# 3.5 Marine Plants and Invertebrates

## 3.5 MARINE PLANTS AND INVERTEBRATES

### 3.5.1 Affected Environment

For purposes of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the Region of Influence (ROI) for marine plants and invertebrates includes the Gulf of Alaska (GOA) Temporary Maritime Activities Area (TMAA). The TMAA is more than 12 nautical miles (nm) (22 kilometers [km]) from land and is therefore outside of United States (U.S.) territorial seas.

#### 3.5.1.1 Existing Conditions

The GOA forms a large, semicircular bight opening southward into the North Pacific Ocean (Royer and Muench 1977, Stabeno et al. 2004; Figure 3.5-1). The region is bounded by the mountainous coast of Alaska to the west, north, and east and encompasses watersheds of the Alaskan Peninsula from 176º west (W) to the Canadian mainland on Queen Charlotte Sound (127.5ºW) (Mundy and Olsson 2005). The GOA is characterized by a broad and deep continental shelf containing numerous troughs and ridges, and the region receives high amounts of freshwater input, experiences numerous storms, and undergoes intense variability in waters overlying the continental shelf (Whitney et al. 2005).

The GOA is one of the world's most productive ocean regions and the habitats associated with these cold and turbulent waters contain identifiable collections of macrohabitats that sustain resident and migratory species including seabirds, marine mammals, invertebrates, and fishes (e.g., salmon and groundfish; Mundy and Cooney 2005, Mundy and Spies 2005); these habitats support some of the largest fisheries in the United States. (Heifetz et al. 2003).

Important ecosystem functions provided by marine plants and invertebrates within the GOA include the following:

- Phytoplankton form the basis of the ocean food chain.
- Zooplankton serves as an important food source for other organisms, including fishes and whales.
- Benthic invertebrates, which range from microscopic crustaceans to clams and crabs, also provide valuable links in the food chain and perform ecosystem functions such as nutrient processing.
- For humans, marine plants and invertebrates contribute to economic, cultural, and recreational activities in the GOA.

The TMAA is more than 12 nm (22 km) from the closest point of land and includes primarily offshore habitats including continental shelf, slope, and abyssal plain regions, which are influenced by both the Alaska Coastal Current and the Alaska Gyre (Figure 3.5-1). The TMAA consists of open ocean, and the following discussion is divided into two distinct habitat types:

- Pelagic, or open ocean habitat, and
- Benthic, or bottom dwelling habitat.

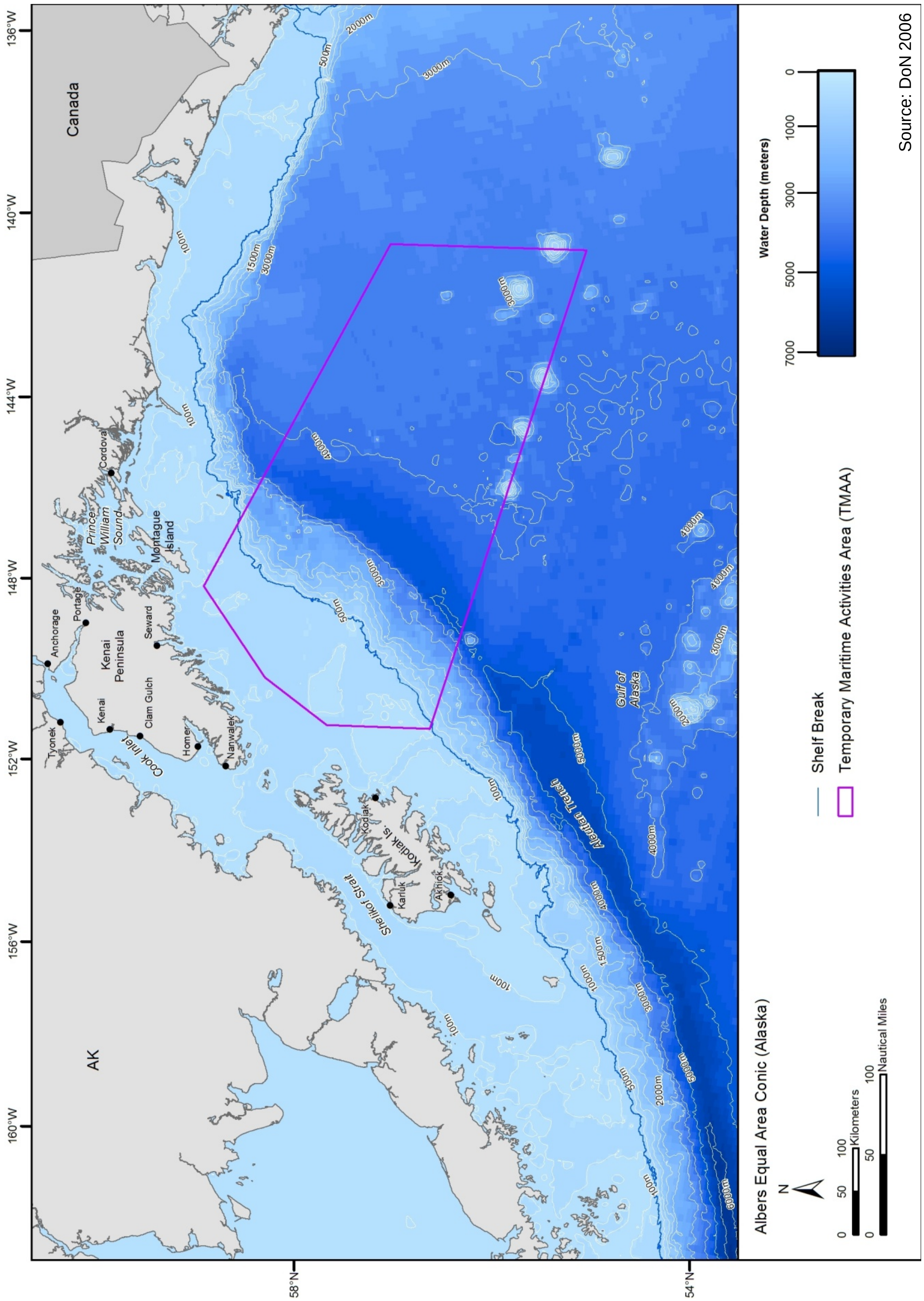


**Figure 3.5-1: 2D Bathymetry of the TMAA and surrounding Vicinity**

## Open Ocean Pelagic Habitats

All areas except those near the coast and the sea floor are called the pelagic or oceanic zone; this zone is further divided into light and depth-dependent zones (Figure 3.5-2). The photic zone (with light) of the open ocean consists of the epipelagic and mesopelagic zones. The aphotic zone (without light) of the open ocean consists of all the zones lower in the ocean. The epipelagic zone stretches from the surface down to 660 feet (ft) (200 meters [m]) and is home to the greatest biodiversity in the sea, largely because of the availability of sunlight that enables photosynthetic organisms to thrive (Department of Navy [DoN] 2006). Both marine plants and animals are present in the epipelagic zone.

From 660 to 3,300 ft (200 to 1,000 m) is the mesopelagic zone, a twilight zone where some light filters through, but does not reach a level of brightness necessary for photosynthesis to occur.

The bathypelagic zone is from 3,300 to 13,200 ft (1,000 to 4,000 m) and completely dark. Plants are non-existent in the bathypelagic zone. Animals that can live here survive on the dead material, or detrius, that falls from surface zones or on other animals that live in the deep sea. Most animals in the abyssalpelagic zone, located from 13,200 ft (4,000 m) down, are blind and colorless due to the complete lack of light.

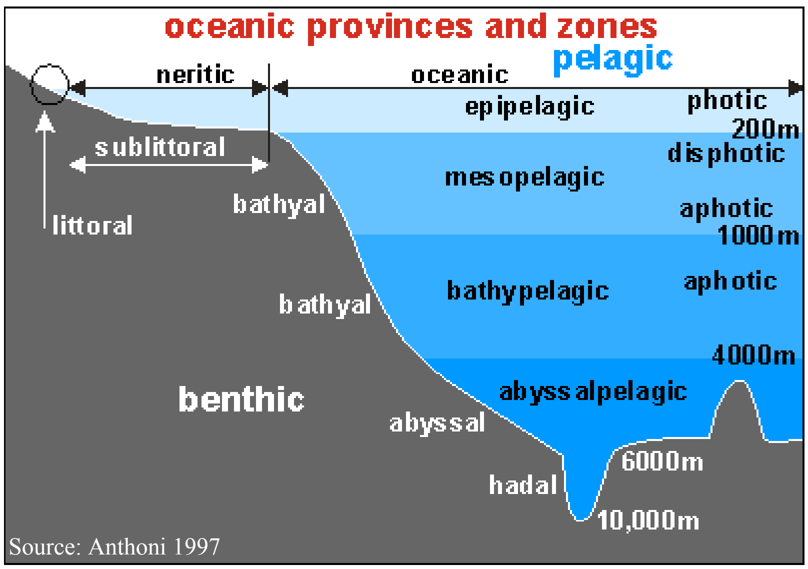


**Figure 3.5-2: Oceanic Zones**

### Microscopic Communities

Plankton are organisms that float or drift in the water column and are unable to maintain their position against the movement of water masses (Parsons et al. 1984); they are at the mercy of the currents in the local aquatic environment. Planktonic assemblages include bacterioplankton (bacteria), zooplankton (animals) including ichthyoplankton (larval fish), and phytoplankton (plant-like). In general, plankton are very small or microscopic although there are exceptions. For example, jellyfish (even though some jellyfish can grow to 10 ft [3 m] in diameter) and pelagic *Sargassum* are considered part of the plankton group due to their inability to move against surrounding currents.

#### *Phytoplankton*

Phytoplankton make up most of the marine plant life in the GOA. These organisms photosynthesize to convert light energy into chemical energy; thereby, in the oceans, they comprise the lowest level of the food web and can be considered the most important group of organisms in the ocean. A vast majority of organisms in the oceans depend either directly or indirectly on phytoplankton for survival. Growth and distribution of phytoplankton are influenced by several factors including temperature (Eppley 1972), light (Yentsch and Lee 1966), nutrient concentration (Goldman et al. 1979), alkalinity (pH), and salinity (Parsons et al. 1984). In general, the distribution of phytoplankton is patchy, occurring in regions with the optimal conditions for growth. The concentration of chlorophyll measured in the water column or at the sea surface can be used as a proxy for phytoplankton; regions of enhanced chlorophyll (chl a) concentrations are indicative of high phytoplankton abundance (Figure 3.5-3). In general, the concentration of phytoplankton decreases with increased distance from the shore and water depth.

### *Continental Shelf and Nearshore Waters*

Although the predominance of downwelling conditions in the GOA limits the supply of nutrients to the shelf, it remains a highly productive region (Ladd et al. 2005b). Frequent storms, high tidal energy, persistent storms, and localized upwelling appear to be the primary mechanisms that enhance vertical mixing along the coastal shelf (Hood 1986, Sambrotto and Lorenzen 1986, Mundy and Spies 2005). Shelf and coastal waters host a traditional phytoplankton community composed of nanoplankton (2 to 20 microns [µm]) and microplankton (20 to 200 µm); large and small diatoms and dinoflagellates tend to dominate the region (Cooney 1986b, Sambrotto and Lorenzen 1986, Sherr et al. 2005). When production is high, diatoms commonly account for more than 80 percent of the phytoplankton (Whitney et al. 2005).

In the GOA, the annual production cycle is characterized by well-defined spring (and sometimes fall) blooms of large diatom species (most are larger than 50 µm; Cooney 2005). These blooms typically begin in late March and early April in response to a seasonal stabilization of the winter-conditioned deep mixed layer, and increased ambient light (Stabeno et al. 2004, Cooney 2005, Mundy and Cooney 2005).

These blooms and their associated high rates of photosynthesis typically last only 4 to 6 weeks before being controlled by nutrient depletion, sinking, and zooplankton grazing (Goering et al. 1973, Mundy and Cooney 2005). The timing, duration, and intensity of blooms are controlled largely by the physical structure of the water column. Depending on the variable conditions of any given spring, the plant bloom may be early or late by as much as 3 weeks; strong periods of wind, tidal mixing, or both during the bloom can prolong bloom events (Cooney 2005, Mundy and Cooney 2005, Weingartner 2005). When the phytoplankton bloom is prolonged in this way, its intensity is lessened.

In the late spring and early summer, large diatom-dominated spring blooms decline as nutrient supplies are diminished; dinoflagellates and other smaller forms are the dominant taxa under these conditions (Cooney 2005). In Prince William Sound, dominance in the phytoplankton bloom was shared by the large chain-forming diatoms including *Skeletonema*, *Thalassiosira*, and *Chaetoceros*. Later in June, when nutrients become more restrictive to growth, phytoplankton are dominated by smaller diatoms (e.g., *Rhizosolenia*) and tiny flagellates. Regions southeast of Kodiak Island have higher standing stocks during the summer than shelf regions to the northeast where fewer submarine canyons and troughs are located. It is believed that intrusion of nutrient-rich waters in these troughs and the subsequent mixing of these nutrients into the euphotic zone support this phytoplankton assemblage (Ladd et al. 2005a).

In some years, a nearshore or inshore fall bloom of diatoms occurs in September and October in response to a deepening wind-mixed layer and enhanced nutrient levels (Cooney 2005). A fall phytoplankton bloom occasionally can be detected in Prince William Sound. The ecological importance of this late-season production and the physical forces responsible are not yet understood (Mundy and Cooney 2005).

