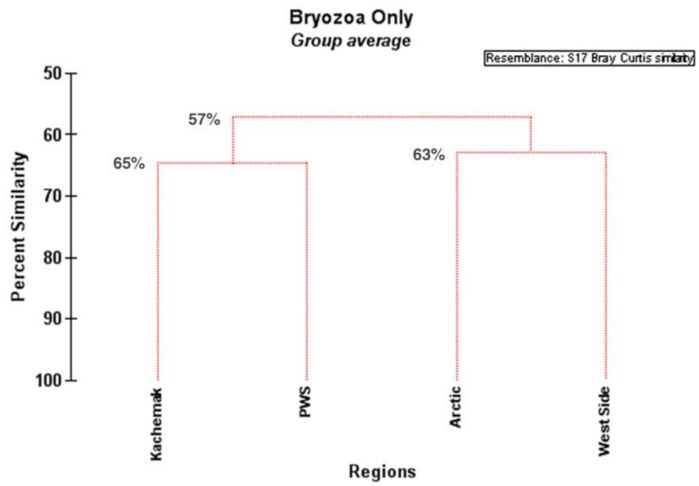


Figure 7. Dendrogram depicting relationships among regions based solely on their bryozoan assemblages. The red shading of branches indicates the linked regions are statistically similar at the 10-percent significance level based on permutation testing.

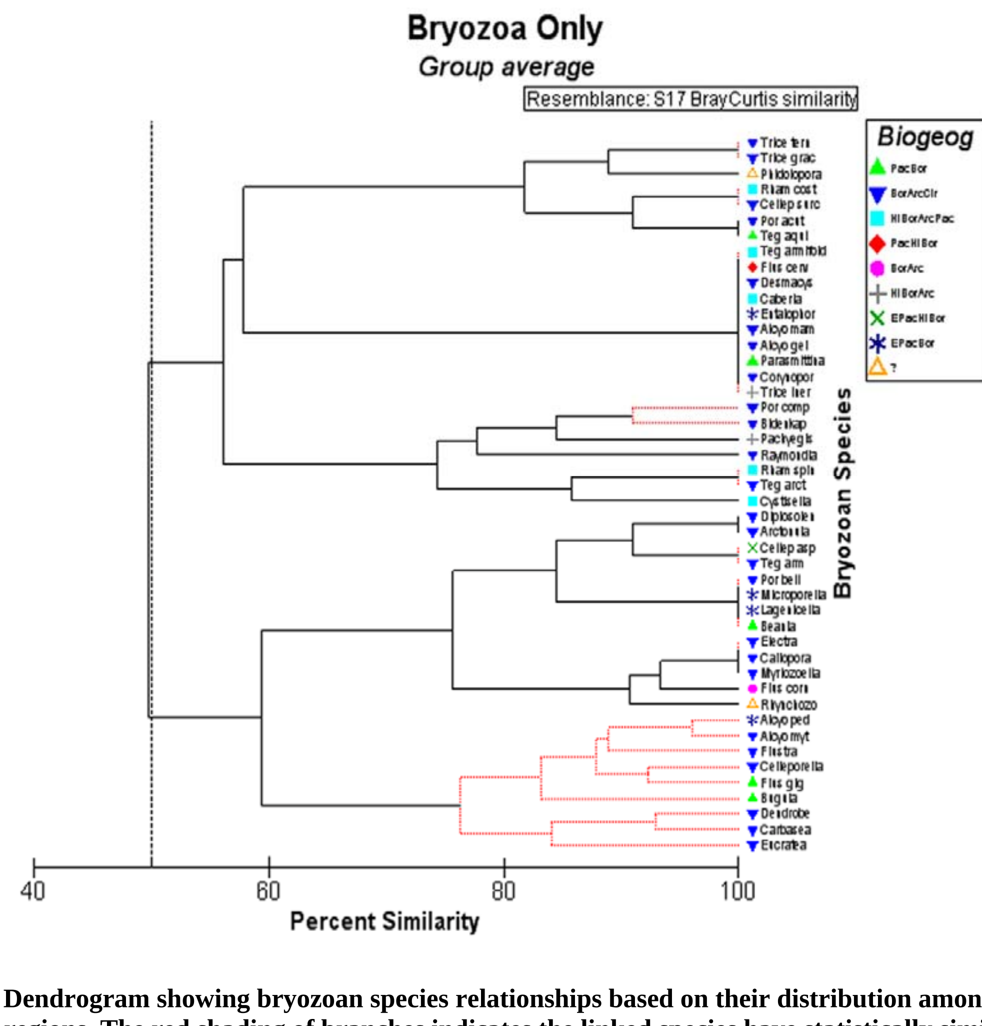


Figure 8. Dendrogram showing bryozoan species relationships based on their distribution among the four regions. The red shading of branches indicates the linked species have statistically similar distributions among the regions at the 10-percent significance level based on permutation testing.

Table 14. Nodal analysis showing distribution of species and species groups among the four regions.

	Group A		Group B		
SPECIES	Arctic	West Side	Kachemak Bay	Prince William Sound	Biogeographical Distribution
Tricellaria ternata		2		2	Boreal Arctic Circumpolar
Tricellaria gracilis		2		2	Boreal Arctic Circumpolar
Phidolopora pacifica		2		3	?
Rhamphostomella costata	2	2		2	High Boreal Arctic Pacific
Celleporina surcularis	2	2		2	Boreal Arctic Circumpolar
Porella acutirostris	1	2		2	Boreal Arctic Circumpolar
Tegella aquilirostris	1	2		2	Pacific Boreal
Tegella armiferoides		2			High Boreal Arctic Pacific
Flustrellidra cervicornis		2			Pacific High Boreal
Desmacystis sandalia		2			Boreal Arctic Circumpolar
Caberia ellisi		2			High Boreal Arctic Pacific
Entalophoroecia vancouverensis		2			East Pacific Boreal
Alcyonidium gelatinosum		2			Boreal Arctic Circumpolar
Alcyonidium mammillatum		2			Boreal Arctic Circumpolar
Parasmittina avicularissima		2			Pacific Boreal
Corynoporella tenuis		2			Boreal Arctic Circumpolar
Tricellaria inermis		2			High Boreal Arctic
Porella compressa	3	2			Boreal Arctic Circumpolar
Bidenkapia spitzbergensis	3	3			Boreal Arctic Circumpolar
Pachyegis princeps	3	1			High Boreal Arctic
Raymondia rigida	5	2			Boreal Arctic Circumpolar
Rhamphostomella spinigera	2	2			High Boreal Arctic Pacific
Tegella arctica	2	2			Boreal Arctic Circumpolar
Cystisella beringiana	1	2			High Boreal Arctic Pacific
Diplosolen obelia arctica	1	2	2		Boreal Arctic Circumpolar
Arctonula arctica	1	2	2		Boreal Arctic Circumpolar
Celleporina aspera	2	2	2		East Pacific High Boreal
Tegella armifera	2	2	2		Boreal Arctic Circumpolar
Porella belli		2	2		Boreal Arctic Circumpolar
Microporella californica		2	2		High Boreal Arctic Pacific
Lagenicella neosocialis		2	2		High Boreal Arctic Pacific

	Group A		Group B		
SPECIES	**Arctic**	**West Side**	**Kachemak Bay**	**Prince William Sound**	**Biogeographical Distribution**
Beania columbiana		2	2		Pacific Boreal
Electra arctica	1	2	2	2	Boreal Arctic Circumpolar
Callopora lineata	1	2	2	2	Boreal Arctic Circumpolar
Myriozoella plana	1	2	2	2	Boreal Arctic Circumpolar
Flustrellidra corniculata	2	2	2	2	Boreal Arctic
Rhynchozoon ?bispinosum		2	2	2	?
Alcyonidium pedunculatum	3	4	3	3	High Boreal Arctic Pacific
Alcyonidium mytili	2	4	3	3	Boreal Arctic Circumpolar
Flustra foliacea	2	3	3	2	Boreal Arctic Circumpolar
Celleporella hyalina	3	3	4	4	Boreal Arctic Circumpolar
Flustrellidra gigantea	2	3	4	3	Pacific Boreal
Bugula pacifica		3	3	3	Pacific Boreal
Dendrobeania murrayana	5	3	3	3	Boreal Arctic Circumpolar
Carbasea carbasea	5	4	3	2	Boreal Arctic Circumpolar
Eucratea loricata	5	4		2	Boreal Arctic Circumpolar

Group B includes 22 species, 16 of which occurred in the Arctic region and 21 16 of which occurred in Kachemak Bay. The largest subgroup comprises nine species that occurred in all four regions; these species were also among the more abundant in their regions. A closely related but smaller subgroup includes five less abundant species that also occurred in all regions. The third subgroup in Group B forms two minor subgroups, each with four species. One of these includes species that occurred only in the west-side and Kachemak Bay regions whereas the species in the other subgroup occurred in the Arctic, west-side, and Kachemak Bay regions (Table 14). Group B includes all species with East Pacific High Boreal biogeographical affinities.

c. Mollusca-Only Species List

Conducting a similar analysis using a Mollusca-only species list demonstrates that molluscan fauna is more strongly influenced by the northeastern Pacific rather than the Arctic faunae. The analysis of only mollusks (83 species, 19 [23%] of which are found in the Arctic) suggests that the strongest linkage is between the west-side and Prince William Sound assemblages but the next strongest links this group with Kachemak Bay assemblages. The similarity among these linkages is statistically significant at the 10-percent level. This grouping of southern regions links to the Arctic assemblage at a relatively low level (Figure 9). Except for the strong linkage between the west-side and Prince William Sound assemblages, this pattern is very similar to that observed for the full West-Side Only species analysis.

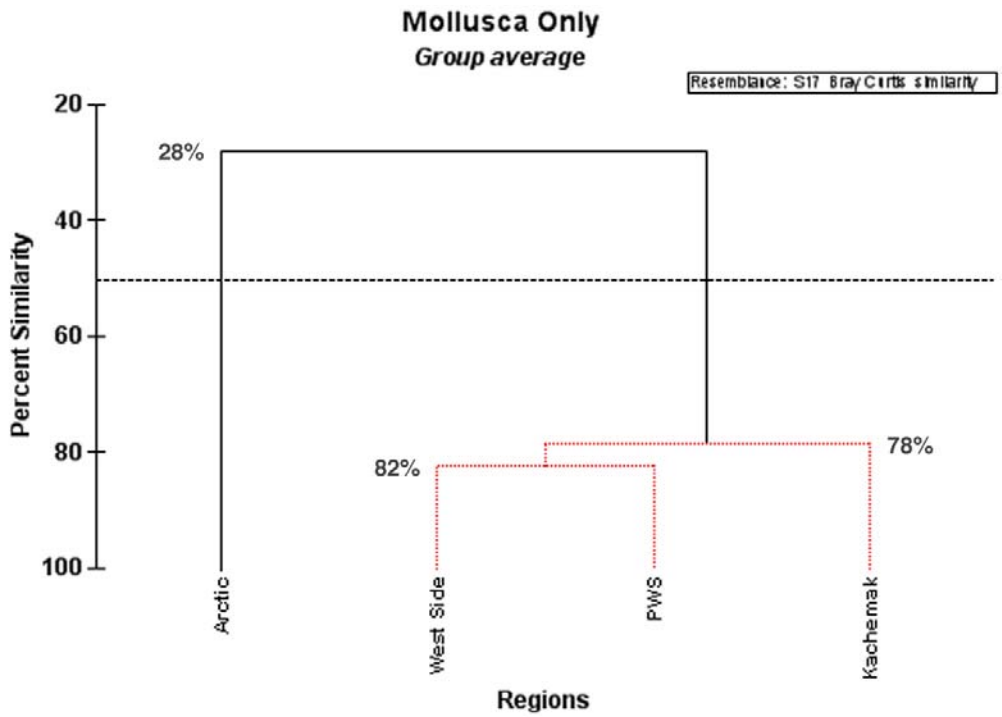


Figure 9. Dendrogram Depicting Relationships Among Regions Based Solely on their Molluscan Assemblages. The red shading of branches indicates the linked regions are statistically similar at the 10-percent significance level based on permutation testing.

