Appendix 5.4 Marine and Coastline Habitats

Featured Species-associated Intertidal Habitats: Rocky Intertidal, Mudflats and Beaches, and Eelgrass Beds

A swath of intertidal habitat occurs wherever the ocean meets the shore. At 44,000 miles, Alaska's shoreline is more than double the shoreline for the entire Lower 48 states (ACMP 2005). This extensive shoreline creates an impressive abundance and diversity of habitats. Five physical factors predominantly control the distribution and abundance of biota in the intertidal zone: wave energy, bottom type (substrate), tidal exposure, temperature, and most important, salinity (Dethier and Schoch 2000; Ricketts and Calvin 1968). The distribution of many commercially important fishes and crustaceans with particular salinity regimes has led to the description of "salinity zones," which can be used as a basis for mapping these resources (Bulger et al. 1993; Christensen et al. 1997). A new methodology called SCALE (Shoreline Classification and Landscape Extrapolation) has the ability to separate the roles of sediment type, salinity, wave action, and other factors controlling estuarine community distribution and abundance.

This section of Alaska's CWCS focuses on 3 main types of intertidal habitat: rocky intertidal, mudflats and beaches, and eelgrass beds. Tidal marshes, which are also intertidal habitats, are discussed in the Wetlands section, Appendix 5.3, of the CWCS.

Rocky intertidal habitats can be categorized into 3 main types: (1) exposed, rocky shores composed of steeply dipping, vertical bedrock that experience high-to-moderate wave energy; (2) exposed, wave-cut platforms consisting of wave-cut or low-lying bedrock that experience high-to-moderate wave energy; and (3) sheltered, rocky shores composed of vertical rock walls, bedrock outcrops, wide rock platforms, and boulder-strewn ledges and usually found along sheltered bays or along the inside of bays and coves.

Rocky substrate, moderate to strong wave and surf exposure, and a visible, vertical zonation pattern characterize rocky intertidal habitat. Colorful communities of invertebrates and algae grow in distinct horizontal bands dominated by rockweed, mussels, or barnacles. These species' physiological tolerance to desiccation and their competitive and predatory interactions with other species largely determine their vertical distribution. Although extensive research has been done on intertidal community structuring processes in temperate regions, including zonation patterns, disturbance processes, and adaptations of organisms, relatively little work has been done in sub-Arctic regions. One difference between temperate and sub-Arctic ecological processes is the pronounced seasonality of intertidal community composition and biomass. Dramatic seasonal changes, such as the cold winter air, shorter daylight, and long winters at or above 59 degrees north latitude (delineation of sub-Arctic), all contribute to the distribution and composition of the intertidal communities. Low light conditions in winter sharply reduce algal growth, which is dependent on sunlight, nutrient availability, length and time of immersion, air temperature, and wave action. Stress from temperature changes causes high interannual variability in living biomass. The effects of these changes range from annual senescence of kelp and other macrophytes (many of which live throughout the year in temperate climates) to extreme intertidal mortality of flora and fauna.

Rocky intertidal habitat at low tide, Port Graham T. Thompson, ADF&G

Macroalgal species grow in abundance during the spring and summer when extended daylight creates intense primary productivity. Their biomass supports communities that inhabit not only the rocky intertidal habitat, but also those of soft-bottom habitats (Lees et al. 1980). Direct consumers in the rocky intertidal habitat include chitons (*Mopalia muscosa*, *Tonicella lineata*), sea urchins (*Strongylocentrotus droebachiensis*), and grazing snails (*Littorina* spp. and *Siphonaria thersites*). After macroalgae die, they decompose and become detritus. Detritus forms the base of the food chain for soft-bottom habitats, and it serves as food for filter feeders, such as barnacles, in other habitats. Deposit- and filter-feeding worms, clams, and other invertebrates are food for birds and fish. The transfer of biomass from the rocky intertidal habitat to other habitats ties the health and productivity of kelp and rockweed in the rocky intertidal area to that of soft-bottom dwellers, such as Dungeness crabs (*Cancer magister*), and flatfish, such as halibut (*Hippoglossus stenolepis*) (Lees et al. 1980; Sanger and Jones 1984; ADF&G 1993).