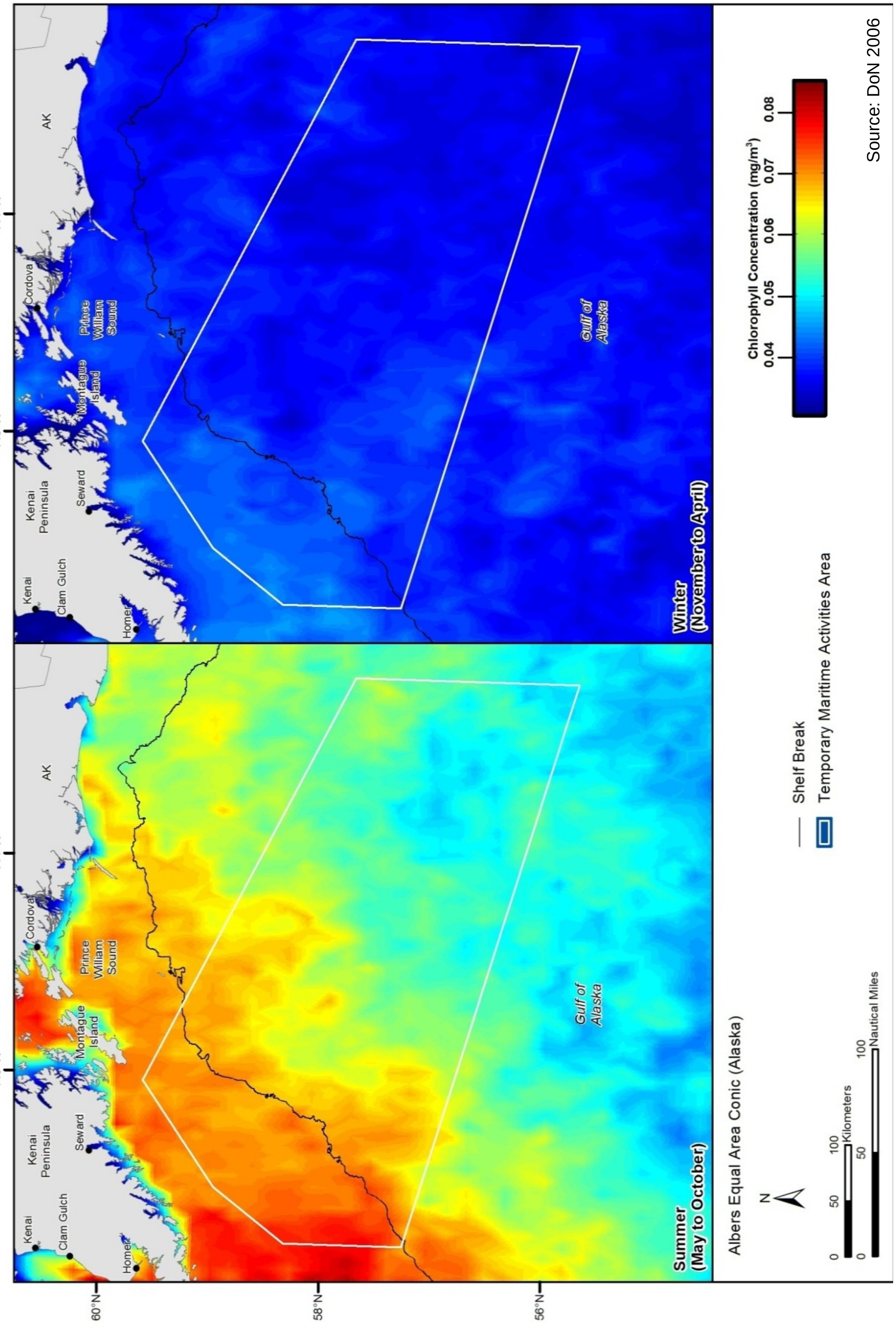


**Figure 3.5-3: Seasonal Distribution of Chlorophyll throughout the TMAA and surrounding Vicinity during Summer (May through October) and Winter (November through April)**

*Offshore and the Alaskan Gyre*

The basin of the GOA is a high-nutrient, low-chlorophyll environment (Ladd et al. 2005b). As a result of winter mixing combined with advection, phytoplankton in the center of the basin are supplied with sufficient nutrients for growth (Wheeler 1993). However, due to iron limitation, concentrations of chlorophyll remain low (approximately 0.3 milligrams [mg] chl/cubic meter [$m^3$]) throughout the year and production does not reach the levels seen in coastal regions (Sambrotto and Lorenzen 1986, Martin et al. 1989, Boyd et al. 1995). The phytoplankton community comprising the oceanic euphotic zone is dominated year-round by very small phytoplankton including small diatoms, naked flagellates, and cyanobacteria (Sambrotto and Lorenzen 1986, Booth 1988). Most of these organisms are smaller than 10 µm in size. The smallest of these phytoplankton include phototrophic bacteria, coccoid cyanobacteria, and picoplankton (<1 to 3 µm); these classes are considered to be the most important phytoplankton in open ocean gyres (Sherr et al. 2005). Unlike the coastal regions of the GOA, the outer shelf and deep ocean regions do not undergo seasonal blooms in phytoplankton abundance (Cooney 2005, Mundy and Cooney 2005).

***Zooplankton***

Zooplankton is a term for microscopic (< 2 µm) to small animals (2 to 20 cm) that live in the open ocean. Examples include ciliates; a wide variety of crustaceans such as copepods and krill (euphausiids); and the eggs, larvae, and juvenile stages of organisms ranging in complexity from jellyfish to fish (Kideys 2002).

Most zooplankton feed on phytoplankton. The zooplankton, in turn, serves as an important food source for other organisms, including fishes and whales. Copepods and krill are the two most important food sources for adult pelagic fish and baleen whales. Krill usually live at depths beyond the range of surface-feeding animals, but during swarming, large numbers may migrate to the surface within reach of flocks of birds (Sheard 1953, Boden et al. 1955).

Shelf waters in the GOA host a traditional plankton community in which large phytoplankton (diatoms and dinoflagellates) are grazed upon by copepods (Cooney 1986b, Sambrotto and Lorenzen 1986, Incze et al. 1997, Coyle and Pinchuk 2003, Cooney 2005, Coyle and Pinchuk 2005). The dominant zooplankton that inhabit the GOA are copepods and cnidarians, and abundance and species composition is largely driven by local salinity (Coyle and Pinchuk 2003). In addition to copepods, larger micronektonic species (e.g., euphausiids, amphipods, and some shrimp species) can be important zooplankton components in the diets of local fish and large predators (Coyle and Paul 1992, Incze et al. 1997, Boldt and Haldorson 2003). Highest levels of biomass tend to occur in the summer months of May (copepods) and August (cnidarians); lowest values tend to occur in February (Coyle and Pinchuk 2003, Zamon and Welch 2005). Cross-shelf distribution of zooplankton is influenced by their depth preferences, migration behavior, salinity and temperature preferences, and water movement. A mid-shelf transition region also can be identified where the zooplankton community is composed of a mixture of neritic and oceanic species (Coyle and Pinchuk 2005).

Grazing by the larger mesozooplankton (i.e., copepods) accounts for only a small percentage of phytoplankton mortality in the Alaska Gyre (Mackas and Tsuda 1999). Rather, production of phytoplankton in the oceanic regions of the GOA is thought to be controlled by an assemblage of microzooplankters and microconsumers, represented by abundant ciliate protozoans and small flagellates, rather than by large copepods (Miller et al. 1991a, Miller et al. 1991b, Booth et al. 1993, Dagg 1993, Frost 1993). Because the growth rates of these grazers are higher than those of the phytoplankton, it is hypothesized that these consumers are capable of efficiently tracking and limiting the overall oceanic productivity by eating the primary producers (Banse 1982, Taniguchi 1999). Oceanic zooplankton in the upper layers of the water column exhibit marked seasonality. In the late winter, biomass of zooplankton in the region increased 5-fold to 100-fold (values increase from 5 to 20 mg/$m^3$ in the winter to 100 to 500 mg/m$^3$ in the mid-summer). During this increase, copepods dominate the zooplankton community (Cooney 1986a, 1986b; Hood 1986; Landry and Lorenzen 1989; Cooney 2005).

Many of the zooplankton inhabiting the GOA migrate diurnally over 330 ft (100 m) or more. These migrations may interact with vertical or horizontal currents in ways that create localized swarms and patches of plankton in the region (Mundy and Cooney 2005, Weingartner 2005).

El Niño events have little effect on the phytoplankton composition within the shelf waters of the GOA (Coyle and Pinchuk 2003, Zamon and Welch 2005). Horizontal expansion of zooplankton stocks occur during warm periods of the Pacific Decadal Oscillation (PDO) along the coast. Both El Niño and the PDO affect the phytoplankton assemblage in the oceanic regions. Following the shift to a positive (warm) PDO regime in the late 1970s, zooplankton biomass doubled in the offshore regions of the GOA (Brodeur and Ware 1992, McFarlane and Beamish 1992, Brodeur et al. 1996, Francis and Hare 1997). During an El Niño event, a shallower mixed layer restricts the supply of nutrients to the ocean surface. In turn, the entire GOA experiences extreme nitrate depletion and decreased levels of primary production. Zooplankton become depleted as their food source is not as abundant (Freeland 2000).

### *Pelagic Invertebrates*

Open-ocean or pelagic invertebrates inhabiting the GOA consist of "jellies"—jellyfish (cnidarians), comb jellyfish (ctenophorans), and salps (chordates)—plus a wide variety of other animals, including shrimp (decapods), gastropods, and polychaete marine worms. Most of these animals filter the sea water for plankton. Salps are more abundant in phytoplankton-rich surface waters, but have been found at depths to 3,300 ft (1,000 m). Many of these soft-bodied invertebrates are important sources of food for sea turtles.

## Open Ocean Deepwater Benthic Habitats

The variety of bottom substrates and the complicated system of water circulation and bathymetry in the GOA results in a complex benthos (Chikuni 1985). The distribution of the benthos in the GOA is primarily a function of depth (i.e., light penetration, temperature, and wave action) and substrate (i.e., availability and type of substrate and movement and accumulation of sediments; Maragos 2000).

In addition, the distribution, diversity, and abundance of the benthos of the GOA are strongly influenced by the Alaska Coastal Current in conjunction with heavy sediment loads that originate from glacial meltwater. The GOA has a relatively wide shelf (up to 54 nm [100 km]) with several banks bisected by submarine canyons. Most regions of the GOA shelf experience high sedimentation rates of clayey silt that results in poorly consolidated sediments; however, in some relatively shallow areas, few sediments accumulate because of scouring by strong bottom currents and frequent winter storm waves. The megahabitats (delineated by water depth) of the GOA include the continental shelf (<660 ft [<200 m]), upper slope (~660 to 9,900 ft [200 to 3,000 m]), submarine canyons (660 to 1,320 ft [200 to 400 m]), and abyssal plain (~9,900 to 16,500 ft [3,000 to 5,000 m]). Over 400 infaunal invertebrate taxa, representing 11 phyla, and approximately 180 epifaunal species, representing 10 phyla, have been described along the continental shelf. Over the entire shelf of the GOA, the mean diversity and species richness was highest on banks and at the shelf break (Feder and Jewett 1986). The more offshore areas of the GOA, the continental slope and abyssal plain, are characterized as having substrata with large grain sizes (e.g., boulders, cobble) that provide macrohabitats to support a diversity of organisms including groundfish and rich epifaunal communities (e.g., coral, sponges, anemones, bryozoans). Since many deepwater areas are characterized by stable environments dominated by long-lived species, the potential impacts of fishing on these areas can be substantial (U.S. Department of Commerce, National Oceanic and Atmospheric Administration [USDC, NOAA] 2005). The following are summaries of each megahabitat.

### Continental Shelf

Much of the continental shelf is covered with sand, mud, silt, bits of broken shell, and other fine materials that are often inhabited by organisms living within the upper layers of the seafloor (infauna) or on the surface of these seafloor substrates (epifauna). The benthic invertebrate fauna of the GOA differs markedly as a function of bottom type. Epifauna live attached to or rove over the sediment surface wherever suitable substrate occurs. For example, sponges, barnacles, anthozoans, soft corals, ascidians, sea whips, sea pens, mussels, and bryozoans are distributed throughout the continental shelf of the GOA, many of which provide important structure to the soft sediment seafloor. Infaunal invertebrates such as polychaetes, clams, nematodes, and amphipods burrow into sand and mud bottoms and stabilize the sediments. These benthic invertebrates serve as prey for mobile epibenthic invertebrates and for demersal fishes. In the GOA, common predatory invertebrates include sea stars (e.g., leather [*Dermasterias imbricate*] and sunflower star [*Pycnopodia helianthoides*]), crabs (e.g., helmet, Dungeness, king, snow, and Tanner crabs), shrimp (*Carangon* and *Pandalus* shrimps), gastropods, and some scavenging invertebrates (AMCC [Alaska Marine Conservation Council] and ASG [Alaska Sea Grant] 2003, Peterson 2005).

The shelf of the GOA is a complex and dynamic geologic environment characterized by banks, patchy rocky substrate, and patchy bottom sediments. Banks are exposed to both wave and current action (particularly during winter storms) that continually resuspend bottom sediments. Bottom material such as sand, gravel, boulders, and broken shells are most characteristic of the banks while finer sediment accumulates in the depressions and the troughs of the region. Sessile suspension feeders are most abundant at the shelf edge with the biomass exceeding 9.9 ounces/ square foot ($ft^2$) (3,000 grams [g]/square meter [$m^2$]) in some regions. Mobile suspension feeders occur mainly in two areas: 1) on the plateau-like surfaces of the shelf in areas with smooth relief and predominance of sand sediments and 2) on the sides of troughs and canyons. Selective deposit-feeders comprise 15 percent of the total biomass of the shelf and are most common between 172 and 521 ft (52 and 158 m) on bottoms covered with fine-grained sand or muddy sediments that are characterized by a smooth relief (Feder and Jewett 1986).