Clustering the molluscan species produces a substantially different and less instructive result than for the bryozoans (Figure 8). Rather than producing sharp contrasts in groups and subgroups, the molluscan species list produces small groups of species that are not strongly associated (*i.e.*, only a few small groupings demonstrate statistically significant similarity in distribution). These patterns suggest the absence of strong organizing factors with regard to the regional distribution of mollusks found in these assemblages. Consequently, we chose not to construct the nodal analysis for mollusks.

B. Algae

a. Comparison of seaweed flora on the east and west sides of Cook Inlet

In general, the seaweed flora of the west side of Cook Inlet appears to comprise a depauperate subset of the overall seaweed flora of Cook Inlet. Only five species of the approximately 175 seaweed species currently known to occur in Cook Inlet are recognized to be restricted to the west side. This number may change as the Cook Inlet area is studied further. Distribution of these five species is described below.

Chordaria chordaeformis. This species was recognized as distinct from *C. flagelliformis* by Kim and Kawai (2002) based on its usually simple thallus (unbranched or with few branches), limited distribution in colder-water regions of the northern hemisphere, and distinctive DNA sequences. Specimens fitting the morphology of *C. chordaeformis* were collected at South Head, Iliamna Bay, in 2002 (voucher herbarium specimen SCL 10001) and the offshore platform reefs, western side of mouth of Douglas River, Kamishak Bay, in 2003 (SCL 10518); whether these are actually *C. chordaeformis* or just a sparsely branched form of *C. flagelliformis* has yet to be determined (no molecular sequence data are available). The only other records of this species in Alaska are from St. Lawrence Island (Kim & Kawai 2002).

Hollenbergia subulata. This represents a new northwesterly distribution record for this species. It was previously known to occur from the south side of the Kenai Peninsula to Monterey, California (Scagel *et al.* 1989).

Neohypophyllum middendorfii. This species is disjunct between Southeast Alaska, its southeastern limit of distribution, and Cook Inlet. Westward of Cook Inlet, it has been recorded from the Kodiak Archipelago, the Alaska Peninsula, the eastern Aleutian Islands and the Bering Sea, including the Pribilof Islands. The species was originally described from the Okhotsk Sea coast of Russia by Ruprecht and has been recorded from as far west as Hokkaido, Japan (Yoshida 1998).

***Mastocarpus* sp**. This putatively undescribed species of *Mastocarpus* is known to occur from Iliamna Bay, west side of Cook Inlet, Alaska, to Kuruma Ishi, Hokkaido, Japan. It has also been collected at Cape Douglas and Kukak Bay (Katmai National Park), possibly several sites on Kodiak Island (these require confirmation) and at Spray Cape (Unalaska Island), Alaska (Lindstrom, 2008).

Odonthalia dentata. This North Atlantic species has been identified as occurring in the Arctic Ocean and in colder parts of coastal Alaska based on vegetative and reproductive similarities. Identity of the North Pacific and Alaskan Arctic specimens with the North Atlantic species needs to be verified using modern molecular tools.

b. Comparison of West Side of Cook Inlet and Arctic Ocean

There is no clear relationship between the species of seaweeds occurring on the west side of Cook Inlet and those occurring in the Arctic Ocean. Both regions are relatively species poor, as is characteristic of depositional environments (see Geology section).

One way to compare the seaweed flora of the west side of Cook Inlet is to look at the species it shares with the seaweed flora of the Arctic coast of Alaska. Based on our current knowledge, 22 of the approximately 66 species (or 33%) of seaweeds known to occur on the Arctic coast of Alaska have also been recorded as occurring on the west side of Cook Inlet (Table 15) All of these species are widely distributed along the coast of Alaska, and many are distributed beyond, to the south, to the west and/or into the North Atlantic Ocean. Among these, *Devaleraea ramentacea* and *Dilsea socialis* were identified by Lüning (1990) as Arctic "endemics" along with *Laminaria solidungula*, *Turnerella pennyi*, and *Pantoneura baerii*. Of the last three species, only *Laminaria solidungula* has been found in Alaska, and then only in the Arctic Ocean.

Although *Alaria taeniata* has been reported to occur in both Cook Inlet and the Arctic Ocean, a molecular analysis of specimens from both areas indicates they are not related at the species level (Lane *et al.* 2007).

Table 15. Algae known from both the west side of Cook Inlet and the arctic coast of Alaska

Taxon	**Known Distribution**	**Biogeographic Region**
Green seaweeds (Chlorophyta)		
Acrosiphonia arcta	North Atlantic, Arctic, North Pacific (Kamchatka to Oregon)	Circumpolar Arctic-Boreal
Blidingia minima	North Atlantic, Arctic, North Pacific, Indian Ocean, Antarctic and subantarctic islands, Australia, New Zealand.	
Blidingia subsalsa	North Atlantic, Arctic, North Pacific (Cook Inlet to California	Circumpolar Arctic-Boreal
Ulva intestinalis		cosmopolitan
Ulva prolifera		cosmopolitan
Ulothrix flacca		nearly cosmopolitan
Urospora neglecta	North Atlantic, Arctic, North Pacific (Washington to Aleutian Islands, Alaska, and perhaps even further west), possibly also Antarctic and subantarctic islands and New Zealand. See Hanic 2005, Lindstrom & Hanic 2005.	
Brown seaweeds (Phaeophyceae)		
Chordaria flagelliformis	North Atlantic, Arctic, North Pacific (Korea to Southeast Alaska)	Circumpolar Arctic-Boreal
Desmarestia viridis	North Atlantic, Arctic, North Pacific (Korea to Baja California, Mexico)	Circumpolar Arctic-Boreal
Dictyosiphon foeniculaceus	North Atlantic, Arctic, North Pacific (Japan to British Columbia)	Circumpolar Arctic-Boreal
Elachista fucicola	North Atlantic, Arctic, North Pacific (Kamchatka to California)	Circumpolar Arctic-Boreal
Fucus distichus subsp. *evanescen*	Arctic? North Pacific (Japan to California)	Arctic-Boreal Pacific
Petalonia fascia	North Atlantic, Arctic, North Pacific (Korea to Baja California)	Circumpolar Arctic-Boreal
Saccharina latissima	North Atlantic, Arctic, North Pacific (Japan, Aleutian Islands to California)	Circumpolar Arctic-Boreal
Red seaweeds (Rhodophyta)		
Bangia spp.	North Atlantic, Arctic, North Pacific (Korea to Costa Rica), Chile, Australia, New Zealand	
Devaleraea ramentacea	North Atlantic, Arctic, North Pacific (Japan to Prince William Sound)	Circumpolar Arctic-Boreal
Dilsea socialis.	North Atlantic, Arctic, North Pacific (Kamchatka to Cook Inlet)	Circumpolar Arctic-Boreal

Taxon	**Known Distribution**	**Biogeographic Region**
Halosaccion glandiforme	Arctic, North Pacific (Kamchatka to California)	Arctic–Boreal Pacific
Odonthalia dentata	North Atlantic, Arctic, North Pacific (Kamchatka to Southeast Alaska	Circumpolar Arctic-Boreal.
Phycodrys riggii	North Atlantic, Arctic, North Pacific (Japan to northern British Columbia)	Circumpolar Arctic-Boreal.
Pterosiphonia bipinnata.	Arctic, North Pacific (Japan to California)	Arctic–Boreal Pacific
Rhodomela tenuissima.	North Atlantic, Arctic, North Pacific (Japan to Southeast Alaska	Circumpolar Arctic-Boreal

c. Other evidence of a “relictual” flora

Recent, unpublished molecular data from specimens of seaweeds from the Northeast Gulf of Alaska do not support the Arctic relictual nature of the flora of the west side of Cook Inlet. However, these data do indicate diversification among seaweed populations in the northwest Gulf of Alaska beyond what might be expected in a glaciated area that was colonized only after the last Ice Age (Tables 16 and 17).

Table 16. Clade 1. Specimens of this species from the Northwest Gulf of Alaska fall into three groups based on sequences from the ITS region of the nuclear ribosomal cistron.

Group	**Kenai Peninsula**	**Cook Inlet**	**Kodiak Archipelago**	**Katmai National Park**
1	East of McArthur Pass	Jakolof Bay	Monashka Bay; Alitak Bay; Cape Sitkinak	Amalik Bay; Katmai Bay
2	No data	No data	Near Island. (Kodiak harbor); Spruce Island lagoon; northwest Afognak Island	Amalik Bay
3	West of McArthur Pass (Port Dick)	Nanwallek Reef; Tutka Bay; Hesketh I.; Cohen I.; Peterson Pt.; **Scott I. (west side)**	Izhut Bay (east side Afognak Island)	Amalik Bay; Katmai Bay

Table 17. Clade 5. Specimens of this species also fall into three groups (specimens from Akhiok Island in Alitak Bay, Kodiak I., and from Amalik Bay and Kiukpalik Island in Katmai National Park overlap Groups 1 and 2) based on sequences from the ITS region of the nuclear ribosomal cistron.

Group	Kenai Peninsula	Cook Inlet	Kodiak Archipelago	Katmai National Park
1	No data	Outside Beach; **Iniskin Bay, Knoll Head (west side)**	No data	Entrance to Kukak Bay
2	No data	No data	No data	Kukak Bay; Hallo Bay; Shakun Islets
3	West of McArthur Pass (Chugach Bay)	Tutka Bay; Passage Island	Three Saints Bay; Cape Sitkinak	Katmai Bay

The single specimen of *Mastocarpus papillatus* species complex from the west side of Cook Inlet (from Scott Island) was part of Group 3. It should be noted that Scott Island was the only site in the Iliamna-Iniskin Bay area where this species, which occurs in the mid to upper intertidal, was found.

In addition to these three groups, three specimens (Chance Cove, east of McArthur Pass, Kenai Peninsula; Outside Beach, Cook Inlet; Perevalnie Passage, Shuyak Island) showed an additional nucleotide substitution that differentiated them from Group 3. It may be of interest that the specimens from Group 1, which includes all of the specimens sequenced from the Iliamna-Iniskin Bay area on the west side of Cook Inlet, shared identical sequences with specimens from northern California whereas Group 3 shared identical sequences with specimens from Southeast Alaska and Unalaska Island. As noted above, additional work is required with these data.