The diversity and highly structured zonation of rocky intertidal communities fascinates researchers and tide-pool visitors. With ample primary productivity forming the basis of an abundant food supply, space is usually the most limiting resource in rocky intertidal communities (Ricketts and Calvin 1968). The distribution of species is governed by the competition for living space and the need to find food and shelter while avoiding predators and without drying out or suffering from intolerable extremes in heat or cold. For example, competition for space among mussels, barnacles, and rockweed leads to the formation of distinct bands dominated by these species. Although consolidated substrates do not allow animals to burrow, as they do in soft-bottom habitats, the cracks, crevices, overhangs, and rock bottoms create microhabitats in which to hide from predators, minimize wave shock, and avoid desiccation.

Rocky Intertidal–associated Species

Black Scoter, *Melanitta nigra Americana*
Surf Scoter, *Melanitta perspicillata*
White-winged Scoter, *Melanitta fusca deglandi*
Black katy chiton, black leather chiton, bidarki, urriitaq in Alutiiq, *Katharina tunicata*
Northern abalone, pinto abalone, Alaskan abalone, Japanese abalone, *Haliotis kamtschatkana*
Northern sea otter, *Enhydra lutris*
Black Oystercatcher, *Haematopus bachmani*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Gunnels


Shorebirds feeding in mudflat habitat ADF&G/KBRR

Mudflats and beaches are intertidal unconsolidated substrate habitats ranging from sheltered tidal flats to steep cobble beaches exposed to pounding waves. Each type of substrate supports a distinct biological community, including numerous species of clams, polychaete worms, amphipods, and other invertebrates. Sand and gravel beaches host similar taxa (with gravel-inhabiting forms adapted to coarser substrate), as well as sand dollars (*Echinarachnius parma*) and sand lance (*Ammodytes hexapterus*). Cobble beaches are subject to greater wave exposure, and fewer species are adapted to survive the stress of pounding waves and grinding substrate. However, when cobble provides a protective armor over a heterogeneous mixture of silt, sand, and other unconsolidated sediments, a rich infaunal community may live beneath it. Of the unconsolidated habitats, mudflats support the greatest species diversity and biomass, and cobble beaches support the fewest (Lees et al. 1980; Carroll and Highsmith 1994).

There are 5 “soft” intertidal habitat types: fine-grained sand beaches, coarse-grained sand beaches, mixed sand and gravel beaches, exposed tidal flats, and sheltered tidal flats. Fine-grained sand beaches usually are broad and gently sloping. Coarse-grained sand beaches are wide, steep beaches and are generally associated with river or stream mouths. Mixed sand and gravel beaches contain coarse-grained sands, gravel of varying sizes, and possibly shell fragments. Exposed tidal flats are composed of sand and/or gravel, and are associated with lagoons found at the heads of coastal bays. They are exposed to moderate wave and tidal energy and river freshwater inputs. Sheltered tidal flats contain soft mud or muddy sand. They occur at the heads of bays and in estuarine wetlands and are exposed to low wave activity and moderate tidal currents (NOAA 1999).

Mudflat and Beach–associated Species

Solitary Sandpiper, *Tringa solitaria; T. s. cinnamomea* race (breeds in Alaska)
Black Oystercatcher, *Haematopus bachmani*
Marbled Godwit, *Limosa fedoa* and subspecies *L. f. beringiae*
Lesser Yellowlegs, *Tringa flavipes*
Bristle-thighed Curlew, *Numenius tahitiensis*
Buff-breasted Sandpiper, *Tryngities subruficollis*
Rock Sandpiper, *Calidris ptilocnemis* subspecies Pribilof Sandpiper, *C. p. ptilocnemis,* subspecies Northern Rock Sandpiper, *C. p. tschuktschorum*
Long-tailed Duck, *Clangula hyemalis*
White-winged Scoter, *Melanitta fusca deglandi*
Surf Scoter, *Melanitta perspicillata*
Black Scoter, *Melanitta nigra americana*
Arctic Tern, *Sterna paradisaea*
Song Sparrow, *Melospiza melodia maxima*
Pacific sand lance, *Ammodytes hexapterus*
Capelin, *Mallotus villosus*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish, *Trichodon trichodon*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Macoma spp.
Clinocardium spp.
Serripes spp.
Mactromeris spp.