In the TMAA, the benthos of Portlock Bank was surveyed in water depths from about 165 to 2,475 ft (50 to 750 m). The seafloor is generally flat and covered with small boulders, cobble, and gravel. The most common epifauna were crinoids, small nonburrowing sea anemones, glass sponges, stylasterid corals, and brittlestars. The glass sponges and stylasterid corals found attached to the boulders were larger than those observed on the surrounding seafloor (Heifetz et al. 2003).

<u>Sponges</u> - The distribution of sponges (Phylum Porifera) in the GOA is patchy. However, there are four common sponges found in the GOA. The barrel sponge (*Halichondria panicea*) is a large, thick-walled colony. Although highly variable in shape, the barrel sponge can reach a maximum height of 12 inches (in) (30 cm). The cloud sponge (*Aphrocallistes vastus*) is an upright sponge that grows to 12 in (30 cm) in height. The hermit sponge (*Suberites ficus*) is a small sponge (less than 6 in [15 cm] in height) that grows over snail shells. The tree sponge (*Mycale loveni*) forms a hard, tree-like skeleton surrounded by soft sponge and attains a maximum height of 10 in (25 cm) (USDC, NOAA 2005). Sponges provide prime habitat for red king crab (*Paralithodes camtschaticus*), rockfish, and Atka mackerel (*Pleurogrammus monopterygius*) (AMCC and ASG 2003).

<u>Bryozoans</u> - Bryozoans are small colonial animals that are common on hard substrates (i.e., rock, live and dead bivalve and gastropod shells, and crab shells). Roughly two-thirds of the known species in the region are low-profile encrusting forms. In the GOA, the bryozoans, *Flustrella* sp. and *Dendrobeania* spp., have been associated with the largest catches of juvenile red king crab, suggesting that bryozoans provide prime habitat for these crabs (USDC, NOAA 2005).

Hydroids - Hydroids are small, mostly colonial, cnidarians; in the GOA, approximately 200 species have been identified. Most hydroids are erect, tree-like, and grow no taller than 6 in (15 cm); other hydroids encrust on mollusk shells, rock, and other hard surfaces. In the GOA, hydroids are considered to be the main food source of juvenile red king crab (USDC, NOAA 2005).

Ascidians - Ascidians, small sedentary marine invertebrates with a saclike body, include members of the genus *Boltenia* (sea onions), *Styela* (sea potato), and *Halocynthia* (sea peach). In the GOA, sea onions, sea potatoes, anemones, and sponges typically cover the sandy seafloor at depths of 83 to 330 ft (25 to100 m) (AMCC and ASG 2003, USDC, NOAA 2005). Sea onions are stalked, solitary ascidians with a white or pinkish bulb-like body that floats in the water column and is tethered to the bottom by a stalk; the entire animal reaches up to 30 cm or more in length. Two species of sea onions, *Boltenia ovifera* and *B. villosa*, are commonly found in the GOA. Compound ascidians, bryozoans, and hydroids frequently attach to the stems and holdfasts of sea onions. Sea onions and associated attached invertebrates are known to provide habitat to small juvenile red king crab. Sea potatoes are dark brown and have a potato-shaped body that can reach a maximum size of 4 in (10 cm). They grow in clumps that permanently attach to snail, clam, or other invertebrate shells. The sea peach, *Halocynthia aurantium*, is a large (up to 7 in [18 cm]), ascidian that is often found in groups. It has a smooth or wrinkled red-orange outer covering with a barrel-shaped body that attaches directly to the substrate (USDC, NOAA 2005).

Anthozoans - Anthozoans are a large taxonomic group that include sea raspberries (*Gersemia* sp.), a soft coral whose groups of small polyps, when inflated, form thick, soft, red lobes in colonies that can reach a height of 10 in (25 cm). When contracted, the colony has a “brain-like” appearance and is considerably smaller. Two species of sea raspberries that are found in the GOA, *G. rubiformis* and *G. fruticosa*, have the widest temperature and substrate preference range of all Alaskan soft corals (AMCC and ASG 2003). Anthozoans also include sea anemones, sea pens, sea whips, and corals, all of which can form dense concentrations in the GOA (USDC, NOAA 2005).

Sea whips and sea pens - Some of the most distinctive groups of long-lived, habitat-forming organisms are the sea whips and sea pens (order Pennatulacea). Sea whips and sea pens can reach a length of 1.5 m or more and can be found on soft substrates at depths greater than 26 ft (8 m) but are more common at greater depths and have been found in depths as great as 300 ft (91 m) (USDC, NOAA 2005). However, several genera are typically collected most frequently at depths exceeding 3,300 ft (1,000 m) worldwide and are known from 1,650 to 3,300 ft (500 to 1,000 m) in the GOA, e.g. *Anthoptilium* spp. (DoN 2006). In the TMAA, the sea whips, *Protoptilum* sp. and *Halipteris willemoesi*, have been found in densities as high as 10 individuals per $m^2$ and sea pens, such as *Ptilosarcus gurneyi*, have been found in dense aggregations at depths less than 99 ft (30 m) (USDC, NOAA 2005).

Stands of sea whips and sea pens provide vertical relief to otherwise flat habitats and shelter for many organisms including gadids (e.g., pollock), rockfish, crab, and the Pacific ocean perch, *Sebastes alutus* (AMCC and ASG 2003; USDC, NOAA 2005). A clear relationship exists between sea whip and sea pen abundance and the diversity of marine life. For example, worms, bivalves, sea cucumbers, basket stars, shrimps, several species of flatfishes, small octopuses, and squids are often found in sea whip and sea pen habitats (AMCC and ASG 2003).

Coral communities - Etnoyer and Morgan (2003, 2005) synthesized data on the occurrence of habitat-forming deep-sea corals in the Northeast Pacific Ocean. Deep-sea corals are typically found from the edge of the continental shelf to the continental rise, on banks, and on seamounts (Freiwald et al. 2004). While the mean depth range of deep-sea corals in the Northeast Pacific Ocean is 875 to 4,165 ft (265 to 1,262 m), deep-sea corals are known to occur in the GOA from the shoreline to the upper slope (3.3 to 2,789 ft [1 to 845 m]) water depth range; Heifetz 2002, Marine Conservation Biology Institute [MCBI] 2003, Etnoyer and Morgan 2005).

True deep-sea coral communities live in complete darkness, in temperatures as low as 39 degrees Fahrenheit (°F) (4 degrees Celsius [°C]) and in waters as deep as 19,800 ft (6,000 m); therefore, they are also known as "cold-water coral reefs" (Freiwald et al. 2004). Deep-sea corals lack the symbiotic zooxanthellae found in tropical reef-building corals. Thus, deep-sea corals do not benefit from a carbon supply provided by symbiotic algae but rather survive solely on suspension feeding. The biological diversity of deep-sea corals communities is high; from an economic perspective, this diversity creates valuable habitat for several commercially fished species (Witherell et al. 2000, Gass 2003).

Deep-sea coral communities usually consist of sessile stony corals (Order Scleractinia), soft corals (Sub Class Octocorallia), black corals (Order Antipatharia), and lace corals (Order Stylasterina) (Freiwald et al. 2004, Hain and Corcoran 2004, Roberts and Hirshfield 2004). These corals can build very large 3D structures in deep-sea environments that are comparable in size and complexity with coral reefs that occur in shallow tropical waters. Deep-sea coral assemblages provide habitat to thousands of species including sponges, polychaetes (or bristle worms), crustaceans (crabs and lobsters), mollusks (clams, snails, octopuses), echinoderms (starfish, sea urchins, brittle stars, feather stars), bryozoans (sea moss), and fish (Freiwald et al. 2004). Yet, much like shallow-water corals, deep-sea corals are fragile and slow growing: thus, they are vulnerable to human-induced physical impacts (Andrews et al. 2002, Roberts and Hirshfield 2003, Freiwald et al. 2004, Roberts and Hirshfield 2004).

The overall size of deep-sea coral communities can range from patches of small solitary corals to massive reef structures (mounds, banks, and forests) several meters to tens of kilometers across and a meter to tens of meters high (Tucker and Wright 1990, Cairns 1994). The red tree coral, *Primnoa pacifica*, found in the GOA (33 to 2,640 ft [10 to 800 m] water depth), can reach 9.9 ft (3 m) in height and 23.1 ft (7 m) in width and achieve over 100 years of age (Heifetz 2000, Andrews et al. 2002, Heifetz 2002, Cairns and Bayer 2005). Bamboo corals (Family Isididae), found at 2,310 ft (700 m) water depth in the GOA, Warwick Seamount (48°3' north [N], 132°44'W), were 75 to 208 years old and their growth rates ranged from 0.05 to 0.16 millimeters (mm)/year (yr) (Roark et al. 2005).

Trawls and heavy fishing gear used by commercial fishing have caused severe damage to deep-sea coral communities in many areas of the world including the GOA (Freese et al. 1999, Roberts and Hirshfield 2004). Deep-sea coral communities are also susceptible to physical impacts caused by oil- and gas-related activities, cable laying, seabed aggregate extraction, shipping activities, the disposal of waste in deep waters, coral exploitation, mineral exploration, and increased atmospheric carbon dioxide ($CO_2$) (Gass 2003, Freiwald et al. 2004, Roberts and Hirshfield 2004). It may take decades to centuries for physically damaged deep-sea coral communities to recover (Freiwald et al. 2004, Roberts and Hirshfield 2004). The recovery of the deep-sea corals is particularly slow not only because of slow growth rates but also because larvae production is positively related to the size of the parent coral colony. Further, some damaged colonies will first devote energy to making repairs before sexual reproduction takes place (Andrews et al. 2002).

Corals in Alaskan waters are found in the GOA, the Aleutian Islands, and the Bering Sea (Heifetz 2002, MCBI 2003). The known distribution of deep-sea corals is contained to water depths that are shallower than 2,970 ft (900 m); however, given the general distribution of deep-sea corals in the Northeast Pacific Ocean it is likely that deep-sea corals occur at greater depths and over a broader geographical extent. In the GOA, the distribution of corals may extend beyond the 2,970 ft (900 m) isobath (Freiwald et al. 2004, Hoff and Stevens 2005). In a recent survey of seamounts in the Kodiak-Bowie Seamount Chain (Kodiak Seamounts), diverse deep-sea coral communities (including new coral species; tentatively belonging to the Primonidae, Isididae, and Antipathidae coral families) and associated invertebrates and fishes were documented in the deep-sea coral distribution database; however, these recent discoveries have yet to be reported in the peer-reviewed literature (Tsao and Morgan 2005).

There are a total of 105 known coral species in Alaskan waters including soft corals, gorgonians, sea pens, sea whips, cup corals, black corals, and hydrocorals (Wing and Barnard 2004). The locations of 14 coral taxa mapped in the GOA include antipatharians (Family Antipathidae), gorgonians (Families Corallidae, Isididae, Paragorgidae, Primnoidae), and hydrozoans (Family Stylasteriidae; Heifetz 2002, MCBI 2003; Figure 3.5-4). Yet the most common coral taxa encountered in the GOA are cup corals (unidentified scleractinians; 31 percent of coral records) and gorgonians (mostly *Callogorgia* and *Primonoa*; ~45 percent of coral records; Heifetz 2002). For comparison, there are 43 coral taxa known for the Aleutian Islands and 8 coral taxa for the Bering Sea. The cup corals found in the GOA are probably of the genera *Balanophyllia* (occurring in waters depth ranging from 0 to 40 ft [12 m]) and *Caryophyllia* (40 to 13,200 ft [12 to 4,000 m]; USDC, NOAA 2005). Black corals (antipatharians) are found throughout the GOA in water depths ranging from 1,320 to 3,300 ft (400 to 1,000 m) (USDC, NOAA 2005). Gorgonians are the most abundant coral taxa in the Aleutian Islands, and soft corals are the most abundant in the Bering Sea (Heifetz 2002). Gorgonians and cup corals occur throughout the Aleutian Islands but have a patchy distribution in the GOA, including substantial patches located off the Kenai Peninsula. Hydrocorals (Order Stylasterina) and soft corals (Order Alcyonacea) are found in a few small patches in the GOA (Heifetz 2002).

Because of their abundance, size, and longevity, red tree corals form essential habitat for fishes and invertebrates. Krieger and Wing (2002) observed colonies of *Primnoa* spp. in the southeast GOA (531 to 1,205 ft [161 to 365 m] water depth) that were used as habitat by rockfish (e.g., rougheye [*Sebastes aleutianus*], redbanded [*S. babcocki*], shortraker [*S. borealis*], sharpchin [*S. zacentrus*], dusky [*S. ciliatus*], and yelloweye [*S. ruberrimus*]), sea stars (e.g., *Hippasteria heathi*), nudibranchs (e.g., *Tritonia exulans*), crinoids (e.g., *Florometra* sp.), basket stars (e.g., *Gorgonocepahlaus eucnemis*), golden king crab (*Lithodes aquaspina*), shrimps, snails, anemones (e.g., *Cribinopsis* spp., *Stomphia* spp., and *Tealia* spp.), and sponges. Seastars, nudibranchs, and snails found on the *Primnoa* colonies were feeding upon and damaging coral polyps. Crinoids, basket stars, anemones, and sponges used *Primnoa* as a substrate for attachment in an effort to filter feed while suspended off the surrounding seafloor. Rockfish, shrimp, and crabs sought refuge within the branches of the *Primnoa* colonies (Krieger and Wing 2002). In the GOA, *Primnoa* colonies have been harvested for jewelry (200 kilograms [kg]/yr) from 1997 to 2001 (Krieger and Wing 2002). Deep-sea corals, including colonies of *Primnoa*, were accidentally but indiscriminately destroyed by commercial bottom trawling (Krieger and Wing 2002, Etnoyer and Morgan 2005). Increased use and geographic expansion of bottom-impacting fishing gear are likely to negatively impact deep-sea coral habitats and associated species. The regulation of fisheries by regional fishery management councils can protect deep-sea coral ecosystems that are currently impacted and prevent the destruction of unexploited areas by using science-based information (surveys and mapping) to implement an ecosystem-based approach (Freese et al. 1999, Witherell et al. 2000, Andrews et al. 2002, Frame and Gillelan 2005).