Phycodrys riggii. Specimens from the outer Kenai Peninsula (Port Dick, Leg M. R. Lindeberg) and from Katmai National Park (Kukak Bay) had identical *rbc*L gene sequences, as did those from southern Kodiak Island (Rodman's Reach, Leg. S. M. Saupe) and the west side of Cook Inlet (Knoll Head, Leg. S. C. Lindstrom). The latter were more closely related to specimens from St. Lawrence Island and from Newfoundland, eastern Canada, than they were to the Kenai and Katmai specimens (Lin, Hommersand & Lindstrom, unpublished research).

All isolates from Katmai and Kodiak have identical *rbc*L gene sequences, which are the same as those from two sites on Unalaska Island. They differ by two nucleotide substitutions from isolates from sites in northern British Columbia, Cook Inlet, Akutan Harbor, and four sites on Unalaska Island.

Porphyra pseudolinearis.
The single isolate from Kodiak had an identical *rbc*L gene sequence to one from Southeast Alaska. These two isolates differed from an isolate from Cook Inlet and one from Katmai by six

nucleotide substitutions. The Cook Inlet and Katmai isolates were identical in sequence to another isolate from Southeast Alaska and to two isolates from Unalaska Island. Other isolates from Unalaska Island diverged even further.

Porphyra schizophylla.
Specimens from Kenai (Morning Cove and the headland at east entrance to McArthur Pass), Kodiak (Big Bay, Shuyak I.; Shark Pt.; Alitak Bay), and Katmai (Amalik Bay) shared one nucleotide substitution unique to them in their *rbc*L gene sequences. The Shark Pt. and Alitak Bay specimens also shared a unique nucleotide substitution with a specimen from the Sitka area in Southeast Alaska. The other specimens sequenced (from Port Dick, Kenai Peninsula, and Yugnat Rocks, between Kukak Point and Cape Nukshak, Katmai National Park) were identical to those from other Southeast Alaska and eastern Aleutian Islands collections.

d. Further Notes on Seaweed Biogeography in the Northwestern Gulf of Alaska

In addition to the species already mentioned, the northwestern Gulf of Alaska also appears to be the eastern limit for at least six species, the western limit for 14 others, and the only known habitat for at least four undescribed species of seaweeds (Table 15).

Cook Inlet was identified as the region of Alaska with a seaweed flora most similar to that of Juneau, Alaska, in a review of the seaweed biogeography of Southeast Alaska (Lindstrom, 2009). Earlier, Lindstrom *et al*. (1986) characterized the seaweed flora of the Juneau area as showing a "cryophilic enrichment." In the more recent analysis (Lindstrom, 2009), the seaweed flora of Juneau also showed a higher similarity to the seaweed flora of the Aleutian Islands westward to Japan and including the Bering Sea and Arctic coast of Alaska, compared to the floras of either Sitka or Ketchikan, which showed higher similarities than Juneau to the seaweed floras of British Columbia and California.

III. Discussion

A. Limitations of the Study

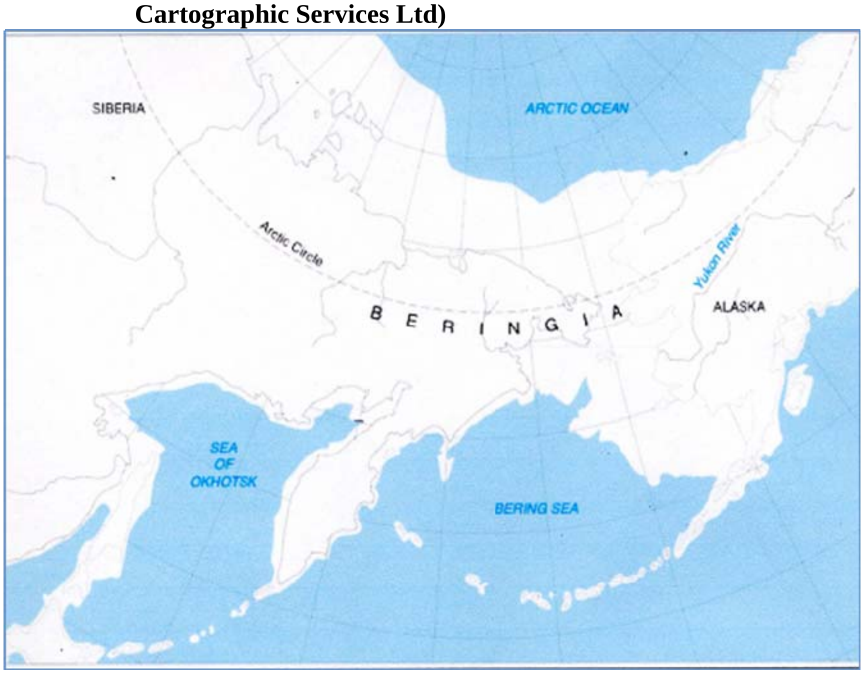
This study is based on existing literature and collections, rather than on field work planned specifically to address the question. Our material represents the difficulty of working in the area and with poorly-known taxa. Accurate identifications for many species in the invertebrate fauna of the northeast Pacific and Arctic are difficult to impossible because of a lack of recent detailed descriptive literature. This is especially true for the sponges, Cnidaria, Bryozoa, and Ascidia, which make up much of the epifauna in the study area.

Selecting an appropriate suite of invertebrate species for comparisons between regions posed a considerable problem. For example, Foster's (2000) species list for Prince William Sound contained more than 450 taxa. However, the species included in this list were based on a variety of sampling methods and included depths far below those examined in area of interest, *i.e.,* the west side of Cook Inlet, especially the northwestern corner of Kamishak Bay, in the vicinity of Iliamna and Iniskin Bays. The same problem existed with the species lists that we compiled from MacGinitie (1955). The initial species list (Appendix) with which we compared species from these four regions comprised 724 taxa, 241 of them from the Arctic, 233 from the west side of Cook Inlet, 239 from the east side, and 467 from Prince William Sound. This list worked reasonably well when comparing among regions but was unwieldy when trying to compare species groupings.

B. Biogeography

The Cook Inlet fauna that we have considered is not an Arctic relict in the sense of a fauna unchanged since the most recent glaciation, living in unglaciated habitats. During the most recent glaciation, ice dams produced a proglacial lake in the southern part of Cook Inlet. We then infer that marine communities in Cook Inlet were established only after this lake drained, approximately 9,000 years ago. Like the Beluga whales, and two fish species (saffron cod and Bering cisco), the less conspicuous invertebrate species are part of a fauna that was probably more widespread throughout the shallow subtidal areas when the Beringian landmass was emergent (Figure 10). Cook Inlet was not ice-free, but there were probably areas in the northwestern Gulf of Alaska, the Bering Sea shelf break, parts of the Alaska Peninsula, and extending to Chukotka and Kamchatka in Asia that were not substantially ice-scoured.

Figure 10. The Beringian landmass (used with permission, Weller Cartographic Services Ltd)



Much paleontological evidence indicates that the Atlantic and Arctic were populated from the Pacific Ocean, dispersal taking place while the Bering Strait was open during the Miocene and Pliocene times. Bernard's (1979: 6-7) discussion of the biogeography of mollusks in the Beaufort seems relevant:

> The Bering Strait opened and closed repeatedly in the late Miocene, Pliocene, and Pleistocene; Hopkins (1973) reviewed and interpreted the sequence of fluctuating sea levels of the Bering Sea. These changes in climatic and geographic features

were accompanied by periods of migration and local extinction of benthic invertebrates.

The disjunct distributions observed in many of the species discussed here may be due to a contraction of their ranges in the north Pacific from a larger range occupied before the last ice age. This suggests that there may be other refugia, perhaps the Yakutat area or Icy Bay. It is plausible that the West side of Cook Inlet that the Arctic- affiliated species moved into Cook Inlet when the inlet became marine, but did not become established in other areas because those areas lost the physical oceanographic characteristics in which the populations became established.

The distribution and the genetic diversification of the algae, also indicate a genetic diversification greater than what would be expected if colonization had occurred since the last ice age. This suggests a refugium or refugia in the Northeastern Gulf of Alaska. Similar data on genetic diversity are not available for marine invertebrates.

C. Implications for Management

There are indications that this biota is vulnerable to changes, both climate change and impacts from development. One of us (DCL) had the opportunity to dive in Iliamna and Iniskin Bays in July 2008. While we were not fortunate enough to revisit the precise areas, nor able to examine any of the habitats in detail that had been examined in 1977-78, we did examine some similar habitats in both bays. The distinct impression was that several of the sedentary epifaunal species that dominated rocky habitats in the late 1970s, particularly the bryozoans and ascidians, no longer occurred in the region. Many of the species that appeared to be missing are large and conspicuous (e.g., the large head-forming bryozoan *Bidenkapia spitsbergensis* and the colonial ascidian *Dendrodoa pulchella*), we are reasonably confident those species did not occupy a significant amount of surface in the rocky habitats that we examined.

Failure to find these species suggests the fauna observed in the late 1970s has suffered substantially in the intervening decades, probably from the elevated temperatures that have been observed. This suggests that the biota in this region is probably moderately susceptible to changes from global warming. It doesn’t provide insight into the susceptibility of the biota to changes resulting from port development.

D. Recommendations for Continued Study

Our samples have come from rather scattered locations within the western Cook Inlet side of Cook Inlet. Further delineation of species distribution within the area may help managers and scientists understand the exact extent of Arctic affiliated species.

Few studies have been conducted in the Bering or Chukchi Seas or Norton Sound, especially of shallow subtidal rocky habitats, making it difficult to conduct a suitable comparison of species between Cook Inlet and the Arctic. We have documented the disjunct occurrence of several invertebrates and algae including some that do not occur nearer to the populations in western Cook Inlet than the Beaufort Sea, effectively isolating these species from similar species or genera. Based on its duration, it is possible that geographic isolation has allowed some species to become genetically distinct, to the point of evolving into separate subspecies or species.

Given their potential isolation, these western Cook Inlet populations could be at risk of significant habitat perturbation and may prove to be sensitive indicators of climate change or other ecological shifts and monitoring of their distributions and abundance could provide a base of information for future work.

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Study Products

Foster, N. R., D. C. Lees and S. Saupe 2005. Evaluating a Potential Relict Arctic Invertebrate and Algal Community on the West Side of Cook Inlet. P. *In* University of Alaska Coastal marine Institute Annual Report No.11   Study MMS University of Alaska and US DOI, MMS, Alaska OCS Region.

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Appendix. Taxa data.