Underwater eelgrass beds, Kachemak Bay ADF&G/KBRR

Eelgrass (*Zostera marina*) grows in beds (clusters) in low intertidal and shallow subtidal sandy mudflats. Like a coral reef or kelp forest, the physical structure of the eelgrass beds provides increased living substrate and cover for myriad invertebrates and fish. The beds also generate food and nutrients for the soft bottom community through primary productivity and plant decay. Unlike kelp, eelgrass is a flowering, marine vascular plant. The size, shape, and density of the eelgrass beds vary from season to season. Eelgrass is sensitive to turbidity and changes in water quality. The depth to which it grows is limited by light penetration. The encrusting algae and invertebrates on the eelgrass blades (epibiota) are as important as the plant itself as a food source for other species. Although eelgrass blades die in the fall, the roots and rhizomes remain dormant through the winter. The perennial root and rhizome systems stabilize the fine substrate sediments, buffering the erosive forces of tidal flushing and seasonal storms (McConnaughey and McConnaughey 1985). This interannual stability allows eelgrass to come back in following years, providing a relatively consistent food source and substrate for the seasonal crop of epibiota. In Alaska, eelgrass beds are distributed along sheltered, shallow portions of the coastline, from Southeast Alaska to the Seward Peninsula. Izembek Lagoon, located on the tidelands and submerged lands of the Izembek State Game Refuge (See Figure 35, Page 131 of CWCS), is the site of one of the largest eelgrass beds in the world. The adjacent Izembek National Wildlife Refuge protects the watershed of Izembek Lagoon, including Applegate Cove and Moffet Lagoon.

Eelgrass Bed-associated Species

Black Scoter, *Melanitta nigra Americana*
Helmet crab, *Telmessus cheiragonus*
Surf Scoter, *Melanitta perspicillata*
Kelp crabs, *Pugettia* spp.
White-winged Scoter, *Melanitta fusca deglandi*
Horse clams, *Tresus capax*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, Pholid families)
Spionid polychaetes
Gunnels
Sea cucumbers, *Parastichopus californicus*
Eelgrass shrimp, *Hippolyte clarki*
Nudibranchs: *Melibe leonine*
Hydroids, *Obelia* spp.
Bivalves:
  Macoma spp.
  Mactromeris spp.
Dungeness crab, *Cancer magister*
Snails, *Lacuna* spp.
  Serripes spp.
Caprellid amphipods

Ecological Role of Intertidal Habitats

Alaska's expansive and varied coastline, numerous freshwater sources, and diverse geomorphology combine to form many intertidal habitat types.

Rocky intertidal habitat supports a diverse and conspicuous assemblage of invertebrates and luxuriant macroalgal growth that produce more organic material than almost any other intertidal habitat (Lees et al. 1980). The uppermost intertidal band, the splash zone, is only occasionally wetted by waves. Periwinkle snails (*Littorina scutulata* and *L. sitkana*) characterize the uppermost reach of this zone. They share the splash zone with a few acorn barnacles (*Balanus glandula*) and patches of black lichen (*Verrucaria* sp.). Below the splash zone is the upper intertidal zone with its lower reaches characterized by a thick band of rockweed (*Fucus gairdneri*). The upper intertidal zone is exposed to air daily, so the organisms found here, such as the beach hoppers, periwinkle snails, and acorn barnacles, must be adapted to temperature, desiccation, and other stresses caused by exposure. The next zone, the mid intertidal, is periodically covered by higher low tides, offering plant and animals species here some protection from desiccation. Mussels (*Mytilus trossulus*) dominate here, but they share space with rockweed and both acorn and thatched barnacles (*Balanus cariosus*). Black leather chitons (*Katherina tunicata*) are common grazers, especially in the lower mid intertidal zone. Breadcrumb sponges (*Halichondria panicea*), hermit crabs (*Pagurus* spp.), dogwinkle snails (*Nucella* spp.), sea stars, and limpets (*Cryptobranchia* spp.) are also common in the mid intertidal zone. Thatched barnacles often dominate space in the lower intertidal zone, and black leather chitons are common here as well. Lush kelps (*Alaria fistulosa*), red algae (*Odonthalia* spp.), frilled anemones (*Metridium senile*), Christmas anemones (*Urticina crassicornis*), and sea stars (*Evasterias troschelii*, *Leptasterias polaris*) are commonly found in the lower intertidal zone (Carroll and Highsmith 1994).