Corals in the TMAA are known in water depths ranging from 3 to 2,789 ft (1 to 845 m) (MCBI 2003; Figure 3.5-4). As noted earlier they occur in deeper water and over a broader expanse potentially including Dall Seamount found within the TMAA. Known corals in the TMAA include antipatharians (Family Antipathidae), gorgonians (Families Corallidae, Isididae, Paragorgidae, and Primnoidae), and hydrozoans (Family Sytlasteriidae; MCBI 2003). However, this area has not been fully sampled and deep-sea corals are likely to occur in deeper water and over a broader expanse within the TMAA (MCBI 2003).

#### Continental Slope

In addition to substrate, the species composition of the benthos in the GOA changes significantly with water depth. The bottom substrate of the continental slope is typically covered with silts, clays, and fine sediments; however, there is the occasional hardbottom substratum (e.g., rocky outcroppings, rubble, talus, vertical wall, and seamounts) that supports a diverse assemblage of deep-sea invertebrates and fishes.

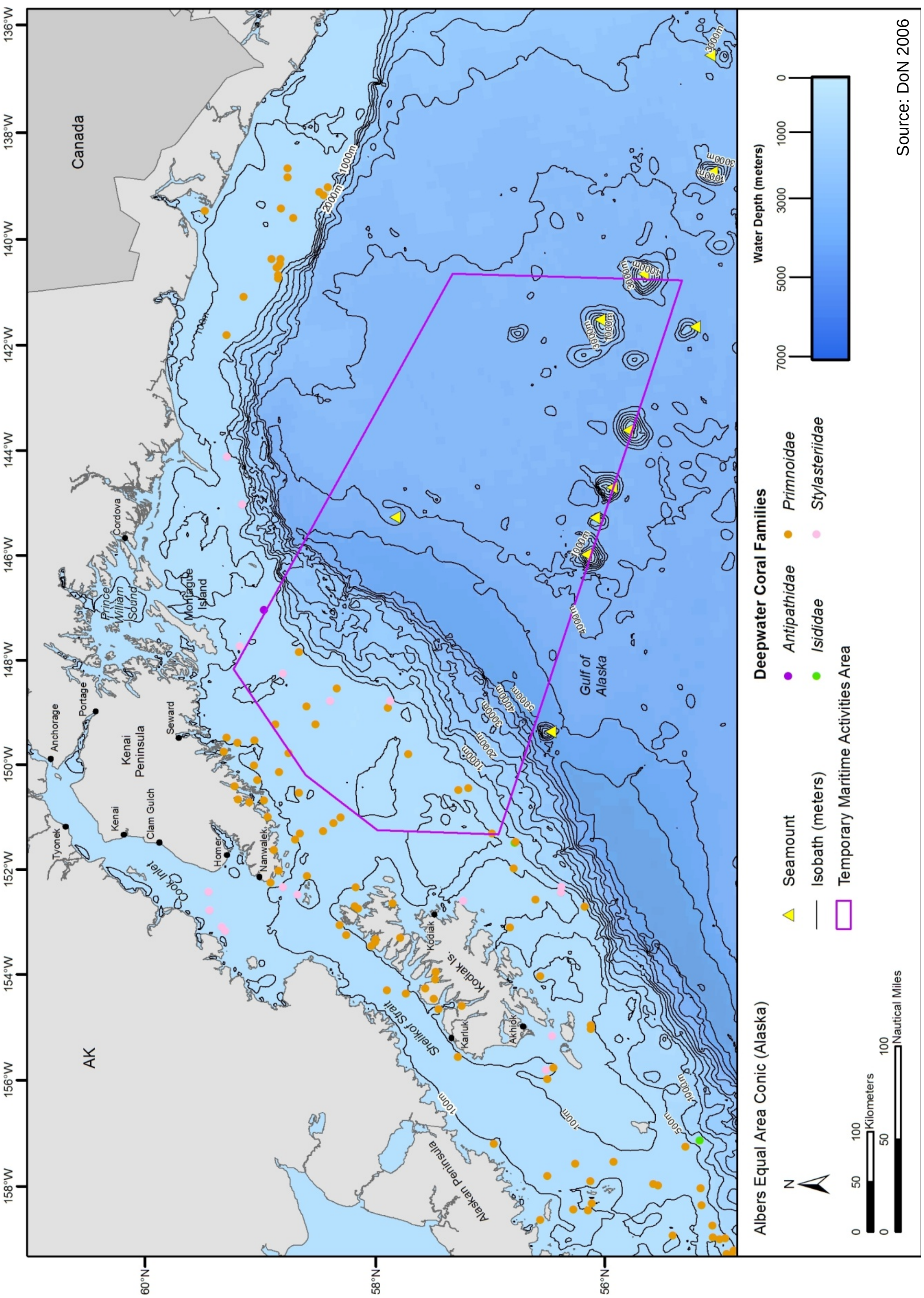


**Figure 3.5-4: Coral Communities (hydrozoans & anthozoans) of the TMAA & Surrounding Vicinity**

Bottom substrate type governs the abundance and diversity of deep-sea organisms. Abundance and diversity are generally higher on hard, irregular substrates than on smooth, hard surfaces (Lissner 1988). Although there have been many descriptive studies detailing the community assemblages on the continental shelf, habitats on the continental slope and deeper are challenging to study because they usually lie beyond the range of self-contained underwater breathing apparatus (SCUBA) and mechanical sampling is difficult (Airamé et al. 2003). Therefore, the outer continental shelf and the continental slope are not well studied in the GOA system. There has been some description of the mobile epibenthic communities and the demersal fish communities (Feder and Jewett 1986); however, most sampling of the continental slope habitats involves trawling and focuses on the commercial fisheries of crabs, shrimps, and demersal fishes. The continental shelf represents key fishing areas in the GOA and has correspondingly high value to humans. Because trawling can dramatically modify and damage the community structure of benthic biogenic habitats such as sponges and soft corals from equipment dragging along the sea floor, this human fishing activity is an object of concern (Peterson 2005).

#### *Submarine Canyon Communities*

The GOA continental shelf and slope is highly dissected by numerous submarine canyons. Submarine canyons contain various habitats, including vertical cliffs, ledges, talus, cobble and boulder fields, and soft mud. Generally, rocky substrate lines steep canyon walls, whereas the bottom of the canyon is formed of a gently sloping bottom that accumulates sediments to form the soft substrate (e.g., silt and mud). The organisms that live in submarine canyon habitats must be able to withstand extreme conditions—depths in excess of 1,650 ft (500 m), little or no light, cold water temperature, and tremendous pressure (up to 318 atmospheres; Airamé et al. 2003).

Some of the production associated with submarine canyons is introduced via adjacent habitats. Drift macroalgae and other organic matter produced in shallow or surface waters may settle and accumulate at the mouth and along the slopes of submarine canyons. This detritus may be washed down into the canyon during storms, contributing to productivity in the deep sea. In addition, the soft substrate at the base of the canyons supports a diverse invertebrate community. The complex structure of rocky substrate in submarine canyons provides cover for numerous fish species (e.g., groundfish) and can help to protect these species from overfishing because they tend to be difficult to locate and target. However, submarine canyons are vulnerable to human activities; they extend across a range of depths and may be heavily influenced by the deposition of sediments and pollutants that is associated with coastal development (Airamé et al. 2003).

#### *Abyssal Plain*

In the GOA, the abyssal plain extends from the bordering continental rises to the south and the mid-oceanic ridge to the west; it is a relatively flat expanse of sea floor that is 9,900 to 16,500 ft (3,000 to 5,000 m) below sea level. Abyssal plains are covered with fine particles that constantly rain down from the overlying water column. These particles, fine, clay-sized sediments and the remains of marine life, drift slowly downward filling in depressions on the irregular rocky ocean floor. They have accumulated to make up the 16,500 ft (5,000 m) thick sediment bed that constitutes the largest portion of the ocean basin (Airamé et al. 2003). Because of this thick layer of sediment, abyssal plains are among the smoothest surfaces on the planet, with less than 5 ft (1.5 m) of vertical variation for every mile. In a few places, extinct volcanoes or seamounts disrupt the monotony of the abyssal plain (Wilson 1976; Beaulieu 2001a, 2001b; Cunha and Wilson 2003; O'Dor 2003). The abyssal plain is regarded as the true ocean floor and is characterized by extremely cold water, no light, and extremely diverse marine inhabitants (e.g., deep sea isopods, polychaetes, worms, sponges, crustaceans, and sea stars) that are adapted to near freezing temperatures and immense pressure (Smith 1991). The deep sea is one of the largest and least explored ecosystems on Earth and is a major reservoir of biodiversity and evolutionary novelty.

Significant physical, chemical, and biological interactions occur between the upper ocean and the deep benthos on time scales of days to millennia (Airamé et al. 2003). Benthic communities that live within, upon, or associated with the ocean bottom rely upon the input of detritus (e.g., marine snow) from the surface waters; this sinking detritus provides the primary source of nutrients for bathypelagic and deep-sea communities. On average, less than 3 percent of primary production sinks through the water column to the deep sea; however, in the northeastern Pacific Ocean, where production is particularly high, approximately 5 to 15 percent of the surface production eventually reaches the deep sea. Deep benthic fauna living on or in the benthos grow more slowly, live longer, have smaller broods than animals living in shallow waters, and although consumption is slow, once organic matter reaches the sea floor, it is almost entirely consumed; a very small portion of the organic matter may dissolve or become buried in sediments (Grassle 1991).

In spite of these extreme conditions, the deep sea supports a remarkable diversity of organisms (Airamé et al. 2003). Due to the unpredictable and patchy supply of food, organisms in the deep sea use a variety of foraging strategies. Many deep-sea animals are "sit-and-wait" predators, while others are active scavengers that break down carcasses on the sea floor, attracting slower-moving animals, such as mollusks, sea stars, brittlestars (ophiuroids), and sea cucumbers. In many areas of the deep sea, ophiuroids are the dominant megafauna; they are often found around sea pen (Pennatulacea) beds and are so abundant that their feeding behavior and high activity levels can alter the ecology of benthic softbottom communities.

### *Seamounts*

Seamounts are isolated mountains rising from 2,970 to 9,900 ft (900 to 3,000 m) above the surrounding bottom. Seamounts are found in all oceans but are more numerous in the Pacific Ocean, with over 2,000 having been identified (Thompson et al. 1993). Very little research has been conducted on seamounts; they are among the least understood habitats in the ocean basins (Rogers 1994). Seamounts provide a unique habitat for both deep-sea and shallow-water organisms due to the large ranges of depth, hard substrate, steep vertical gradients, cryptic topography, variable currents, clear oceanic waters, and geographic isolation that characterize seamount habitats (Rogers 1994). Thus, seamounts are capable of supporting a wide range of organisms (Wilson and Kaufmann 1987). The most common invertebrates found on seamounts worldwide are cnidarians and the most common fishes are scorpaenids and morids (Wilson and Kaufmann 1987). The abundant and diverse benthic fauna consists of a wide array of sponges (including large brilliant-yellow barrel sponges that have been known to support intrinsic communities), coral (including large gorgonians and huge golden coral sea fans), brittlestars, crinoids, clams, seastars, polychaetes, crabs, tunicates, sea urchins, sea cucumbers, and octopi (Rogers 1994). Seamounts attract various predators, including fishes and marine mammals as a result of this relatively high biomass.

A total of 597 invertebrate species have been recorded from seamounts in studies that have been conducted worldwide (Wilson and Kaufmann 1987). A rich and diverse benthic fauna with a high degree of endemism exists on seamounts. In one study, levels of endemism among 850 macro- and megafaunal species (including fish) were as high as 29 to 34 percent (Richer de Forges et al. 2000). Thus, seamounts can function ecologically as island groups or chains, leading to localized species distributions with apparent speciation. Dispersal of organisms from the seamounts is likely an active and a passive process; seamounts appear to provide "stepping stones" for transoceanic dispersal of animals in both the Atlantic and Pacific Oceans (Richer de Forges et al. 2000; Johnston and Santillo 2004). Few studies have investigated the interaction between seamount-inhabiting organisms and the surrounding abyssal plain, nearshore area, and other seamount habitats.

Seamount communities are extremely vulnerable to the impacts of fishing. Some seamount fish and benthos are already known to have been seriously impacted by fishing activities (Johnston and Santillo

2004); their recovery is complicated by the limited fixed habitat, the extreme longevity of many species (on the order of 100 years and more), and the slow or limited recruitment between seamounts (Richer de Forges et al. 2000). The global status of seamount benthic communities is unknown; however, the limited distribution of seamount biota greatly increases the threat of extinction. The conservation and protection of seamount communities is necessary and requires action to be taken on a local scale (O'Dor 2003).