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Annelida: Polychaeta	*Chone infundibuliformis*	x			
Annelida: Polychaeta	*Crucigera zygophora*			x	x
Annelida: Polychaeta	*Myxicola infundibulum*			x	x
Annelida: Polychaeta	*Nephtys ciliata*	x			
Annelida: Polychaeta	*Owenia fusiformis/collaris*		x	x	
Annelida: Polychaeta	*Pectinaria brevicoma*				x
Annelida: Polychaeta	*Pectinaria granulata*	x	x	x	
Annelida: Polychaeta	*Pectinaria hyperborea*	x			
Annelida: Polychaeta	*Phyllochaetopterus* sp.			x	
Annelida: Polychaeta	*Pista flexuosa*	x			
Annelida: Polychaeta	*Pista maculata*	x			
Annelida: Polychaeta	*Potamilla neglecta*	x			
Annelida: Polychaeta	*Potamilla reniformis*	x		x?	
Annelida: Polychaeta	*Pseudopotamilla* sp.		x		
Annelida: Polychaeta	*Sabella crassicornis*	x			
Annelida: Polychaeta	*Schizobranchia insignis*		x	x	
Arthropoda: Cirripedia	*Balanus balanus*	x			
Arthropoda: Cirripedia	*Balanus crenatus*	x	x	x	
Arthropoda: Cirripedia	*Balanus glandula*		x	x	x
Arthropoda: Cirripedia	*Balanus hesperius levidomus*		x		
Arthropoda: Cirripedia	*Balanus nubilus*			x	x
Arthropoda: Cirripedia	*Balanus rostratus alaskanus*		x	x	x
Arthropoda: Cirripedia	*Balanus rostratus apertus*	x			
Arthropoda: Cirripedia	*Chthamalus dalli*		x	x	x
Arthropoda: Cirripedia	*Semibalanus balanoides*		x	x	x
Arthropoda: Cirripedia	*Semibalanus cariosus*		x	x	x
Arthropoda: Crustacea	*Argus lar*	x			
Arthropoda: Crustacea	*Cancer oregonensis*			x	x
Arthropoda: Crustacea	*Caprella ?laeviuscula*				x
Arthropoda: Crustacea	*Caprella borealis*				x
Arthropoda: Crustacea	*Chionocetes bairdi*			x	
Arthropoda: Crustacea	*Chionocetes opilio*	x			
Arthropoda: Crustacea	*Crangon communis*	x			
Arthropoda: Crustacea	*Crangon* sp.		x	x	x
Arthropoda: Crustacea	*Discorsopagurus schmitti*			x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Arthropoda: Crustacea	*Elassochirus gilli*		x	x	x
Arthropoda: Crustacea	*Elassochirus tenuimanus*		x	x	x
Arthropoda: Crustacea	*Heptacarpus* sp.				x
Arthropoda: Crustacea	*Hyas coarctatus alutaceus*	x			
Arthropoda: Crustacea	*Hyas lyratus*		x	x	
Arthropoda: Crustacea	*Labidochirus splendescens*			x	
Arthropoda: Crustacea	*Lebbeus grandimanus*			x	x
Arthropoda: Crustacea	*Lebbeus polaris*	x	x		
Arthropoda: Crustacea	*Metacaprella kennerlyi*				x
Arthropoda: Crustacea	*Oregonia gracilis*		x	x	x
Arthropoda: Crustacea	*Pagurus ?dalli*			x	
Arthropoda: Crustacea	*Pagurus aleuticus*			x	
Arthropoda: Crustacea	*Pagurus beringanus*		x	x	x
Arthropoda: Crustacea	*Pagurus capillatus*			x	
Arthropoda: Crustacea	*Pagurus caurinus*				x
Arthropoda: Crustacea	*Pagurus hirsutiusculus*		x	x	x
Arthropoda: Crustacea	*Pagurus kennerleyi*		x		x
Arthropoda: Crustacea	*Pagurus ochotensis*		x	x	
Arthropoda: Crustacea	*Pagurus splendescens*	x			
Arthropoda: Crustacea	*Pagurus trigonocheirus*	x		x	
Arthropoda: Crustacea	*Pandalus borealis*	x			
Arthropoda: Crustacea	*Pandalus goniurus*	x			
Arthropoda: Crustacea	*Paralithodes camtschatica*	x		x	
Arthropoda: Crustacea	*Phyllolithodes papillosus*		x	x	
Arthropoda: Crustacea	*Placetron wosnesenskii*		x		
Arthropoda: Crustacea	*Pugettia gracilis*			x	x
Arthropoda: Crustacea	*Sclerocrangon boreas*	x			
Arthropoda: Crustacea	*Telmessus cheiragonus*		x	x	
Arthropoda: Isopoda	*Pentidotea wosnesenskii*			x	x
Arthropoda: Isopoda	*Saduria entomon*	x	x		
Arthropoda: Isopoda	*Saduria sabini*	x			
Brachiopoda	*Diestothyrus frontalis*	x	x	x	
Brachiopoda	*Diestothyrus spitzbergensis*	x	x		
Brachiopoda: Articulata	*Hemithyris psittacea*	x	x	x	x
Brachiopoda: Articulata	*Laqueus californianus*				x
Brachiopoda: Articulata	*Terebratalia transversa*		x	x	x
Brachiopoda: Articulata	*Terebratulina crossei*				x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Brachiopoda: Articulata	*Terebratulina unguicula*				x
Bryozoa:Cheilostomata: Anasca	*Antropora commandorica*			x	
Bryozoa:Cheilostomata: Anasca	*Beania columbiana*		x	x	
Bryozoa:Cheilostomata: Anasca	*Beania mirabilis*				x
Bryozoa:Cheilostomata: Anasca	*Bidenkapia spitzbergensis*	x	x		
Bryozoa:Cheilostomata: Anasca	*Bugula californica*				x
Bryozoa:Cheilostomata: Anasca	*Bugula pacifica*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Caberia ellisi*		x		
Bryozoa:Cheilostomata: Anasca	*Callopora armata*				
Bryozoa:Cheilostomata: Anasca	*Callopora horrida*				x
Bryozoa:Cheilostomata: Anasca	*Callopora lineata*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Callopora spitsbergensis*	x			
Bryozoa:Cheilostomata: Anasca	*Calloporella craticula*	x			x
Bryozoa:Cheilostomata: Anasca	*Carbasea carbasea*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Cauloramphus "variegata"*				x
Bryozoa:Cheilostomata: Anasca	*Cauloramphus cymbaeformis*	x			
Bryozoa:Cheilostomata: Anasca	*Cauloramphus pseudospinifer*				x
Bryozoa:Cheilostomata: Anasca	*Cryptosula zavjalvensis*			x	
Bryozoa:Cheilostomata: Anasca	*Cryptosula okadai*				x
Bryozoa:Cheilostomata: Anasca	*Dendrobeania curvirostrata*				x
Bryozoa:Cheilostomata: Anasca	*Dendrobeania lichenoides*				x
Bryozoa:Cheilostomata: Anasca	*Dendrobeania murrayana*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Desmacystis sandalia*		x		
Bryozoa:Cheilostomata: Anasca	*Electra arctica*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Electra crustulenta*	x			
Bryozoa:Cheilostomata: Anasca	*Eucratea loricata*	x	x		x
Bryozoa:Cheilostomata: Anasca	*Flustra foliacea*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Flustrellidra cervicornis*		x		
Bryozoa:Cheilostomata: Anasca	*Flustrellidra corniculata*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Flustrellidra gigantea*	x	x	x	x
Bryozoa:Cheilostomata: Anasca	*Harmeria scutulata*				x
Bryozoa:Cheilostomata: Anasca	*Hincksina gothica*	x			
Bryozoa:Cheilostomata: Anasca	*Hincksina nigrans*	x			
Bryozoa:Cheilostomata: Anasca	*Membranipora membranacea*				x
Bryozoa:Cheilostomata: Anasca	*Membranipora membranipora*				x
Bryozoa:Cheilostomata: Anasca	*Membranipora serrilamella*				x
Bryozoa:Cheilostomata: Anasca	*Microporina articulata*				x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Bryozoa:Cheilostomata: Anasca	*Microporina borealis*			x	x
Bryozoa:Cheilostomata: Anasca	*Reginella spitzbergensis*	x			
Bryozoa:Cheilostomata: Anasca	*Scrupocellaria scabra var paenulata*	x			
Bryozoa:Cheilostomata: Anasca	*Scrupocellaria unidentified*				x
Bryozoa:Cheilostomata: Anasca	*Tegella aquilirostris*	x	x		x
Bryozoa:Cheilostomata: Anasca	*Tegella arctica*			x	
Bryozoa:Cheilostomata: Anasca	*Tegella armifera*			x	x
Bryozoa:Cheilostomata: Anasca	*Tegella armiferoides*		x		
Bryozoa:Cheilostomata: Anasca	*Tegella magnipora*	x			
Bryozoa:Cheilostomata: Anasca	*Tricellaria erecta*	x	x		
Bryozoa:Cheilostomata: Anasca	*Tricellaria gracilis*		x		x
Bryozoa:Cheilostomata: Anasca	*Tricellaria inermis*		x		
Bryozoa:Cheilostomata: Anasca	*Tricellaria occidentalis*				x
Bryozoa:Cheilostomata: Anasca	*Tricellaria peachi*	x			
Bryozoa:Cheilostomata: Anasca	*Tricellaria ternata*		x		x
Bryozoa:Cheilostomata: Ascophora	*Arctonula arctica*	x	x	x	
Bryozoa:Cheilostomata: Ascophora	*Cellepora craticula*	x			x
Bryozoa:Cheilostomata: Ascophora	*Cellepora procumbens*				x
Bryozoa:Cheilostomata: Ascophora	*Cellepora robertsonae*				x
Bryozoa:Cheilostomata: Ascophora	*Celleporella hyalina*	x	x	x	x
Bryozoa:Cheilostomata: Ascophora	*Celleporella reflexa*			x	
Bryozoa:Cheilostomata: Ascophora	*Celleporina aspera*	x	x	x	
Bryozoa:Cheilostomata: Ascophora	*Celleporina surcularis*	x	x		x
Bryozoa:Cheilostomata: Ascophora	*Corynoporella tenuis*		x		
Bryozoa:Cheilostomata: Ascophora	*Costazia nordenskjoldi*	x	?		
Bryozoa:Cheilostomata: Ascophora	*Cribrilina annulata*				x
Bryozoa:Cheilostomata: Ascophora	*Cribrilina corbicula*				x
Bryozoa:Cheilostomata: Ascophora	*Cystisella beringiana*		x		
Bryozoa:Cheilostomata: Ascophora	*Cystisella bicornis*	x	x		x
Bryozoa:Cheilostomata: Ascophora	*Cystisella fragilis*	x			