Mudflats are an important stopover for migrating birds such as Western Sandpiper (*Calidris mauri*) and Dunlin (*Calidris alpina*), which depend on ice-free foraging grounds during their spring migration. The sandpipers are among the millions of migrating shorebirds that focus on baltic macoma (*Macoma balthica*), a small clam that can provide up to 30 percent of the birds' diet during migration (Senner and West 1978). Clams are also an important food source for waterfowl such as Greater Scaups (*Aythya marila*), Long-tailed Ducks (*Clangula hyemalis*), Surf Scoters (*Melanitta perspicillata*), and Black Scoters (*M. nigra*), which feed on the mudflats throughout the winter (Sanger 1983; Lees et al. 1980). Harbor seals (*Phoca vitulina*) also use mudflats and protected beaches as haulout areas (ADF&G 1993). Mudflats and beaches play an important, but poorly understood, role as nursery and spawning habitat for several commercially and recreationally important fish and invertebrates, including Pacific herring (*Clupea pallasi*), Tanner crabs (C*hionoecetes bairdi*), and Dungeness crabs (*Cancer magister*). Pacific herring spawn in the intertidal mudflats and in the mixed sand, gravel, and mud beaches. They are an important prey for birds, marine mammals, and predatory fish. Sand and gravel beaches provide spawning habitat for capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*), two primary food sources for seabirds (Sanger 1983).

Dense eelgrass beds serve as a refuge from predators for small fish, such as sculpins and gunnels, and invertebrates, such as kelp crabs (*Pugettia* spp.), helmet crabs *(Telmessus cheiragonus*), spionid polychaetes, sea cucumbers (Parastichopus californicus), eelgrass shrimp (*Hippolyte clarki*), nudibranchs, including *Melibe leonine*, hydroids (*Obelia* spp.), clams (*Macoma* spp., *Mactromeris* spp., *Serripes* spp., *Tresus capax*), snails (*Lacuna* spp.), and caprellid amphipods. Many commercial and recreationally important species, such as herring (*Clupea pallasi*), Dungeness crab (*Cancer magister*), horse crabs (*Telmessus cheiragonus*), and juvenile salmon (*Onchorhynchus* spp.), use eelgrass as a nursery area. Herring spawn on eelgrass, laying as many as 3 million eggs per eelgrass blade in the spring (Hood and Zimmerman 1986). The nutritious eggs attract gulls, scoters (*Melanitta nigra Americana*, *M. perspicillata*, *M. fusca deglandi*), and other birds and fish. Some species of ducks and geese, such as the Pacific brant (*Branta bernicla*), consume the plant directly, while others forage among the leaves for epifauna. Brant depend on eelgrass for food during their long migration from Baja California to Alaska and Canada. Almost the entire population of brant congregates each fall and spring to forage at Izembek Lagoon.

Eelgrass meadows occur in shallow water, near the shore; as a result they are threatened by some types of coastal development activities. The plant is vulnerable because it has a narrow tolerance for turbidity, sediment disturbance, and eutrophication, as well as a need for high ambient light. Sedimentation and water quality impacts from coastal development and logging contribute to turbidity. Excess nutrients from wastes, fertilizers, or other sources promote the growth of epiphytic algae on eelgrass and phytoplankton in the water column. Decreased light penetration reduces eelgrass photosynthesis and growth. Changes in sedimentation patterns, propeller wash from boats, and other physical disturbances can smother or uproot eelgrass from the fine sediments in which it grows. Although these threats have been documented in the Pacific Northwest and on the east coast of the United States (Wyllie-Echeverria and Thom 1994), their potential impacts have received little attention in Alaska.