There are several seamounts located in the TMAA (Figure 3.5-5). The coral and rocky relief that are associated with the Dall seamount are known to provide shelter for adult and juvenile rockfish, greenlings, and ling cod and attachment substrates for hydrocorals and red tree corals. With further explorations some undiscovered pinnacles and seamounts will undoubtedly be identified; this exploration will help to unveil their ecological value to the surrounding ocean habitats. For example, deep-sea explorers of seamounts in the GOA have discovered that lingcod spawn in very deep water at the base of pinnacles and seamounts and giant spider crabs have been discovered that span over 7 feet across. Some pinnacles, such as the Albatross Pinnacle south of Kodiak Island, come close to the surface and provide a substrate for kelp that in turn provide essential rearing habitat for juvenile fish. These pinnacles are known to be covered with sponges, anemones, hydroids, tunicates, barnacles, crabs, worms, snails, chitons, and other invertebrates and algae (AMCC and ASG 2003).

#### *Chemosynthetic Ecosystem*

In a normal marine ecosystem, the primary producers (e.g., phytoplankton and seagrasses) produce energy through photosynthesis (a photosynthetic ecosystem). In methane- and sulfide-rich environments, chemolithoautotrophic bacteria (i.e., sulfur-oxidizing bacteria, methane-oxidizing bacteria, and sulfide-reducing bacteria) create the energy that can be used by the organisms in the environment (a chemosynthetic ecosystem; Hessler and Lonsdale 1991, Hashimoto et al. 1995, Galkin 1997). Some of the benthic fauna associated with chemosynthetic ecosystems contain symbiotic chemosynthetic bacteria inside their bodies to obtain essential nutrients (Nybakken 2001). Chemosynthetic communities are a significant source of biological productivity on the deep-sea floor. In some locations, vast fields of hydrothermal vents can support benthic communities (Fisher et al. 2000, Lanoil et al. 2001, Reed et al. 2002). In other locations, gas hydrates in the sediments support extensive chemosynthetic communities (Fujikura et al. 2002).

Chemosynthetic habitats are formed by a variety of geological and biological processes on continental margins, and despite their location in the deep sea, have high biomasses maintained by chemosynthetic bacterial production (Hessler and Lonsdale 1991, Hashimoto et al. 1995, Galkin 1997, Smith et al. 2003) Cold seeps, natural whale falls, hydrothermal vents, and wood falls provide specific habitat duration and each of these chemosynthetic habitats appears to foster a characteristic fauna (Fujikura et al. 2002, Smith et al. 2003). In general, chemosynthetic communities in the GOA are characterized by tubeworms, giant white clams, mussels, gastropods, and sponges (Anderson et al. 1993).

#### *Cold Seeps*

A cold seep (sometimes referred to as a cold vent) is a region of the seafloor that releases hydrogen sulfide, methane, and other hydrocarbon-rich fluids (Hashimoto et al. 1989, Kvenvolden 1993). Cold seep communities depend upon chemolithoautotrophic production associated with the emission of reducing chemicals from “cold” hypersaline brines or other hydrocarbon seeps such as methane hydrates (Airamé et al. 2003).

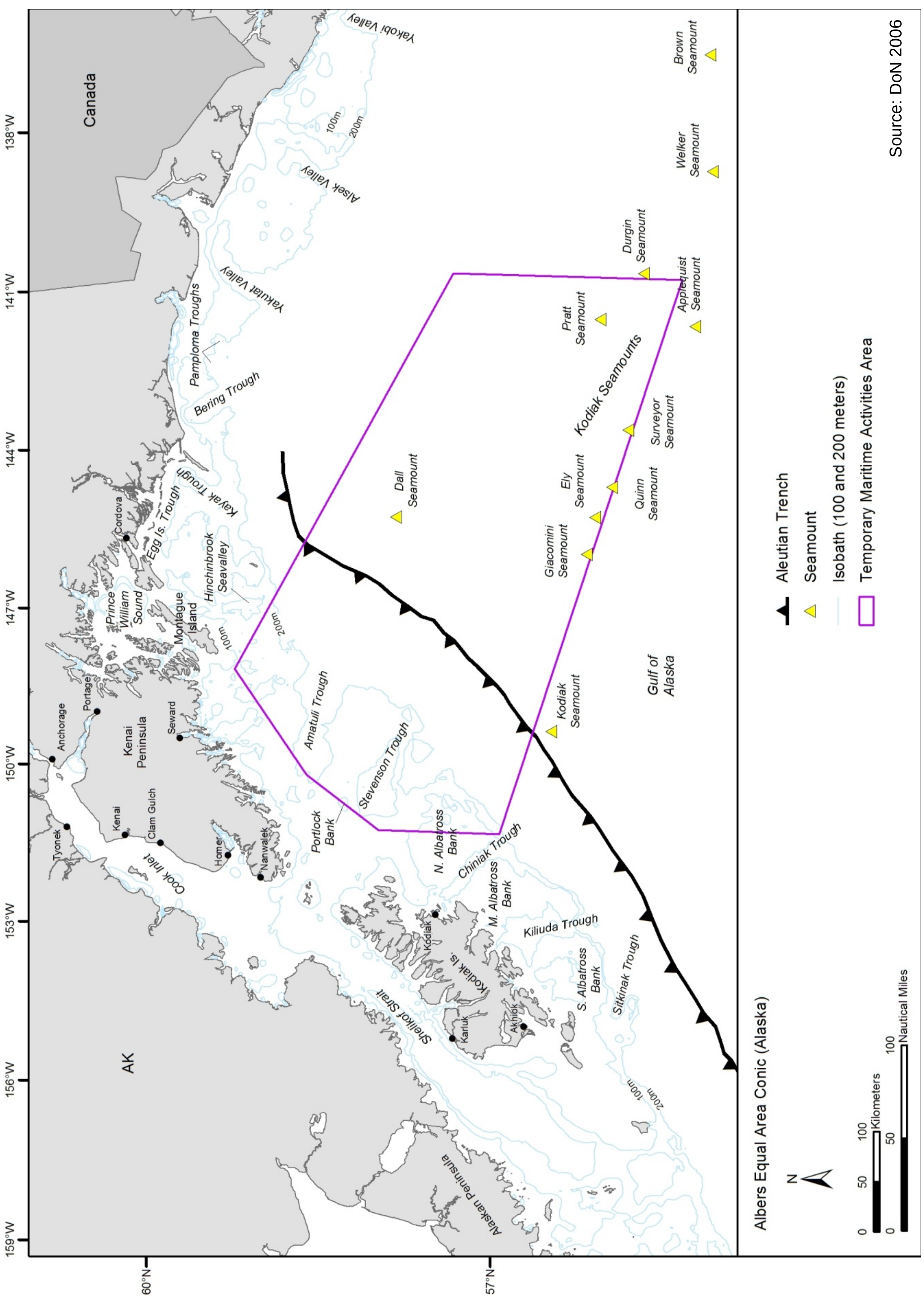


**Figure 3.5-5: Major Geological Features of the TMAA and Surrounding Vicinity**

Chemolithoautotrophic bacteria oxidize the reduced chemicals to form organic matter from carbon dioxide. Typically, cold seeps originate from relatively young sediments and are common along basin margins (Kvenvolden 1993). However, in recent years many seep communities have been reported in tectonically passive margins, active regions of plate collision, and along marginal basins (Schmidt 2004).

Cold seeps have formed along much of the GOA where the water is cold and the pressure is sufficient to support formation; although they are not known to occur in the TMAA, in the GOA region, two seep microhabitats were observed at 14,563 to 14,662 ft (4,413 to 4,443 m). These seep areas were populated by dense aggregations of *Calyptogena phaseoliformis* (clams), *Siboglinidae* (pogonophorans), and galatheid crabs (Levin and Michener 2002).

#### *Whale Falls*

Whale carcasses on the seafloor support a high abundance of organisms commonly found near seeps, vents, and other deep-sea hard substrates (Smith and Baco 2003). It has been estimated that at any given time there may be in excess of 500,000 sulfide-rich whale skeletons on the deep-sea floor (Smith et al. 2003). Whale falls promote high species diversity by providing hard substrates for settling, organic enrichment, and free sulfides on a typically organic-poor, sediment-covered sea floor (Smith et al. 2003); these whale falls can support productive communities of chemosynthetic organisms for decades. The falls of large whales yield massive pulses of organic matter to the deep-sea floor (Smith et al. 2003). The chemosynthetic communities associated with whale falls are probably the least known of the chemosynthetic ecosystems. Studies of whale falls have revealed that chemolithoautotrophic bacteria reside in, on, and around whale falls (Smith and Baco 2003). Sulfide diffuses out of the bone and provides the energy source for the chemolithoautotrophic bacteria (Bennett et al. 1994, Butman et al. 1995, Smith and Baco 2003).

Although whales have been much reduced throughout the world's oceans, Smith (1992) estimates that such sulfide-rich whale falls may have an average spacing of one per 14 nm (25 km) in the North Pacific and may give credence to the hypothesis that such falls may be the stepping stones that permit the sulfide-based communities to disperse over vast distances between the vent systems.

#### *Artificial Habitat*

Artificial habitats (shipwrecks, artificial reefs, jetties, pontoons, docks, and other man-made structures) are physical alterations to the naturally occurring marine environment. In addition to artificial structures intentionally or accidentally placed on the seafloor, fish aggregating devices are suspended in the water column and anchored on the seafloor to attract fish (Fager 1971, Bohnsack et al. 1991). Artificial structures provide a substrate upon which a marine community can develop (Ritter et al. 1999). Navigational, meteorological, and oceanographic buoys suspended in the water column potentially function like artificial habitats.

When solid, hard objects with numerous and varied surfaces are introduced to the seafloor, artificial substrates are provided for the settlement and colonization of epibenthic organisms (e.g., algae, sponges, barnacles, mussels, amphipods, soft corals, sea anemones, and hydroids; Ambrose and Swarbrick 1989, DeMartini et al. 1994). The initial colonization of artificial habitats works to build communities that increase marine production by providing an attachment substrate and a biotope suitable for larger motile organisms (e.g., starfish, lobster, crabs, fishes; Ritter et al. 1999).

Artificial habitat sites are often important nearshore locations for human activities including commerce, navigation, aquaculture, and recreation (Baine 2001). Fishermen often target these artificial habitats as they tend to provide food, shelter, and nurseries for a variety of demersal and pelagic fishes (including sport fishes) and many invertebrates (Seaman and Jensen 2000). Under optimal conditions, artificial habitats benefit benthic communities and offshore/onshore economies. The benefits experienced by marine biological communities increase with time (Ambrose and Swarbrick 1989, DeMartini et al. 1994). There are a significant number of artificial habitats available for the marine communities in the GOA including shipwrecks, buoys, and moorings (Figure 3.5-6); however, in the TMAA, moorings and buoys are the only artificial habitats.

#### *Buoys and Moorings*

A buoy is a floating platform used for navigational purposes or for supporting scientific instruments that measure environmental conditions. Moorings are floating blocks used for scientific study of a particular area; instruments are usually fastened along the line, which is fixed firmly to the seafloor. Both buoys and moorings can act as a substrate for attachment and aggregation locations for pelagic fish. Currently, two buoys and twelve moorings are located in the TMAA, none of which are owned by the Navy (DoN 2006, Figure 3.5-6).

## Federally Protected Areas

### Marine Protected Areas

Marine Protected Area (MPA) is a general term for natural and cultural marine resources that are protected by federal, state, tribal, or local governments. There are many different kinds of MPAs, including national parks, wildlife refuges, monuments and marine sanctuaries, critical habitat for species of concern, state parks, and estuarine reserves. MPAs complement other management measures such as fishery regulations and pollution controls. Each of these areas is afforded varying degrees of protection under law.

Marine Management Areas (MMAs) are similar to MPAs, but encompass a wider range of management intents, including geological, cultural, or recreational resources, plus security zones, shellfish closures, sewage discharge areas, and pipeline and cable corridors. The primary difference between MPAs and MMAs is the duration of the site. MMAs must provide yearly protection for at least 3 months out of each year, and must provide a minimum of 2 years of protection. MPAs must be designated with the intention to become permanent. Seven sites are located within the TMAA and vicinity. Examples include the Alaska Maritime National Wildlife Refuge, Steller Sea Lion Protection Areas, Kachemak Bay Research Reserve, Katmai National Park and Preserve, and the Kodiak Island Wildlife Refuge (DoN 2006).

### National Marine Sanctuaries

The National Marine Sanctuary (NMS) system is administered by National Oceanic and Atmospheric Administration (NOAA) and protects special natural and cultural resources. There are 14 sites in the NMS program, creating a system that protects over 113,123 square nm (nm$^2$) (388,000 square km [km$^2$]) of U.S. ocean waters and habitats. Each NMS has an established management plan that guides the activities and sanctuary programs, sets priorities, and contains relevant regulations. There are no NMSs located within the boundaries of the TMAA.

### Protected Habitats

Protected areas (Conservation Areas) throughout the GOA restrict groundfish harvest to minimize harmful impacts of fishing methodology and equipment to ocean bottom habitat (Figure 3.5-7). A widespread Atka mackerel closure established in 2002 under Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) extends from the coastline to the EEZ boundary (200 nm) throughout the GOA (DoN 2006). Fishing restrictions also reduce food resource competition by increasing Steller sea lion prey abundance (NMFS 1997). Protected areas are located around Steller sea lion haulout and rookery sites with coverage varying from 3 to 20 nm (5.6 to 37 km). Access, harvest, and fishing restrictions are modified for all 79 sites. Restriction enforcement and fishery management are controlled by NOAA, North Pacific Fishery Management Council (NPFMC), and United States Coast Guard (USCG).