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Bryozoa:Cheilostomata: Ascophora	*Cystisella saccata*	x			x
Bryozoa:Cheilostomata: Ascophora	*Emballotheca stylifera*	x			
Bryozoa:Cheilostomata: Ascophora	*Hippodiplosia cancellata*	x			
Bryozoa:Cheilostomata: Ascophora	*Hippodiplosia insculpta*				x
Bryozoa:Cheilostomata: Ascophora	*Hippodiplosia reticulo-punctata*				x
Bryozoa:Cheilostomata: Ascophora	*Hippoporina vulgaris*				x
Bryozoa:Cheilostomata: Ascophora	*Hippothoa divaricata*	x			
Bryozoa:Cheilostomata: Ascophora	*Hippothoa expansa*	x			
Bryozoa:Cheilostomata: Ascophora	*Lagenicella neosocialis*	x	x	x	
Bryozoa:Cheilostomata: Ascophora	*Microporella californica*	x	x	x	
Bryozoa:Cheilostomata: Ascophora	*Microporella germana*				x
Bryozoa:Cheilostomata: Ascophora	*Mucronella abyssicola*	x			
Bryozoa:Cheilostomata: Ascophora	*Mucronella emucronata*	x			
Bryozoa:Cheilostomata: Ascophora	*Mucronella microstoma*	x			
Bryozoa:Cheilostomata: Ascophora	*Mucronella ventricosa*	x			
Bryozoa:Cheilostomata: Ascophora	*Myriozoella plana*	x	x	x	x
Bryozoa:Cheilostomata: Ascophora	*Myriozoella subarctatum*	x			
Bryozoa:Cheilostomata: Ascophora	*Parasmittina alaskensis*				
Bryozoa:Cheilostomata: Ascophora	*Parasmittina avicularissima*	x	x		
Bryozoa:Cheilostomata: Ascophora	*Parasmittina* sp.		x		
Bryozoa:Cheilostomata: Ascophora	*Parasmittina trispinosa*				x
Bryozoa:Cheilostomata: Ascophora	*Phidolopora pacifica*		x		x
Bryozoa:Cheilostomata: Ascophora	*Porella acutirostris*	x	x		x
Bryozoa:Cheilostomata: Ascophora	*Porella belli*		x	x	
Bryozoa:Cheilostomata:	*Porella cocinna*	x			x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Ascophora					
Bryozoa:Cheilostomata: Ascophora	*Porella compressa*	x	x		
Bryozoa:Cheilostomata: Ascophora	*Porella minuta*	x			
Bryozoa:Cheilostomata: Ascophora	*Porella patens*				x
Bryozoa:Cheilostomata: Ascophora	*Porella tumida*	x		x	
Bryozoa:Cheilostomata: Ascophora	*Posterula sarsi*	x			
Bryozoa:Cheilostomata: Ascophora	*Ragionula rosacea*	x			
Bryozoa:Cheilostomata: Ascophora	*Raymondia rigida*	x	x		
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella bilaminata*	x	x		x
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella costata*	x		x	
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella fortissima*	x			
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella gigantea*	x			x
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella hincksi*				x
Bryozoa:Cheilostomata: Ascophora	*Rhamphostomella spinigera*	x	x		
Bryozoa:Cheilostomata: Ascophora	*Rhynchozoon ?bispinosum*		x	x	x
Bryozoa:Cheilostomata: Ascophora	*Schizomavella porifera*				x
Bryozoa:Cheilostomata: Ascophora	*Schizoporella "unicornis"*				x
Bryozoa:Cheilostomata: Ascophora	*Smittina bella*	x			
Bryozoa:Cheilostomata: Ascophora	*Smittina jefferysi*	x			
Bryozoa:Cheilostomata: Ascophora	*Smittina majuscula*	x		x	
Bryozoa:Cheilostomata: Ascophora	*Stomachetosella cruenta*				
Bryozoa:Cheilostomata: Ascophora	*Stomachetosella distincta*	x			
Bryozoa:Cheilostomata: Ascophora	*Stomachetosella sinuosa*	x			
Bryozoa:Ctenostomata	*Alcyonidium disciforme*	x			
Bryozoa:Ctenostomata	*Alcyonidium enteromorpha*	x			
Bryozoa:Ctenostomata	*Alcyonidium gelatinosum*		x		

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Bryozoa:Ctenostomata	*Alcyonidium hirsutum*				x
Bryozoa:Ctenostomata	*Alcyonidium mammilatum*		x		
Bryozoa:Ctenostomata	*Alcyonidium mytili*	x	x	x	x
Bryozoa:Ctenostomata	*Alcyonidium pedunculatum*	x	x	x	x
Bryozoa:Ctenostomata	*Bowerbankia gracilis aggregata*	x			
Bryozoa:Cyclostomata	*Bientalophora* sp.				x
Bryozoa:Cyclostomata	*Borgiola pustulosa*	x			
Bryozoa:Cyclostomata	*Crisia crabraria*	x			
Bryozoa:Cyclostomata	*Crisia eburnea*	x			
Bryozoa:Cyclostomata	*Crisia occidentalis*				x
Bryozoa:Cyclostomata	*Crisia serrulata*				x
Bryozoa:Cyclostomata	*Diaperoecia intermedia*	x			
Bryozoa:Cyclostomata	*Diaperoecia johnstoni*	x			
Bryozoa:Cyclostomata	*Diaperoecia unidentified*				x
Bryozoa:Cyclostomata	*Diplosen obelia arctica*	x		x	
Bryozoa:Cyclostomata	*Disporella alaskensis*				x
Bryozoa:Cyclostomata	*Entalophoroecia vancouverensis*	x	x		
Bryozoa:Cyclostomata	*Filicrisia franciscana*				x
Bryozoa:Cyclostomata	*Filicrisia geniculata*				x
Bryozoa:Cyclostomata	*Filicrisia smitti*				x
Bryozoa:Cyclostomata	*Heteropora alaskensis*			x	
Bryozoa:Cyclostomata	*Heteropora magna*				x
Bryozoa:Cyclostomata	*Heteropora pacifica*				x
Bryozoa:Cyclostomata	*Heteropora sp.*			x	x
Bryozoa:Cyclostomata	*Lichenopora canaliculata*				
Bryozoa:Cyclostomata	*Lichenopora unidentified*			0	x
Bryozoa:Cyclostomata	*Lichenopora verrucaria*	x			
Bryozoa:Cyclostomata	*Myriapora coarctata*	x		x	x
Bryozoa:Cyclostomata	*Plagioecia grimaldii*	x			
Bryozoa:Cyclostomata	*Tubulipora flabellaris*				x
Bryozoa:Cyclostomata	*Tubulipora tuba*				x
Cnidaria: Anthozoa	*Anthopleura artemisia*		x	x	x
Cnidaria: Anthozoa	*Carophyllia alaskensis*				x
Cnidaria: Anthozoa	*Cerianthus borealis*	x			
Cnidaria: Anthozoa	*Clavularia sp.*				x
Cnidaria: Anthozoa	*Cribrinopsis fernaldi*		x	x	
Cnidaria: Anthozoa	*Epizoanthus unidentified*				x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Cnidaria: Anthozoa	*Gersemia rubiformis*	x		x	x
Cnidaria: Anthozoa	*Halcampa decemtentaculata*			x	x
Cnidaria: Anthozoa	*Halcampa duodecimcirrata*	x			
Cnidaria: Anthozoa	*Metridium farcimen (=senile)*		x	x	x
Cnidaria: Anthozoa	*Pachycerianthus unidentified*				x
Cnidaria: Anthozoa	*Peachia unidentified*				x
Cnidaria: Anthozoa	*Pennatula unidentified*				x
Cnidaria: Anthozoa	*Ptilosarcus gurneyi*			x	x
Cnidaria: Anthozoa	*Stomphia coccinea?*	x			x
Cnidaria: Anthozoa	*Stylatula elongata*				x
Cnidaria: Anthozoa	*Urticina ?lofotensis*		x	x	
Cnidaria: Anthozoa	*Urticina crassicornis*		x	x	x
Cnidaria: Anthozoa	*Virgularia unidentified*				x
Cnidaria: Hydrozoa	*Allopora californica*				x
Cnidaria: Hydrozoa:Athecata	*Bougainvillia superciliaris*				x
Cnidaria: Hydrozoa:Athecata	*Eudendrium* sp.		x		x
Cnidaria: Hydrozoa:Athecata	*Eudendrium vaginatum*				x
Cnidaria: Hydrozoa:Athecata	*Garveia formosa*				x
Cnidaria: Hydrozoa:Athecata	*Garveia franciscana*				x
Cnidaria: Hydrozoa:Athecata	*Hybocodon prolifera*		x		x
Cnidaria: Hydrozoa:Athecata	*Hydractinia ?aggregata*				x
Cnidaria: Hydrozoa:Athecata	*Hydractinia* sp.	x			
Cnidaria: Hydrozoa:Athecata	*Syncoryne* sp.	x			
Cnidaria: Hydrozoa:Athecata	*Tubularia prolifera*				x
Cnidaria: Hydrozoa:Athecata	*Tubularia* sp.	x		x	x
Cnidaria: Hydrozoa:Thecata	*?Grammaria abietina*				x
Cnidaria: Hydrozoa:Thecata	*Abietinaria ?amphora*		x		
Cnidaria: Hydrozoa:Thecata	*Abietinaria filicula*		x		x
Cnidaria: Hydrozoa:Thecata	*Abietinaria gigantea*		x	x	x
Cnidaria: Hydrozoa:Thecata	*Abietinaria kincaidi*			x	x
Cnidaria: Hydrozoa:Thecata	*Abietinaria thujarioides*		x		
Cnidaria: Hydrozoa:Thecata	*Abietinaria turgida*		x		x
Cnidaria: Hydrozoa:Thecata	*Abietinaria unidentified*		x	x	x
Cnidaria: Hydrozoa:Thecata	*Abietinaria variabilis*		x		
Cnidaria: Hydrozoa:Thecata	*Calycella syringa*		x	x	x
Cnidaria: Hydrozoa:Thecata	*Campanularia speciosa*				x
Cnidaria: Hydrozoa:Thecata	*Campanularia urceolata*		x		

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Cnidaria: Hydrozoa:Thecata	*Campanularia volubilis*				x
Cnidaria: Hydrozoa:Thecata	*Campanulina rugosa*				x
Cnidaria: Hydrozoa:Thecata	*Clytia gregaria*				x
Cnidaria: Hydrozoa:Thecata	*Clytia hemisphaerica?*				x
Cnidaria: Hydrozoa:Thecata	*Clytia kincaidi*				x
Cnidaria: Hydrozoa:Thecata	*Cuspidella unidentified*				x
Cnidaria: Hydrozoa:Thecata	*Eucopella compressa*				x
Cnidaria: Hydrozoa:Thecata	*Gonothyraea clarki*				x
Cnidaria: Hydrozoa:Thecata	*Grammaria immersa*				x
Cnidaria: Hydrozoa:Thecata	*Halecium ?parvulum*				x
Cnidaria: Hydrozoa:Thecata	*Halecium muricatum*			x	
Cnidaria: Hydrozoa:Thecata	*Hydrallmania distans*		x		
Cnidaria: Hydrozoa:Thecata	*Lafoea dumosa*		x		x
Cnidaria: Hydrozoa:Thecata	*Lafoea fruticosa*		x	x	x
Cnidaria: Hydrozoa:Thecata	*Lafoeina maxima*	x			
Cnidaria: Hydrozoa:Thecata	*Obelia borealis*				x
Cnidaria: Hydrozoa:Thecata	*Obelia longissima*		x		x
Cnidaria: Hydrozoa:Thecata	*Obelia* sp.	x	x		
Cnidaria: Hydrozoa:Thecata	*Opercularella lacerata*				x
Cnidaria: Hydrozoa:Thecata	*Sertularella albida*				x
Cnidaria: Hydrozoa:Thecata	*Sertularella polyzonias var gigantea*				x
Cnidaria: Hydrozoa:Thecata	*Sertularella reticulata*			x	
Cnidaria: Hydrozoa:Thecata	*Sertularella robusta*				x
Cnidaria: Hydrozoa:Thecata	*Sertularella sp.*	x			
Cnidaria: Hydrozoa:Thecata	*Sertularella tenella*		x		
Cnidaria: Hydrozoa:Thecata	*Sertularella turgida*				x
Cnidaria: Hydrozoa:Thecata	*Sertularia cupressoides*		x		x
Cnidaria: Hydrozoa:Thecata	*Sertularia robusta*				x
Cnidaria: Hydrozoa:Thecata	*Sertularia rugosa*				x
Cnidaria: Hydrozoa:Thecata	*Sertularia tolli*				x
Cnidaria: Hydrozoa:Thecata	*Stegopoma plicatile*				x
Cnidaria: Hydrozoa:Thecata	*Symplectoscyphus tricuspidatus*				x
Cnidaria: Hydrozoa:Thecata	*Thuiaria articulata*			x	
Cnidaria: Hydrozoa:Thecata	*Thuiaria carica*			x	
Cnidaria: Hydrozoa:Thecata	*Thuiaria cylindrica*		x		
Cnidaria: Hydrozoa:Thecata	*Thuiaria distans*			x	
Cnidaria: Hydrozoa:Thecata	*Thuiaria elegans*	x			

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Cnidaria: Hydrozoa:Thecata	*Verticillina verticillata*			x	x
Echinodermata:Asteroidea	*Asterias amurensis*		?	x	
Echinodermata:Asteroidea	*Ceramaster arcticus*			x	x
Echinodermata:Asteroidea	*Ceramaster patagonicus*				x
Echinodermata:Asteroidea	*Crossaster borealis*				x
Echinodermata:Asteroidea	*Crossaster papposus*	x	x	x	x
Echinodermata:Asteroidea	*Dermasterias imbricata*			x	x
Echinodermata:Asteroidea	*Diplopteraster multipes*				x
Echinodermata:Asteroidea	*Evasterias troschelii*			x	x
Echinodermata:Asteroidea	*Henricia aspera*				x
Echinodermata:Asteroidea	*Henricia asthenactis*				x
Echinodermata:Asteroidea	*Henricia leviuscula*			x	x
Echinodermata:Asteroidea	*Henricia longispina*				x
Echinodermata:Asteroidea	*Henricia sanguinolenta*	x	x	x	x
Echinodermata:Asteroidea	*Henricia tumida*		x		
Echinodermata:Asteroidea	*Leptasterias ?hylodes*		x	x	
Echinodermata:Asteroidea	*Leptasterias arctica forma arctica*	x			
Echinodermata:Asteroidea	*Leptasterias groenlandica*	x			
Echinodermata:Asteroidea	*Leptasterias hexactis*		x	x	x
Echinodermata:Asteroidea	*Leptasterias polaris acervata*	x	x	x	
Echinodermata:Asteroidea	*Leptasterias polaris katherinae*		x		
Echinodermata:Asteroidea	*Lethasterias nanimensis*			x	
Echinodermata:Asteroidea	*Luidia foliolata*				x
Echinodermata:Asteroidea	*Mediaster aequalis*				x
Echinodermata:Asteroidea	*Orthasterias koehleri*			x	x
Echinodermata:Asteroidea	*Pisaster ochraceus*				x
Echinodermata:Asteroidea	*Pteraster militaris*				x
Echinodermata:Asteroidea	*Pteraster tesselatus*		x	x	x
Echinodermata:Asteroidea	*Pycnopodia helianthoides*			x	x
Echinodermata:Asteroidea	*Solaster dawsoni*			x	x
Echinodermata:Asteroidea	*Solaster endeca*	x	x		x
Echinodermata:Asteroidea	*Solaster paxillatus*				x
Echinodermata:Asteroidea	*Solaster stimpsoni*		x	x	x
Echinodermata:Echinoidea	*Echinarachnius parma*		x		x
Echinodermata:Echinoidea	*Strongylocentrotus droebachiensis*	x	x	x	x
Echinodermata:Echinoidea	*Strongylocentrotus franciscanus*			x	x
Echinodermata:Holothuroidea	*Chiridota sp.*			x	x

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Echinodermata:Holothuroidea	*Cucumaria frondosa japonica*		x	x	x
Echinodermata:Holothuroidea	*Cucumaria miniata*		x	x	x
Echinodermata:Holothuroidea	*Cucumaria sp.*			x	
Echinodermata:Holothuroidea	*Cucumaria vegae*		x	x	x
Echinodermata:Holothuroidea	*Eupentacta pseudoquinquesemita*				x
Echinodermata:Holothuroidea	*Eupentacta quinquesemita*		x	x	
Echinodermata:Holothuroidea	*Leptosynapta clarki*				x
Echinodermata:Holothuroidea	*Myriotrochus rinkii*	x			
Echinodermata:Holothuroidea	*Parastichopus californicus*				x
Echinodermata:Holothuroidea	*Psolus chitonoides*		x	x	x
Echinodermata:Holothuroidea	*Psolus fabricii*	x			
Echinodermata:Holothuroidea	*Psolus squamatus*				x
Echinodermata:Ophiuroidea	*Amphioplus macraspis*				x
Echinodermata:Ophiuroidea	*Amphioplus pugetana*				x
Echinodermata:Ophiuroidea	*Amphioplus squamata*				x
Echinodermata:Ophiuroidea	*Amphipholis* sp.				x
Echinodermata:Ophiuroidea	*Amphiura sundevalli*	x			
Echinodermata:Ophiuroidea	*Diamphiodia craterodmeta*	x			x
Echinodermata:Ophiuroidea	*Gorgonocephalus stimpsoni*	x			
Echinodermata:Ophiuroidea	*Ophiocantha bidentata*	x			
Echinodermata:Ophiuroidea	*Ophiopholis aculeata*	x	x	x	x
Echinodermata:Ophiuroidea	*Ophiura quadrispina*				x
Echinodermata:Ophiuroidea	*Ophiura robusta*	x			
Echinodermata:Ophiuroidea	*Ophiura sarsi*	x			x
Echinodermata:Ophiuroidea	*Stegophiura nodosa*	x	x		
Echiura	*Bonelliopsis alaskana*		x	x	
Echiura	*Echiurus echiurus alaskensis*	x	x	x	x
Entoprocta	*Barentsia gorbunovi*	x			
Entoprocta	*Barentsia ramosa*		x		
Mollusca:Bivalvia	*Astarte borealis*	x			x
Mollusca:Bivalvia	*Astarte compacta*				x
Mollusca:Bivalvia	*Astarte elliptica*				x
Mollusca:Bivalvia	*Astarte esquimaulti*				x
Mollusca:Bivalvia	*Astarte montagui*	x			
Mollusca:Bivalvia	*Astarte* sp.		x		
Mollusca:Bivalvia	*Astarte vernicosa*			x	
Mollusca:Bivalvia	*Chlamys ?hastata*			x	