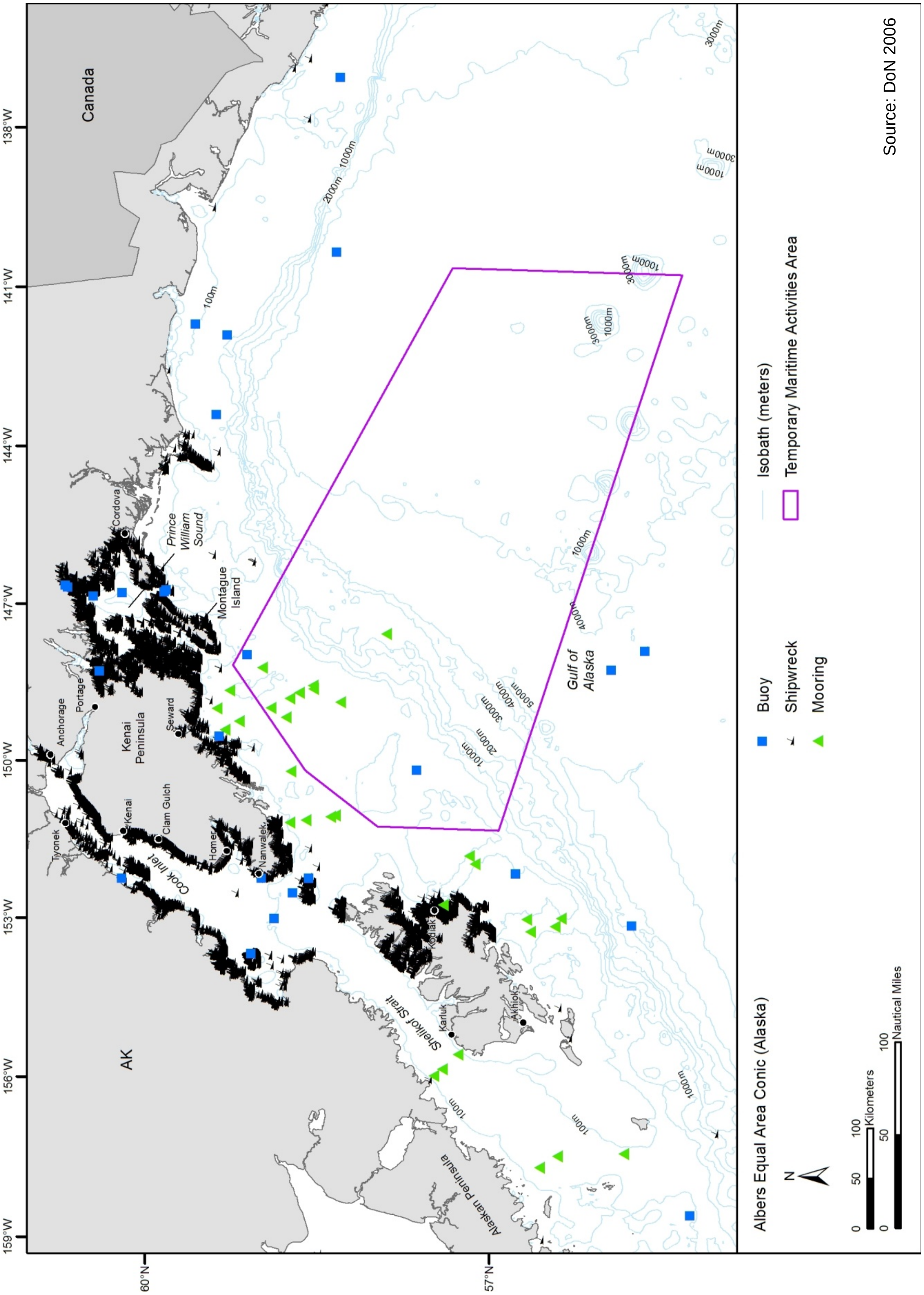


**Figure 3.5-6: Artificial Habitat (e.g., buoys & moorings) within the TMAA & Surrounding Vicinity**

Several habitat types identified as HAPCs (Habitat Areas of Particular Concern) focus on specific habitat locations, such as seamounts and hard coral areas (NPFMC 2005). Amendments to the Fishery Management Plan (FMP) for salmon fisheries in the EEZ off the coast of Alaska, the FMP for the scallop fishery off Alaska, and the FMP for groundfish of the GOA have established the following Habitat Conservation Areas and Habitat Protection Areas in the GOA: ten Gulf of Alaska Slope Habitat Conservation Areas (GOASHCAs), 15 Alaska Seamount Habitat Protection Areas (ASHPAs), and five Gulf of Alaska Coral Habitat Protection Areas (NMFS 2006). Within the TMAA, one GOASHCA (Cable) and three ASHPAs (Dall, Giacomini, and Quinn Seamounts) occur almost entirely within the TMAA (Figure 3.5-7). Other areas, such as the Kodiak Seamount and Middleton West GOASHCA, are partially located in the TMAA.

#### 3.5.1.2 Current Requirements and Practices

The Navy has no existing protective measures in place specifically for marine plants and invertebrates. However, marine plants and invertebrates benefit from measures in place to protect marine mammals, sea turtles, and Essential Fish Habitat. For a complete description of these measures, see Chapter 5.

### 3.5.2 Environmental Consequences

As noted in Section 3.5.1, the ROI for consideration of impacts on marine plants and invertebrates is the GOA TMAA. Aircraft overflight and training activities are assumed to have no impacts to marine communities because impacts of sound on plants and invertebrates are unknown and difficult to quantify.

#### 3.5.2.1 Regulatory Framework

**Federal**

Impacts to wetlands, estuarine mud flats, and marine vegetated shallows are regulated under Section 404 of the Clean Water Act (CWA; 33 U.S.C. 1251, et seq.) and Executive Order (EO) 11990, *Protection of Wetlands*. Dredge and fill activities are permitted by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA). Other provisions of the CWA are intended to address water quality, such as excess nutrient that can affect the health of estuarine habitat like seagrass beds. The EO directs federal agencies to minimize wetland loss and degradation resulting from federal projects and land management activities.

Executive Order 13158 “Marine Protected Areas” was authorized in May 2000 to protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the nation's system of MPAs. The purpose of the order was to, consistent with domestic and international law: (a) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs; (b) develop a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources; and (c) avoid causing harm to MPAs through federally conducted, approved, or funded activities.

The United States claims jurisdiction over marine areas extending 200 nautical miles from its coast and has regulated resources in the zones composing this area under multiple legal authorities including federal, state, territorial, tribal, or local entities. Several current laws which might provide authority for the creation of MPAs are aimed specifically at the ocean environment; the National Marine Sanctuary Program, established by the Marine Protection, Research and Sanctuaries Act, the Magnuson-Stevens Fishery Conservation and Management Act, and the Coastal Zone Management Act each specifically contemplate various levels and forms of aquatic resource protection.

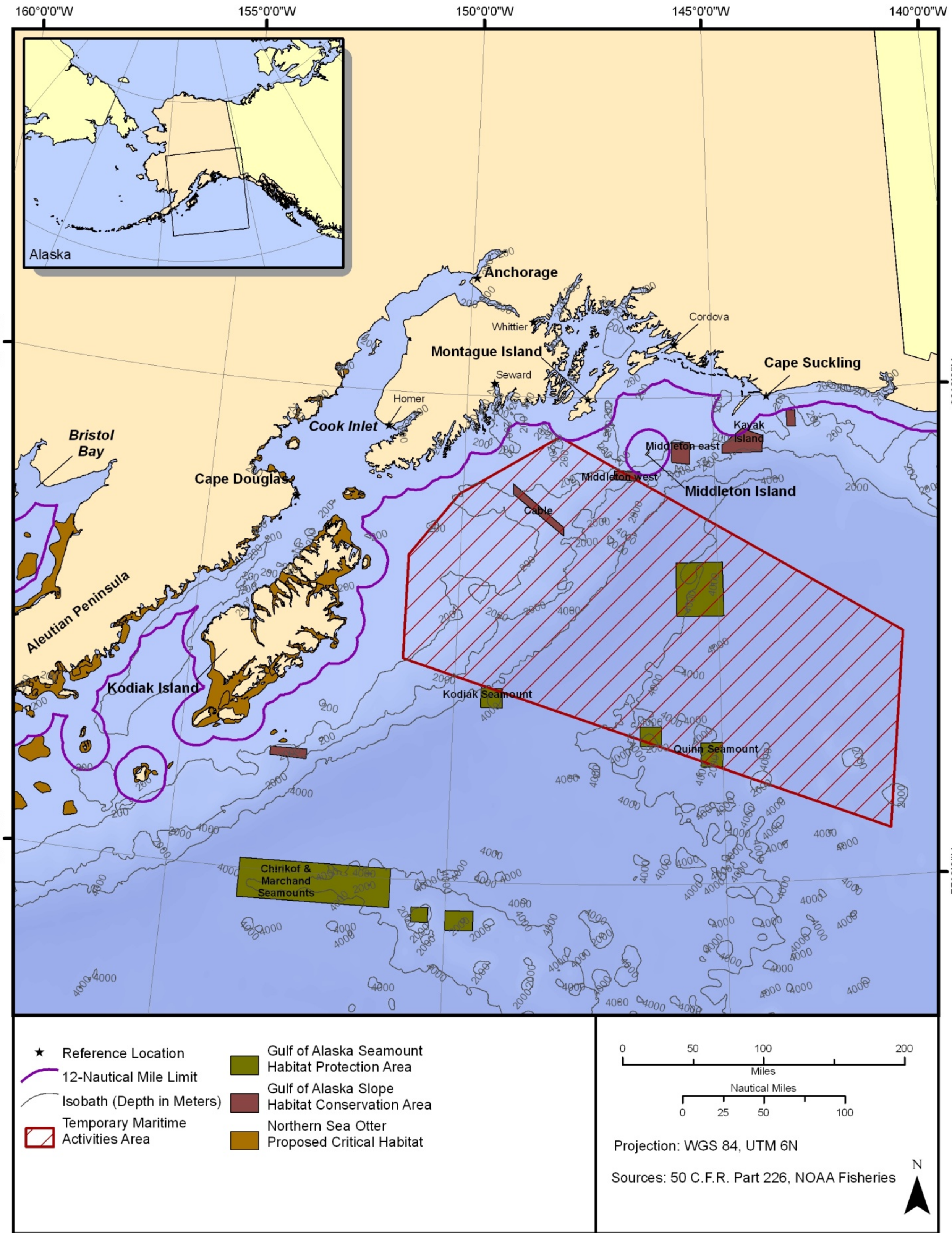


**Figure 3.5-7: Conservation Areas in Vicinity of the TMAA**

The federal Coastal Zone Management Act (CZMA; 16 U.S.C. 1451, et seq.) is a voluntary federal-state partnership that encourages states to adopt programs that meet federal goals of protecting and restoring coastal zone resources, including protecting coastal waters from nonpoint source pollution (16 U.S.C. 1455[b]). The program is administered by NOAA. The act requires participating coastal states to develop management programs that demonstrate how states will carry out their obligations and responsibilities in managing their coastal areas.

Upon federal approval of a state's coastal zone management program, the state benefits by becoming eligible for federal coastal zone grants and by gaining review authority over certain federal activities in the coastal zone and the consistency of those activities with the coastal zone management plan. CZMA specifically excludes federal lands from state designation. However, federal consistency requirements in the act (Section 307) require that federal activities be consistent with the management program to the "maximum extent practicable."

#### State and Local Governments

Alaska has several protected areas, such as state parks and significant biological areas, along its coast. However, ocean training activities under the Proposed Action would occur at least 20 nm (37 km) offshore. Therefore, the materials expended during training, and the explosions and impacts anticipated, will not affect these areas. More details regarding state programs related to CZMA may be found in Section 3.3, Water Resources.

### 3.5.2.2 Approach to Analysis

#### Data Sources

A systematic review of relevant literature and data was conducted to complete this analysis for marine plants and invertebrates in the GOA. Sources included journals, books, Internet sites, natural resource management plans, previous NEPA documents for facilities and activities in the GOA, Department of Defense (DoD) operations reports, and other technical reports published by government agencies, private businesses, and consulting firms. The literature and other information sources cited are identified in Chapter 8, References.

#### Assessment Methods

Potential stressors to marine communities in the TMAA that would result from changes in activities between the No Action Alternative and the other alternatives are limited to 1) direct impacts to bottom-dwelling communities from materials expended during training, or the accumulation of those materials; and 2) explosions on or below the sea surface. Impacts to pelagic and benthic marine communities could include localized disturbance of water column habitat, alteration or destruction of benthic habitat, or detrimental effects to federal and state species of concern or their habitats. Some of the metals and other materials used during training are hazardous, such as lead ballast and battery components. The impact of these materials on marine water and sediment quality is discussed in Sections 3.2 and 3.3, Expended Materials and Water Resources, respectively. Other potential stressors that are analyzed in Section 3.6, such as vessel movement or aircraft overflights that were determined not to affect marine plants or invertebrates, were removed from further analysis.

#### Materials Expended during Training

Impacts on marine communities that may arise from materials expended during training were evaluated based on the estimated amount under each alternative, the geographic dispersion of the proposed activities, the resulting density of the expended materials, and timing of and duration of training exercises.

#### Explosions

Alternatives were evaluated for long-term effects on marine communities that would result from explosions, based on their force, location, and proximity to the bottom. Short-term effects, including increases in local turbidity, were not considered because they dissipate relatively quickly under the influence of ocean and tidal currents, wind-generated currents, and the natural sediment transport processes that operate continuously in the open ocean.