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Bivalvia	*Chlamys rubida*			x	x
Mollusca:Bivalvia	*Clinocardium blandum*			x	x
Mollusca:Bivalvia	*Clinocardium californiense*			x	x
Mollusca:Bivalvia	*Clinocardium ciliatum*	x			x
Mollusca:Bivalvia	*Clinocardium nuttallii*		x	x	x
Mollusca:Bivalvia	*Crassdoma gigantea*				x
Mollusca:Bivalvia	*Crassostrea gigas*				x
Mollusca:Bivalvia	*Cyclocardia crassidens*			x	
Mollusca:Bivalvia	*Cyclocardia crebricosta*				x
Mollusca:Bivalvia	*Cyclocardia ventricosa*		x		x
Mollusca:Bivalvia	*Diplodonta impolita*				x
Mollusca:Bivalvia	*Diplodonta aleutica*	x	?	?	
Mollusca:Bivalvia	*Diplodonta orbella*			x	
Mollusca:Bivalvia	*Entodesma navicula*			x	x
Mollusca:Bivalvia	*Gari californica*				x
Mollusca:Bivalvia	*Glycymeris septentrionalis*		x		x
Mollusca:Bivalvia	*Hiatella arctica*	x	x	x	x
Mollusca:Bivalvia	*Humilaria kennerleyi*				x
Mollusca:Bivalvia	*Kellia suborbicularis*				x
Mollusca:Bivalvia	*Liocyma fluctuosum*	x	x	x	x
Mollusca:Bivalvia	*Liocyma norvegica*				
Mollusca:Bivalvia	*Lyonsia arenosa*				x
Mollusca:Bivalvia	*Macoma balthica*	x	x	x	x
Mollusca:Bivalvia	*Macoma brota*				x
Mollusca:Bivalvia	*Macoma calcarea*	x			x
Mollusca:Bivalvia	*Macoma carlottensis*				x
Mollusca:Bivalvia	*Macoma dexioptera*				x
Mollusca:Bivalvia	*Macoma elimata*				x
Mollusca:Bivalvia	*Macoma expansa*				x
Mollusca:Bivalvia	*Macoma golikovi*		x	x	x
Mollusca:Bivalvia	*Macoma inquinata*			x	x
Mollusca:Bivalvia	*Macoma lipara*				x
Mollusca:Bivalvia	*Macoma moesta*	x			x
Mollusca:Bivalvia	*Macoma nasuta*				x
Mollusca:Bivalvia	*Mactromeris polynyma*		x	x	x
Mollusca:Bivalvia	*Modiolus modiolus*		x	x	x
Mollusca:Bivalvia	*Musculus discors*	x	x	x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Bivalvia	*Musculus glacialis*	x			x
Mollusca:Bivalvia	*Musculus niger*	x	x	x	x
Mollusca:Bivalvia	*Mya arenaria*		x	x	x
Mollusca:Bivalvia	*Mya baxteri*			x	
Mollusca:Bivalvia	*Mya arenaria*	x			
Mollusca:Bivalvia	*Mya pseudoarenaria*		x		x
Mollusca:Bivalvia	*Mya truncata*	x	x	x	x
Mollusca:Bivalvia	*Mytilus trossulus*		x	x	x
Mollusca:Bivalvia	*Neaeromya compressa*		x		x
Mollusca:Bivalvia	*Ennucula tenuis*	x			
Mollusca:Bivalvia	*Nuculana arctica*	x			
Mollusca:Bivalvia	*Nuculana minuta*	x			
Mollusca:Bivalvia	*Nuculana* sp.			x	
Mollusca:Bivalvia	*Nutricola lordi*		x		x
Mollusca:Bivalvia	*Pandora filosa*			x	
Mollusca:Bivalvia	*Panomya ampla*	x	x	x	x
Mollusca:Bivalvia	*Panomya norvegica*	x			x
Mollusca:Bivalvia	*Chlamys behringiana*	x			
Mollusca:Bivalvia	*Pododesmus macroschisma*		x	x	x
Mollusca:Bivalvia	*Protothaca staminea*		x	x	x
Mollusca:Bivalvia	*Saxidomus gigantea*			x	x
Mollusca:Bivalvia	*Serripes groenlandicus*	x		x	x
Mollusca:Bivalvia	*Serripes laperousii*			x	x
Mollusca:Bivalvia	*Serripes notabilis*				x
Mollusca:Bivalvia	*Siliqua alta*		x		x
Mollusca:Bivalvia	*Siliqua patula*		x	x	x
Mollusca:Bivalvia	*Tellina lutea*		x	x	
Mollusca:Bivalvia	*Tellina modesta*				x
Mollusca:Bivalvia	*Tellina nuculoides*			x	
Mollusca:Bivalvia	*Thracia challisiana*				x
Mollusca:Bivalvia	*Thracia condoni*				x
Mollusca:Bivalvia	*Thracia myopsis*				x
Mollusca:Bivalvia	*Thracia trapeziodes*				x
Mollusca:Bivalvia	*Tresus capax*			x	x
Mollusca:Bivalvia	*Tresus nuttallii*				x
Mollusca:Bivalvia	*Vilasina seminuda*				x
Mollusca:Bivalvia	*Vilasina vernicosus*		x		x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Bivalvia	*Yoldia hyperborea*	x			
Mollusca:Bivalvia	*Yoldia myalis*	x			
Mollusca:Bivalvia	*Yoldia scissurata*	x			
Mollusca:Bivalvia	*Yoldia* sp.			x	
Mollusca:Cephalopoda	*Benthoctopus hokkaidoensis*	x			
Mollusca:Cephalopoda	*Octopus dofleini*		x	x	x
Mollusca:Gastropoda: Opisthobranchia	*Acanthodoris ?pillosa*		x		
Mollusca:Gastropoda: Opisthobranchia	*Acteocina culcitella*				x
Mollusca:Gastropoda: Opisthobranchia	*Acteocina harpa*				x
Mollusca:Gastropoda: Opisthobranchia	*Aeolidia papillosa*		x	x	x
Mollusca:Gastropoda: Opisthobranchia	*Aglaja diomedea*				x
Mollusca:Gastropoda: Opisthobranchia	*Aglaja ocelligera*				x
Mollusca:Gastropoda: Opisthobranchia	*Aglaja* sp.		x		
Mollusca:Gastropoda: Opisthobranchia	*Alderia modesta*				x
Mollusca:Gastropoda: Opisthobranchia	*Ancula pacifica*				x
Mollusca:Gastropoda: Opisthobranchia	*Anisodoris lentigenosa*				x
Mollusca:Gastropoda: Opisthobranchia	*Anisodoris nobilis*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Archidoris montereyensis*				x
Mollusca:Gastropoda: Opisthobranchia	*Archidoris odhneri*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Armina californica*				x
Mollusca:Gastropoda: Opisthobranchia	*Austrodoris* sp.				x
Mollusca:Gastropoda: Opisthobranchia	*Cadlina luteomarginata*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Coryphella salmonacea*	x			
Mollusca:Gastropoda: Opisthobranchia	*Coryphella* sp.		x	x	x
Mollusca:Gastropoda: Opisthobranchia	*Cylichna occulta*	x			
Mollusca:Gastropoda: Opisthobranchia	*Cylichna* sp.				x
Mollusca:Gastropoda: Opisthobranchia	*Dendronotus albus*			x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Gastropoda: Opisthobranchia	*Dendronotus dallli*			x	
Mollusca:Gastropoda: Opisthobranchia	*Dendronotus frondosus*				x
Mollusca:Gastropoda: Opisthobranchia	*Dendronotus iris*				x
Mollusca:Gastropoda: Opisthobranchia	*Dendronotus* sp.	x	x		
Mollusca:Gastropoda: Opisthobranchia	*Dialula sandiegensis*		x		x
Mollusca:Gastropoda: Opisthobranchia	*Diaphana* cf. *minuta*			x	
Mollusca:Gastropoda: Opisthobranchia	*Dirona albolineata*				x
Mollusca:Gastropoda: Opisthobranchia	*Dirona aurantia*		x		x
Mollusca:Gastropoda: Opisthobranchia	*Flabellina salmonacea*				x
Mollusca:Gastropoda: Opisthobranchia	*Flabellina trophina*				x
Mollusca:Gastropoda: Opisthobranchia	*Gastropteron pacificum*				x
Mollusca:Gastropoda: Opisthobranchia	*Haminoea vesicula*				x
Mollusca:Gastropoda: Opisthobranchia	*Haminoea virescens*				x
Mollusca:Gastropoda: Opisthobranchia	*Hermissenda crassicornis*		x	x	x
Mollusca:Gastropoda: Opisthobranchia	*Melibe leonina*				x
Mollusca:Gastropoda: Opisthobranchia	*Onchidella borealis*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Onchidiopsis glacialis*	x			
Mollusca:Gastropoda: Opisthobranchia	*Onchidoris bilamellata*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Onchidoris muricata*				x
Mollusca:Gastropoda: Opisthobranchia	*Siphonaria thersites*		x	x	x
Mollusca:Gastropoda: Opisthobranchia	*Tochuina tetraquetra*			x	x
Mollusca:Gastropoda: Opisthobranchia	*Triopha carpenteri*			x	
Mollusca:Gastropoda: Opisthobranchia	*Triopha catalinae*				x
Mollusca:Gastropoda: Opisthobranchia	*Tritonia diomedea*				x
Mollusca:Gastropoda:	*Tritonia festiva*				x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Opisthobranchia					
Mollusca:Gastropoda: Opisthobranchia	*Trochuina tetraquetra*				x
Mollusca:Gastropoda: Prosobranchia	*Acmaea mitra*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Admete middendorffiana*	x			
Mollusca:Gastropoda: Prosobranchia	*Admete regina*	x			
Mollusca:Gastropoda: Prosobranchia	*Admete viridula*	x		x	x
Mollusca:Gastropoda: Opisthobranchia	*Aldisa zetlandica*	x			
Mollusca:Gastropoda: Prosobranchia	*Alia carinata*				x
Mollusca:Gastropoda: Prosobranchia	*Alvania compacta*				x
Mollusca:Gastropoda: Prosobranchia	*Amphissa columbiana*			x	x
Mollusca:Gastropoda: Prosobranchia	*Amphissa reticulata*				x
Mollusca:Gastropoda: Prosobranchia	*Ancistrolepis eucosmuis*				x
Mollusca:Gastropoda: Prosobranchia	*Aquilonaria turneri*	x	x		
Mollusca:Gastropoda: Prosobranchia	*Lacuna crassior*		x	x	
Mollusca:Gastropoda: Prosobranchia	*Beringius* cf. *beringi*		x		
Mollusca:Gastropoda: Prosobranchia	*Beringius kennicotti*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Beringius rotundatus*		x		
Mollusca:Gastropoda: Prosobranchia	*Beringius stimpsoni*	x			
Mollusca:Gastropoda: Prosobranchia	*Boreotrophon clathratus*	x	x	x	x
Mollusca:Gastropoda: Prosobranchia	*Boreotrophon multicostata*			x	x
Mollusca:Gastropoda: Prosobranchia	*Boreotrophon stuarti*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Boreotrophon truncatus*	x	x	x	x
Mollusca:Gastropoda: Prosobranchia	*Buccinum angulosum*	x			
Mollusca:Gastropoda: Prosobranchia	*Buccinum baeri*		x		x
Mollusca:Gastropoda: Prosobranchia	*Buccinum ciliatum*	x			

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Gastropoda: Prosobranchia	*Buccinum fringillum*	x			
Mollusca:Gastropoda: Prosobranchia	*Buccinum glaciale*	x		x	
Mollusca:Gastropoda: Prosobranchia	*Buccinum morchianum*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Buccinum plectrum*	x		x	x
Mollusca:Gastropoda: Prosobranchia	*Buccinum polare*	x			
Mollusca:Gastropoda: Prosobranchia	*Buccinum tenue*	x			
Mollusca:Gastropoda: Prosobranchia	*Calliostoma annulatum*				x
Mollusca:Gastropoda: Prosobranchia	*Calliostoma ligatum*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Calyptraea fastigiata*				x
Mollusca:Gastropoda: Prosobranchia	*Capulacmaea commodum*		x		
Mollusca:Gastropoda: Prosobranchia	*Ceratostoma foliolata*				x
Mollusca:Gastropoda: Prosobranchia	*Cerithiopis autefilosa*				x
Mollusca:Gastropoda: Prosobranchia	*Cerithiopsis* sp.		x		
Mollusca:Gastropoda: Prosobranchia	*Collisella* spp.			x	
Mollusca:Gastropoda: Prosobranchia	*Colus aphelus*				x
Mollusca:Gastropoda: Prosobranchia	*Colus herendeeni*			x	x
Mollusca:Gastropoda: Prosobranchia	*Colus halli*				x
Mollusca:Gastropoda: Prosobranchia	*Colus spitzbergensis*	x			
Mollusca:Gastropoda: Prosobranchia	*Crepidula grandis*	x			
Mollusca:Gastropoda: Prosobranchia	*Crepidula nummaria*		x	x	
Mollusca:Gastropoda: Prosobranchia	*Crepipatella lingulata*				x
Mollusca:Gastropoda: Prosobranchia	*Cryptobranchia alba*				x
Mollusca:Gastropoda: Prosobranchia	*Cryptobranchia concentrica*			x	x
Mollusca:Gastropoda: Prosobranchia	*Diadora aspera*				x
Mollusca:Gastropoda:	*Boreoscala greenlandica*	x	x	x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Prosobranchia					
Mollusca:Gastropoda: Prosobranchia	*Fusitriton oregonensis*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Lacuna carinata*				x
Mollusca:Gastropoda: Prosobranchia	*Lacuna marmorata*				x
Mollusca:Gastropoda: Prosobranchia	*Lacuna* sp.		x		
Mollusca:Gastropoda: Prosobranchia	*Lacuna variegata*				x
Mollusca:Gastropoda: Prosobranchia	*Lacuna vincta*			x	x
Mollusca:Gastropoda: Prosobranchia	*Lepeta caeca*	x			
Mollusca:Gastropoda: Prosobranchia	*Lirabuccinum dira*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Littorina subrotundata*				
Mollusca:Gastropoda: Prosobranchia	*Littorina scutulata*			x	x
Mollusca:Gastropoda: Prosobranchia	*Littorina sitkana*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Lottia borealis*		x		
Mollusca:Gastropoda: Prosobranchia	*Lottia digitalis*				x
Mollusca:Gastropoda: Prosobranchia	*Lottia instabilis*				x
Mollusca:Gastropoda: Prosobranchia	*Lottia ochracea*		x		x
Mollusca:Gastropoda: Prosobranchia	*Lottia paradigitalis*				x
Mollusca:Gastropoda: Prosobranchia	*Lottia pelta*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Lottia triangularis*				x
Mollusca:Gastropoda: Prosobranchia	*Lussivolutopsius filosa*				x
Mollusca:Gastropoda: Prosobranchia	*Margarites beringensis*				x
Mollusca:Gastropoda: Prosobranchia	*Margarites baxteri*		x		
Mollusca:Gastropoda: Prosobranchia	*Margarites costalis*	x			
Mollusca:Gastropoda: Prosobranchia	*Margarites frigidus*	x			
Mollusca:Gastropoda: Prosobranchia	*Margarites helicinus*			x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Gastropoda: Prosobranchia	*Margarites pribiloffensis*	x			
Mollusca:Gastropoda: Prosobranchia	*Margarites pupillus*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Margarites vahli*	x			
Mollusca:Gastropoda: Prosobranchia	*Margarites vorticiferus*	x			
Mollusca:Gastropoda: Prosobranchia	*Nassarius mendicus*				x
Mollusca:Gastropoda: Prosobranchia	*Cryptonatica affinis*	x	x	x	x
Mollusca:Gastropoda: Prosobranchia	*Neadmete circumcincta*			x	
Mollusca:Gastropoda: Prosobranchia	*Neadmete modesta*				x
Mollusca:Gastropoda: Prosobranchia	*Neptunea borealis*		x		
Mollusca:Gastropoda: Prosobranchia	*Neptunea lyrata*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Neptunea pribiloffensis*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Neptunea ventricosa*	x			
Mollusca:Gastropoda: Prosobranchia	*Tectura* spp.			x	
Mollusca:Gastropoda: Prosobranchia	*Nucella canaliculata*			x	x
Mollusca:Gastropoda: Prosobranchia	*Nucella emarginata*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Nucella lamellosa*			x	x
Mollusca:Gastropoda: Prosobranchia	*Nucella lima*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Ocenebra interfossa*				x
Mollusca:Gastropoda: Prosobranchia	*Ocenibrina lurida*				x
Mollusca:Gastropoda: Prosobranchia	*Oenopota* sp.		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Olivella baetica*				x
Mollusca:Gastropoda: Prosobranchia	*Piliscus commodus*	x	x		
Mollusca:Gastropoda: Prosobranchia	*Plicifusus kroyeri*	x			
Mollusca:Gastropoda: Prosobranchia	*Plicifusus verkruzeni*	x			
Mollusca:Gastropoda:	*Polinices monteronus*	x			