### Ballast Water and Invasive Species

In 1990, Congress enacted the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA; Title I of P.L. 101-646; 16 U.S.C. §§4701, et seq.), which established a federal program to prevent the introduction and to control the spread of unintentionally introduced aquatic nuisance species and gave the U.S Coast Guard jurisdiction over ballast water management. Thereafter, the U.S. Coast Guard published final rules on ballast water management for vessels entering the Great Lakes as well as the Hudson River and eventually made procedures mandatory for vessels entering those areas. The Coast Guard, along with U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (FWS), Army Corps of Engineers, and National Oceanic and Atmospheric Administration (NOAA) also share responsibilities for implementing this effort, acting cooperatively as members of an Aquatic Nuisance Species (ANS) Task Force to conduct studies and report to Congress to (1) identify areas where ballast water exchange can take place without causing environmental damage; and (2) determine the need for controls on vessels entering U.S. waters other than the Great Lakes.

In 1996, the National Invasive Species Act (NISA) amended NANPCA to create a national ballast management program modeled after the Great Lakes program wherein all ships entering U.S. waters (after operating outside the U.S. Exclusive Economic Zone) are directed to undertake high seas (i.e., mid-ocean) ballast exchange or alternative measures pre-approved by the Coast Guard as equally or more effective. In 2001, U.S. Coast Guard published a final rule that established regulations for ballast water management for Control of Nonindigenous species in waters of the United States (66 FR 58381). In 2004, the U.S. Coast Guard published a final rule making the ballast water management program mandatory requiring all vessels equipped with ballast water tanks and bound for ports or places of the United States to conduct a mid-ocean ballast water exchange, retain their ballast water onboard, or use an alternative environmentally sound ballast water management method approved by the Coast Guard. Additionally, the Coast Guard set penalties for failure to comply with reporting requirements under 33 CFR 151.

When NISA amended the NANPCA in 1996, 16 USC 4713 was added, which indicated that the Department of Defense was to establish its own "ballast water management program for seagoing vessels of the Department of Defense to minimize the risk of introduction of nonindigenous species from releases of ballast water." Additionally, the Clean Water Act was amended in 1996 to allow for the Secretary of the Defense and Administrator of the EPA to work in consultation with the U.S. Coast Guard and interested states to determine discharges incidental to the normal operation of a vessel of the Armed Forces for which it is reasonable and practicable to require use of a marine pollution control device. On May 10, 1999, EPA and DOD published the final rule establishing regulations for undertaking to establish the Uniform National Discharge Standards for Vessels of the Armed Forced. This rule completed the first phase of a three-phase process to set the Uniform National Discharge standards. This Phase I rule determined the type of vessel discharges that require control by MPCDs and those that do not, based on anticipated environmental effects of the discharge as well as factors listed in the Clean Water Act. A total of 25 vessel discharges that have the potential to cause an adverse impact on the environment requiring control standards have been identified under Phase I of the program (Federal Register 64[89], 25126-25138). Dirty ballast was one of the types of incidental discharges identified to require a marine pollution control device in Phase I. Phase II involves developing performance standards and control procedures for those discharges. The Navy and EPA have agreed to promulgate Phase II standards in batches. The batch rulemaking approach allows the Navy and EPA to conduct technical analyses and develop discharge standards in batches (approximately five discharges per batch) rather than conducting analyses and developing standards for all 25 discharges at one time. To date, this Phase II process is still ongoing.

Therefore, since Navy ships operate worldwide, the Navy has chosen to adopt the intent of the Coast Guard standards with respect to ballast water management even though U.S. Coast Guard regulations exempt vessels of the Armed Forces that are subject to the Uniform National Discharge Standards from the ballast water guidelines. Under Navy policy, if it is necessary for a surface ship to load ballast water in an area that is either potentially polluted or within 3 nm from the shore, the ship will pump the ballast water out when outside 12 nm from shore and twice fill the tank(s) with clean sea water and pump prior to the next entry within 12 nm from shore. It is also Navy policy to not exchange ballast water during local operations (within the same locale) or when returning within 12 nm in the same locale as the ballast water was initially loaded. Surface ships maintain records of all ballast water exchanges. To further reduce potential for entry of non-indigenous species, surface ships routinely wash down anchors, chains and appendages to prevent on board collection of sediment, mud and silt. Where possible following anchor retrieval, surface ships wash down chain lockers outside 12 nm from land to flush out sediment, mud or silt.

**Invertebrate Hearing Overview**

Very little is known about sound detection and use of sound by invertebrates (see Budelmann 1992a, b, Popper et al. 2001 for reviews). The limited data shows that some crabs are able to detect sound, and there has been the suggestion that some other groups of invertebrates are also able to detect sounds. In addition, cephalopods (octopus and squid) and decapods (lobster, shrimp, and crab) are thought to sense low-frequency sound (Budelmann 1992b). Packard et al. (1990) reported sensitivity to sound vibrations between 1 and 100 hertz (Hz) for three species of cephalopods. Lovell et al. (2005) concluded that at least one species from the invertebrate subphylum of crustacean (*Palaemon serratus*), is sensitive to the motion of water particles displaced by low-frequency sounds ranging from 100 Hz up to 3000 Hz. Wilson et al. (2007) documents a lack of physical or behavioral response for squid exposed to experiments using high-intensity sounds designed to mimic killer whale echolocation signals. In contrast, McCauley et al. (2000) reported that caged squid would show behavioral responses when exposed to sounds from a seismic airgun.

There has also been the suggestion that invertebrates do not detect pressure since few, if any, have air cavities that would function like the fish swim bladder in responding to pressure. It is important to note that some invertebrates, and particularly cephalopods, have specialized end organs, called statocysts, for determination of body and head motions that are similar in many ways to the otolithic end organs of fish. The similarity includes these invertebrates having sensory cells which have some morphological and physiological similarities to the vertebrate sensory hair cell, and the "hairs" from the invertebrate sensory cells are in contact with a structure that may bear some resemblance to vertebrate otolithic material (reviewed in Budelmann 1992a, b). As a consequence of having statocysts, it is possible that these species could be sensitive to particle displacement (Popper et al. 2001).

It is also important to note that invertebrates may have other organs that potentially detect the particle motion of sound, the best known of which are special water motion receptors known as chordotonal organs (e.g., Budelmann 1992a). These organs facilitate the detection of potential predators and prey and provide environmental information such as the movement of tides and currents. Indeed, fiddler crab (*Uca* sp.) and spiny lobster (*Panulirus* sp.) have both been shown to use chordotonal organs to respond to nearby predators and prey.

Like fish, some invertebrate species produce sound, with the possibility that it is used for communication. Sound is used in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Popper et al. 2001). Well-known sound producers include lobsters (*Panulirus* sp.) (Latha et al. 2005) and snapping shrimp (*Alpheus heterochaelis*) (Heberholz and Schmitz 2001). Of all marine invertebrates, perhaps the one best known to produce sound is the snapping shrimp (Heberholz and Schmitz 2001). Snapping shrimp are found in oceans all over the world and make up a significant portion of the ambient noise budget in many locales (Au and Banks 1998).

#### Effects of Sound on Invertebrates

McCauley et al. (2000) found evidence that squid exposed to seismic airguns show a behavioral response including inking. However, these were caged animals, and it is not clear how unconfined animals may have responded to the same signal and at the same distances used. In another study, Wilson et al. (2007) played back echolocation clicks of killer whales to two groups of squid (*Loligo pealeii*) in a tank. The investigators observed no apparent behavioral effects or any acoustic debilitation from playback of signals up to 199 to 226 dB re 1 micro-Pascal (μPa).

In another report on squid, Guerra et al. (2004) claimed that dead giant squid turned up around the time of seismic airgun operations off of Spain. The authors suggested, based on analysis of carcasses, that the damage to the squid was unusual when compared to other dead squid found at other times. However, the report presents conclusions based on a correlation to the time of finding of the carcasses and seismic testing, but the evidence in support of an effect of airgun activity was totally circumstantial. Moreover, the data presented showing damage to tissue is highly questionable since there was no way to differentiate between damage due to some external cause (e.g., the seismic airgun) and normal tissue degradation that takes place after death, or due to poor fixation and preparation of tissue. To date, this work has not been published in peer-reviewed literature, and detailed images of the reportedly damaged tissue are also not available.

There has been a recent and unpublished study in Canada that examined the effects of seismic airguns on snow crabs (DFO 2004). However, the results of the study were not at all definitive, and it is not clear whether there was an effect on physiology and reproduction of the animals.

There is also some evidence that an increased background noise (for up to 3 months) may affect at least some invertebrate species. Lagardère (1982) demonstrated that sand shrimp (*Crangon crangon*) exposed in a sound-proof room to noise that was about 30 dB above ambient for 3 months demonstrated decreases in both growth rate and reproductive rate. In addition, Lagardère and Régnault (1980) showed changes in the physiology of the same species with increased noise, and that these changes continued for up to a month following the termination of the signal.

Finally, there was a recently published statistical analysis that attempted to correlate catch rate of rock lobster in Australia over a period of many years with seismic airgun activity (Parry and Gason 2006). The results, while not examining any aspects of rock lobster behavior or doing any experimental study, suggested that there was no effect on catch rate from seismic activity.

### 3.5.2.3 No Action Alternative

Activities under the No Action Alternative that may affect marine communities include materials expended during training as well as explosions and impacts. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

#### Expended Materials

Materials expended during training include sonobuoys; parachutes and nylon cord; some towed, stationary, and remote-controlled targets; inert munitions; and exploded and unexploded munitions, including missiles, bombs, and shells. These materials arise from 1) missiles and bombs used during Missile Exercises (MISSILEX) and Bombing Exercises (BOMBEX), respectively; and 2) shells fired during Gunnery Exercises (GUNEX) and BOMBEX. BOMBEX mostly involves the use of inert training munitions, but explosives are occasionally used.

Materials from these sources include a variety of plastics, metals, and batteries. Unless otherwise noted in the discussion or the table, targets are not recovered. Most of these materials are inert and dense, and will settle deep in bottom sediments, become covered by sediments, or encrusted by physical or biological processes. However, some of the metals and other materials such as lead, lithium, and batteries, are hazardous.

Additional materials expended during training include illuminating flares, marine markers, and chaff. These materials were dismissed from further analysis because, for both canisters and markers, the majority of the constituents are consumed by heat and smoke, both of which dissipate in the air. Any remaining materials from marine markers would sink into bottom sediments or become encrusted by chemical processes or by marine animals. Phosphorus contained in the markers reacts with seawater to produce phosphoric acid, a variable, but normal, component of seawater. Chaff consists of aluminum-coated polymer fibers inside of a launching mechanism, and are widely dispersed on deployment. Chaff settling on the ocean surface may temporarily raise turbidity, but will quickly disperse with particles eventually settling to the ocean floor.

The impact of these materials on marine water and sediment quality is discussed in Sections 3.2 and 3.3, Expended Materials and Water Resources, respectively.

**Open Ocean Habitats**

The effect of materials expended during training in the TMAA is assessed by the number of expended items per unit area. Under the No Action Alternative, an estimated 15,982 items would be expended in this area (Table 3.5-1). Based on a TMAA size of 42,146 $nm^2$ (144,557 $km^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, 1.9 items per $nm^2$ (0.5 per $km^2$) per year would be deposited in the ocean. More than 97 percent of these items would be from gunshells and small caliber rounds.

**Table 3.5-1: Expended Training Materials in the TMAA – All Alternatives**

| Training Material | No Action Alternative | Alternative 1 | | Alternative 2 | |
|---|---|---|---|---|---|
| | Number | Number | % Increase from No Action | Number | % Increase from No Action |
| Bombs | 120 | 180 | 50% | 360 | 200% |
| Missiles | 22 | 33 | 50% | 66 | 200% |
| Targets and Pyrotechnics | 252 | 322 | 28% | 644 | 160% |
| Naval Gunshells | 10,564 | 13,188 | 25% | 26,376 | 150% |
| Small Caliber Rounds | 5,000 | 5,700 | 14% | 11,400 | 130% |
| Sonobuoys | 24 | 793 | 3,200% | 1,587 | 6,500% |
| PUTR | 0 | 7 | NA | 7 | NA |
| SINKEX | 0 | 0 | NA | 858 | NA |
| **Total** | **15,982** | **20,223** | **26%** | **41,298** | **160%** |

Notes: Numbers of training items are estimates.

***Pelagic Communities***

Pelagic species, whether plankton or large invertebrates, are most common in the surface and near-surface layers of the open ocean. Therefore, any expended materials have the potential to kill or harm individual animals and plants in the immediate vicinity. In situations where expended materials are deposited in an area with a high concentration of individuals, the extent of death or harm would be greater than in a more barren area. However, pelagic species are abundant, have high rates of reproduction, are widely distributed, both across the ocean surface and vertically in the water column, and their distribution tends to be patchy rather than uniform. Because of these factors and the very low density of expended materials that would be associated with the No Action Alternative, negligible impacts are anticipated.

#### *Deepwater Benthic Habitats*

The shelf of the TMAA is a complex and dynamic geologic environment characterized by banks, patchy rocky substrate, and patchy bottom sediments (DoN 2006). Banks are exposed to both wave and current action (particularly during winter storms) that continually resuspend bottom sediments. Bottom material such as sand, gravel, boulders, and broken shells are most characteristic of the banks while finer sediment accumulates in the depressions and the troughs of the region. The bottom substrate of the continental slope is typically covered with silts, clays, and fine sediments; however, there is the occasional hard bottom substratum (e.g., rocky outcroppings, rubble, talus, vertical wall, and seamounts) that supports a diverse assemblage of deep-sea invertebrates and fishes.