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Prosobranchia					
Mollusca:Gastropoda: Prosobranchia	*Euspira pallida*	x			x
Mollusca:Gastropoda: Prosobranchia	*Ptychatractus occidentalis*	x			
Mollusca:Gastropoda: Prosobranchia	*Puncturella cooperi*				x
Mollusca:Gastropoda: Prosobranchia	*Puncturella eyerdami*				x
Mollusca:Gastropoda: Prosobranchia	*Puncturella galeata*		x		x
Mollusca:Gastropoda: Prosobranchia	*Puncturella multicostata*				x
Mollusca:Gastropoda: Prosobranchia	*Puncturella multistriata*		x		x
Mollusca:Gastropoda: Prosobranchia	*Puncturella noachina*	x			x
Mollusca:Gastropoda: Prosobranchia	*Puncturella unidentified*				x
Mollusca:Gastropoda: Prosobranchia	*Pyrulofusus deformis*	x			
Mollusca:Gastropoda: Prosobranchia	*Pyrulofusus harpa*				x
Mollusca:Gastropoda: Prosobranchia	*Scabrotrophon maltzani*			x	
Mollusca:Gastropoda: Prosobranchia	*Solariella obscura*	x			
Mollusca:Gastropoda: Prosobranchia	*Tachyrhynchus reticulatus*	x			
Mollusca:Gastropoda: Prosobranchia	*Tectura fenestrata*		x		x
Mollusca:Gastropoda: Prosobranchia	*Tectura persona*			x	x
Mollusca:Gastropoda: Prosobranchia	*Tectura scutum*			x	x
Mollusca:Gastropoda: Prosobranchia	*Tectura testudinalis*	x	x		
Mollusca:Gastropoda: Prosobranchia	*Trichotropis bicarinata*	x			
Mollusca:Gastropoda: Prosobranchia	*Trichotropis borealis*	x			x
Mollusca:Gastropoda: Prosobranchia	*Trichotropis cancellata*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Trichotropis insignis*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Trichotropis kroyeri*	x			
Mollusca:Gastropoda: Prosobranchia	*Trophonopsis lasius*		x	x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Gastropoda: Prosobranchia	*Velutina laevigata*		x	x	
Mollusca:Gastropoda: Prosobranchia	*Velutina plicatilis*				x
Mollusca:Gastropoda: Prosobranchia	*Velutina prolongata*		x		x
Mollusca:Gastropoda: Prosobranchia	*Velutina rubra*		x		x
Mollusca:Gastropoda: Prosobranchia	*Velutina undata*				x
Mollusca:Gastropoda: Prosobranchia	*Velutina velutina*	x	x		x
Mollusca:Gastropoda: Prosobranchia	*Volutharpa ampullacea*		x	x	x
Mollusca:Gastropoda: Prosobranchia	*Volutopsius behringi kobelti*	x			
Mollusca:Gastropoda: Prosobranchia	*Volutopsius castaneus*		x	x	
Mollusca:Gastropoda: Prosobranchia	*Volutopsius stefanssoni*	x			
Mollusca:Polyplacophora	*Amicula vestita*	x	x		
Mollusca:Polyplacophora	*Cryptochiton stelleri*		x	x	x
Mollusca:Polyplacophora	*Ischnochiton ?trifidus*		x	x	
Mollusca:Polyplacophora	*Ischnochiton albus*	x	x	x	x
Mollusca:Polyplacophora	*Katharina tunicata*			x	x
Mollusca:Polyplacophora	*Lepidozona interstincta*				x
Mollusca:Polyplacophora	*Lepidozona trifida*		x	x	x
Mollusca:Polyplacophora	*Leptochiton rugatus*				x
Mollusca:Polyplacophora	*Leptochiton sp.*		x		
Mollusca:Polyplacophora	*Mopalia ciliata*		x	x	x
Mollusca:Polyplacophora	*Mopalia cirrata*				x
Mollusca:Polyplacophora	*Mopalia ferreirai*				x
Mollusca:Polyplacophora	*Mopalia hindsii*			x	
Mollusca:Polyplacophora	*Mopalia laevior*				x
Mollusca:Polyplacophora	*Mopalia lignosa*		x		x
Mollusca:Polyplacophora	*Mopalia mucosa*		x		x
Mollusca:Polyplacophora	*Mopalia sinuata*				x
Mollusca:Polyplacophora	*Mopalia* sp.		x	x	
Mollusca:Polyplacophora	*Mopalia spectabilis*				x
Mollusca:Polyplacophora	*Mopalia swanii*				x
Mollusca:Polyplacophora	*Placiphorella rufa*			?	x
Mollusca:Polyplacophora	*Schizoplax brandtii*		x	x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Mollusca:Polyplacophora	*Tonicella insignis*		x	x	x
Mollusca:Polyplacophora	*Tonicella lineata*		x	x	x
Mollusca:Polyplacophora	*Tonicella rubra*		x		x
Porifera	*?Esperiopsis* sp.		x	x	x
Porifera	*Choanites lutkeni*	x			
Porifera	*Choanites mineri*	x			
Porifera	*Choanites suberea*	x			
Porifera	*Cioxeamistia sp.*	x			
Porifera	*Cliona celata*		x	x	x
Porifera	*Cliona thosina*				x
Porifera	*Craniella cranalta*	x			
Porifera	*Echinoclathria beringius*	x			
Porifera	*Esperiopsis laxa*		x	x	x
Porifera	*Esperiopsis quatsinoensis*		x		
Porifera	*Halichondria lambei*	x			
Porifera	*Halichondria panicea*		x	x	x
Porifera	*Leuconia alaskensis*	x			
Porifera	*Leuconia ananas*	x			
Porifera	*Mycale lingua*		x	x	x
Porifera	*Myxilla incrustans*	x	x		x
Porifera	*Polymastia andrica*	x			x
Porifera	*Scypha ciliata*				x
Porifera	*Scypha compacta*				x
Porifera	*Scypha compressa*				x
Porifera	*Suberites ficus*		x	x	x
Porifera	*Tetilla spinosa*				x
Porifera	*Tetilla villosa*				x
Porifera	*Topsentia disparilis*	x			
Priapulida	*Halicryptus spinulosus*	x			
Priapulida	*Priapulus caudatus*	x			x
Sipuncula	*Golfingia margaritacea*	x		x	x
Sipuncula	*Golfingia vulgaris*				x
Sipuncula	*Phascolion strombi*				x
Sipuncula	*Phascolosoma agassizii*				x
Urochordata: Ascidiacea	*Amaroucium fragile*	x			
Urochordata: Ascidiacea	*Aplidiopsis pannosum*	x			
Urochordata: Ascidiacea	*Aplidium arenatum*				x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Urochordata: Ascidiacea	*Aplidium coei*				x
Urochordata: Ascidiacea	*Aplidium ritteri*				x
Urochordata: Ascidiacea	*Aplidium translucidum*				x
Urochordata: Ascidiacea	*Archidistoma ritteri*				x
Urochordata: Ascidiacea	*Ascidia callosa*	x			x
Urochordata: Ascidiacea	*Ascidia columbiana*				x
Urochordata: Ascidiacea	*Boltenia echinata*	x	x		x
Urochordata: Ascidiacea	*Boltenia ovifera*	x			x
Urochordata: Ascidiacea	*Botrylloides violaceus*				x
Urochordata: Ascidiacea	*Chelyosoma columbiana*				x
Urochordata: Ascidiacea	*Chelyosoma macleayanum*	x			
Urochordata: Ascidiacea	*Chelyosoma productum*				x
Urochordata: Ascidiacea	*Cnemidocarpa finmarkiensis*		x		x
Urochordata: Ascidiacea	*Corella inflata*				x
Urochordata: Ascidiacea	*Corella willmeriana*				x
Urochordata: Ascidiacea	*Cystodytes lobatus*				x
Urochordata: Ascidiacea	*Dendrodoa grossularia*	x			
Urochordata: Ascidiacea	*Dendrodoa pulchella*	x	x		
Urochordata: Ascidiacea	*Didemnum albidum*	x			x
Urochordata: Ascidiacea	*Didemnum carnulentum*				x
Urochordata: Ascidiacea	*Didemnum smithi*				x
Urochordata: Ascidiacea	*Distaplia alaskensis*				x
Urochordata: Ascidiacea	*Distaplia occidentalis*			x	x
Urochordata: Ascidiacea	*Distaplia smithi*				x
Urochordata: Ascidiacea	*Eugyra glutinans*	x			
Urochordata: Ascidiacea	*Halocynthia aurantium*	x	x	x	x
Urochordata: Ascidiacea	*Halocynthia igaboja*				x
Urochordata: Ascidiacea	*Metandrocarpa taylori*				x
Urochordata: Ascidiacea	*Molgula griffithsi*	x			
Urochordata: Ascidiacea	*Molgula retortiformis*	x			x
Urochordata: Ascidiacea	*Pelonaia corrugata*	x	x		
Urochordata: Ascidiacea	*Polyclinum sp.*				x
Urochordata: Ascidiacea	*Pycnoclavella stanleyi*				x
Urochordata: Ascidiacea	*Pyura haustor*				x
Urochordata: Ascidiacea	*Rhizomolgula globularis*	x			x
Urochordata: Ascidiacea	*Ritterella pulchra*			x	x
Urochordata: Ascidiacea	*Styela ?montereyensis*		x	x	x

PHYLUM/CLASS/ORDER	GENUS/SPECIES	Arctic	West Side/ Kamishak	Kachemak/ Anchor Point	Prince William Sound
Urochordata: Ascidiacea	*Styela clavata*				x
Urochordata: Ascidiacea	*Styela coriacea*	x			
Urochordata: Ascidiacea	*Styela rustica macrenteron*	x			
Urochordata: Ascidiacea	*Styela truncata*				x
Urochordata: Ascidiacea	*Styela yakutatensis*		x		
Urochordata: Ascidiacea	*Synoicum jordani*				x
Urochordata: Ascidiacea	*Synoicum kincaidi?*				x
Listed number of taxa		241	233	239	467

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.