Most expended materials are inert and dense and readily sink deep into existing sediments or become covered with sediment over time. These materials would also become encrusted by chemical processes or by marine organisms that further isolates them from the environment. Once deposited, the materials would not pose a hazard to benthic communities. Because high quality habitat occupies only a small portion of the benthic environment, there is a small potential for the communities to be affected by initial impact of expended materials. However, injury or death could occur to bottom-dwelling organisms if struck.

The deposition of training materials on the ocean bottom under the No Action Alternative is judged to have negligible impacts because 1) expended materials are distributed widely enough that less than two items would be deposited on the bottom per $nm^2$; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

## Explosions

Under the No Action Alternative, activities involving explosive munitions occur at or just below the surface in the TMAA. These include sea surface explosions from missiles and bombs used during BOMBEX and SINKEX; and shells fired during GUNEX and BOMBEX. Additional subsurface explosions involve the use of explosive sonobuoys used during Tracking Exercises (TRACKEX).

### Open Ocean Habitats

The effect of explosions in the TMAA is based on the number and force of explosive munitions in proximity to pelagic and deepwater benthic habitats. Under the No Action Alternative an estimated 88 explosive munitions would be used in the open ocean of the TMAA (Table 3.5-2). Based on a TMAA size of 42,146 $nm^2$ (144,557 $km^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, 0.01 explosions would occur per $nm^2$ (0.003 per $km^2$) per year.

#### *Pelagic Communities*

Pelagic species, whether plankton or large invertebrates, are most common in the surface and near-surface layers of the open ocean. Therefore, any surface or near-surface explosions or impacts have the potential to kill or harm individual animals and plants in the immediate vicinity. However, the shock waves from such explosions attenuate quickly (within a period of milliseconds). In situations where an explosion or impact occurred in an area with a high concentration of individuals, the extent of death or harm would be greater than in a more barren area.

**Table 3.5-2: Explosive Munitions Used in the TMAA – All Alternatives**

| Training Material | No Action Alternative | Alternative 1 | | Alternative 2 | |
|---|---|---|---|---|---|
| | Number | Number | % Increase from No Action | Number | % Increase from No Action |
| Bombs | 48 | 72 | 50% | 166 | 246% |
| Naval Gunshells (5-inch / 76 mm) | 40 | 56 | 40% | 112 | 180% |
| IEER Sonobuoys | 0 | 40 | NA | 80 | NA |
| SINKEX | 0 | 0 | NA | 858 | NA |
| **Total** | **88** | **168** | **91%** | **1,194** | **1,257%** |

Notes: Numbers of training items are estimates.

However, pelagic species are abundant, have high rates of reproduction, are widely distributed, both across the ocean surface and vertically in the water column, and their distribution tends to be patchy rather than uniform. Because of these factors and the very low density of explosions that would be associated with the No Action Alternative, negligible impacts are anticipated.

***Deepwater Benthic Habitats***

All of the explosions listed in Table 3.5-2 would occur at or near the surface of waters that generally exceed 1,650 ft in depth (500 m) over the continental shelf, and several thousand feet deep over the slope and abyssal plain. In such settings, the shock waves from explosions and impacts at or near the surface would largely attenuate well before reaching bottom-dwelling habitats. Thus, adverse impacts are not considered likely under the No Action Alternative.

### 3.5.2.4 Alternative 1

Alternative 1 is a proposal designed to meet Navy and DoD current and near-term operational training requirements. If Alternative 1 were to be selected, in addition to training activities currently conducted, the ATA would support an increase in training activities to include conducting ASW activities and the use of MFA sonar during ASW activities, as well as increases in training activities due to force structure changes associated with the introduction of new weapon systems, vessels, aircraft, and training instrumentation into the Fleet. Under Alternative 1, baseline-training activities would be increased for some activities. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, Guided Missile Submarine (SSGN), P-8 Multimission Maritime Aircraft (MMA), Guided Missile Destroyer [DDG] 1000 [Zumwalt Class] destroyer, and unmanned aerial systems (UASs). Force structure changes associated with new weapons systems would include new sonobuoys. Force structure changes associated with new training instrumentation include the Portable Undersea Training Range (PUTR).

Activities under Alternative 1 that may affect marine communities include materials expended during training as well as explosions and impacts. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

**Materials Expended during Training**

**Open Ocean Habitats**

Under Alternative 1, an estimated 20,223 items would be expended in the open ocean of the TMAA, a 26 percent increase over the No Action Alternative (see Table 3.5-1). Based on an open ocean area of 42,146 nm$^2$ (144,557 km$^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, 2.4 items per nm$^2$ (0.7 per km$^2$) per year would be deposited in the ocean. More than 93 percent of these items would be from gunshells and small caliber rounds**.**

#### *Pelagic Communities*

Pelagic species are abundant, have high rates of reproduction and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, Alternative 1 would have negligible impacts on pelagic communities.

#### *Deepwater Benthic Habitats*

Similar to the No Action Alternative, the deposition of training materials on the ocean bottom under Alternative 1 is judged to have negligible impacts because 1) using conservative estimates (assumed that activities would occur in the only 20% of the TMAA instead of the using the entire TMAA; therefore, greater concentration) expended materials are distributed widely enough that less than three items would be deposited on the bottom per nm$^2$; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

## Explosions

### Open Ocean Habitats

As shown in Table 3.5-2, an estimated 168 explosions would occur in the TMAA under Alternative 1, an increase of 91 percent over the No Action Alternative. Based on an open ocean area of 42,146 nm$^2$ (144,557 km$^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, there would be about 0.02 explosions per nm$^2$ (0.006 per km$^2$) per year.

#### *Pelagic Communities*

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions under Alternative 1 would be negligible.

#### *Deepwater Benthic Habitats*

Because all explosions in the open ocean would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 1 would be negligible.

## Portable Undersea Tracking Range

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

No area supporting a PUTR system has been identified; however, potential impacts to marine habitats that support plants and invertebrates can be assessed based on several assumptions. Assuming that transponders are deployed on soft-bottom habitats, impacts would be similar to those discussed for expended materials. There would be direct impact to soft bottom habitat where the clump weight contacted the bottom, which may result in localized mortality to epifauna and infauna within the footprint, although it is anticipated that recolonization would occur within a relatively short period of time. Upon completion of the exercise, the transponders, which have an acoustic link, are sent a signal that breaks the link and the transponders float to the surface for recovery. This design feature eliminates any potential impacts associated with hazardous materials such as batteries and electronic components. The clump weights are not recovered, and since they are composed of inert material, they are not a potential source of contaminants, and could provide a substrate for benthic fauna. There may also be indirect effects associated with increased turbidity due to resuspension of sediments from the clump weights contacting the bottom. The turbidity plume is expected to be localized and temporary, as sediment would eventually settle to the ocean floor or be dispersed by ocean currents. Therefore, localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated.

### 3.5.2.5 Alternative 2

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing specific training activities to include the use of active sonar, and accommodating force structure changes). In addition, under Alternative 2 the following activities would occur:

- Conduct one additional separate summertime CSG exercise lasting up to 21 days within the ATA.
- Conduct a SINKEX in each summertime exercise (a maximum of two) in the TMAA.

Activities under Alternative 2 that may affect marine communities include materials expended during training as well as explosions. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the TMAA.

#### Materials Expended During Training

#### Open Ocean Habitats

Under Alternative 2, an estimated 41,298 items would be expended in the TMAA, an increase of 160 percent over the No Action Alternative (see Table 3.5-1). Based on an open ocean area of 42,146 nm$^2$ (144,557 km$^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, 4.9 items per nm$^2$ (1.4 per km$^2$) per year would be deposited in the ocean. More than 91 percent of these items would be from gunshells and small caliber rounds.

#### *Pelagic Communities*

Pelagic species are abundant, have high rates of reproduction, and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, negligible impacts are anticipated under Alternative 2 (same as the No Action Alternative).

#### *Deepwater Benthic Habitats*

Similar to the No Action Alternative, the deposition of training materials on the ocean bottom under the Alternative 2 is judged to have negligible impacts because 1) using conservative estimates expended materials are distributed widely enough that less than five items would be deposited on the bottom per nm$^2$; and 2) the majority of those items are small caliber rounds that would have little impact. However, if sensitive habitats were struck by larger objects, localized impacts could occur. These communities usually have slow rates of recovery; however, over the long term, such objects could also provide new, hard substrate for benthic communities to utilize.

### Explosions

#### Open Ocean Habitats

Under Alternative 2, an estimated 1,194 explosions would occur in the open ocean of the TMAA, an increase of 1,257 percent over the No Action Alternative (see Table 3.5-2). Based on an open ocean area of 42,146 $nm^2$ (144,557 $km^2$) and conservatively assuming that activities occur across 20 percent of the TMAA, there would be 0.14 explosions per $nm^2$ (0.04 $km^2$) per year.

#### *Pelagic Communities*

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions under Alternative 2 would be negligible.

#### *Deepwater Benthic Habitats*

Because all explosions in the open ocean of the TMAA would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 2 would be negligible.

### Portable Undersea Tracking Range

Under Alternative 2, impacts from the PUTR would be the same as those described for Alternative 1, with localized and temporary impacts to benthic fauna, but no long-term impacts are anticipated.

### SINKEX

A SINKEX is conducted under the auspices of an overarching permit from the USEPA (40 CFR § 229.2, Transport of Target Vessels, and the August 1999 Navy/USEPA agreement that details vessel preparation requirements to address PCBs under the SINKEX permit). Operations involve the use of missiles, bombs, and torpedoes, which contain missile propellants, fuel, engine oil, hydraulic fluid, and batteries, all of which may affect marine water quality and biota. The detailed analysis of Sections 3.2 (Expended Materials) and 3.3 (Water Resources) indicates that the concentration of potential contaminants associated with bombs, missiles, and torpedoes is below criteria established for the protection of aquatic life. Although localized and temporary impacts to the pelagic environment would occur, the relatively small quantities of materials expended, dispersed as they are over a very large area, would have no adverse physical effects on marine biological resources. In addition, SINKEX operations occur in the open ocean (at least 1,000 fathoms [6,000 ft] deep) and in avoidance of HAPCs. However, the sunken vessel may alter soft-bottom habitats, but may provide a beneficial use by providing habitat in the deep water environment. Given these reasons, impacts to open ocean habitats from SINKEX are negligible.

## 3.5.3 Mitigation

As summarized in Section 3.5.2, the actions proposed under the alternatives described in this EIS/OEIS would have minimal impacts on the marine plant and invertebrate communities of the TMAA. Therefore, no resource-specific mitigation measures would be required. See Chapter 5 for additional discussion of mitigation measures.

## 3.5.4 Summary of Effects

The Proposed Action alternatives would have minimal impacts on marine plant or invertebrate resources in the TMAA. These effects would be related to ordnance use and expended materials, and would not be anticipated to be measurable (detectable), given the large area over which activities occur and the dynamic nature of the marine environment of the TMAA. Table 3.5-3 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on marine plants and invertebrates under both the National Environmental Policy Act (NEPA) and EO 12114.

**Table 3.5-3: Summary of Effects by Alternative**

| Alternative | NEPA<br>(U.S. Territorial Seas, 0 to 12 nm) | EO 12114<br>(Non-U.S. Territorial Seas, > 12 nm) |
|---|---|---|
| **No Action Alternative** | • Overflights would not affect marine plants and invertebrates. | • Expended materials and the release of munitions constituents and other materials would be distributed across 20 percent of the TMAA (1.9 items per $nm^2$ [0.5 per $km^2$]) and have minimal effects on pelagic and benthic communities. More than 97 percent of these items would be from gunshells and small caliber rounds.<br>• Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.01 explosions would occur per $nm^2$ (0.003 per $km^2$) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth. |
| **Alternative 1** | • Overflights would not affect marine plants and invertebrates. | • Expended materials and the release of munitions constituents and other materials would be distributed across 20 percent of the TMAA (2.4 items per $nm^2$ [0.7 per $km^2$]) and have minimal effects on pelagic and benthic communities. More than 93 percent of these items would be from gunshells and small caliber rounds.<br>• Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.02 explosions would occur per $nm^2$ (0.006 per $km^2$) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth.<br>• Localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated. |

**Table 3.5-3: Summary of Effects by Alternative (continued)**

| Alternative | NEPA (U.S. Territorial Seas, 0 to 12 nm) | EO 12114 (Non-U.S. Territorial Seas, > 12 nm) |
|---|---|---|
| **Alternative 2 (Preferred Alternative)** | • Overflights would not affect marine plants and invertebrates. | • Expended materials and the release of munitions constituents and other materials would be distributed across 20 percent of the TMAA (4.9 items per $nm^2$ [1.4 per $km^2$]) and have minimal effects on pelagic and benthic communities. More than 91 percent of these items would be from gunshells and small caliber rounds.<br>• Surface or near-surface explosions have the potential to kill or harm individual animals and plants in the immediate vicinity resulting in localized impacts. Given the TMAA size and using conservative estimates, 0.14 explosions would occur per $nm^2$ (0.04 per $km^2$) per year resulting in minimal effects. Benthic communities would not be affected by explosions due to water depth.<br>• Localized and temporary impacts to benthic fauna may occur from the PUTR, but no long-term impact is anticipated.<br>• Although localized and temporary impacts to the pelagic environment would occur from a SINKEX, the relatively small quantities of materials expended, dispersed as they are over a very large area, would have no adverse effect on marine biological resources. |

Note: Quantitative estimates conservatively assumed that activities occurred across 20 percent of the TMAA.

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