Intertidal Habitats Conservation Status

While terrestrial ecosystems may contain geographic and other barriers, the seamless nature of the marine environment presents unique management challenges. Marine ecosystems are open, and everything from rich fishery stocks to oil slicks can pass easily from one place to another. Inputs and changes in physical, chemical, and biological interactions affecting the marine ecosystems have spatial scales—ranging from the Pacific Ocean to a local geographic area such as a particular cove—and temporal scales—ranging from decades to one tidal cycle. Environmental changes in the Pacific Ocean affect local fisheries production, offering a prime example of how local issues may be controlled by global processes (Francis et al. 1998; Hare et al. 1999; Anderson and Piatt 1999). No marine organism or part of the ocean can be considered a discrete unit. Conservation actions should carefully consider aggregation sites and convergences that often represent areas of high productivity, including for the transport and dispersal of larva (Beck 2003).

Conservation concerns for intertidal habitats include shoreline development, invasive species, acute and chronic pollution, and overharvest. Shoreline stabilization, residential and commercial shoreline development, dredging to aid marine transportation, and other human activities can destroy intertidal and shallow subtidal habitats and biological communities. Human activities can indirectly impact communities by introducing new species through ballast water, fouled communities on hulls, and aquaculture. Oil spills cause lasting damage to marine communities, as demonstrated by the 1989 Exxon Valdez oil spill. Heavy metals and other toxins accumulate in filter-feeding invertebrates, such as clams and mussels, and make their way up the food chain to contaminate humans and other predators. However, air- and sea-borne contaminants reach Alaska from distant shores as well as local sources, making their control difficult. Some biological effects of oiling on Cook Inlet's intertidal environments are discussed in Lees et al. (1980). Complex policy issues, such as protecting sensitive resources from pollution and managing international fisheries, such as salmon and halibut, require a broad biological, legal, political, and economic understanding. However, a general lack of baseline data and a poor understanding of natural variability make it difficult to determine natural versus anthropogenic impacts. While researchers and managers have studied the fisheries of crab, shrimp, and halibut, the dearth of information on noncommercial species in intertidal habitats greatly limits our ability to understand and respond to natural and anthropogenic changes. Large-scale ecosystem monitoring efforts, such as the GEM Program, funded by the EVOS Trustees Council, will increase our understanding of large-scale patterns in the marine environment. Research focused on species assemblages should focus on understanding the links between these large-scale patterns and local community patterns.

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Featured Species-associated Coastal Islands and Sea Cliffs

Alaska has over 5 million of acres of spectacular islands and sea cliffs, spreading along its 64,400 km (44,000 mi) coastline, from the Alaskan Panhandle in the southeast, around the Gulf of Alaska, across the Aleutian Islands, and north through the Bering Sea to above the Arctic Circle. Past and present volcanic activity shapes these islands, creating features such as calderas, craters, cone-shaped peaks, hot springs, ash falls, and lava flows.

The islands of Southeast Alaska are part of the temperate rain forest region, receiving close to 700 cm (300 in) of rain annually. At elevations below 500 m, dense conifer forests cloak the islands with lush undergrowth of ferns and mosses. The climate becomes harsher toward the north, and the islands are treeless. The Aleutian Island chain extends from the Alaska Peninsula almost 1500 km to the west. Located between the Bering Sea and the Gulf of Alaska, it is composed of sedimentary islands capped by steep volcanoes, with elevations ranging from sea level to more than 1900 m. The higher volcanoes are glaciated (World Wildlife Fund 2001). Dwarf willow shrubs occur on some islands, their prostrate form gripping the ground because of the strong winds. Carpets of tiny wildflowers also bloom close to the ground. The marine tundra Aleutian vegetation is composed of species from both the North American and Asian continents, dominated by heath, grass and composite families. In general, 3 plant communities can be distinguished: beach communities, lowland tundra, and upland tundra (UNESCO 2005). Seals, sea lions, walruses, sea otters and seabirds (over 40 million of 30 different species) make Alaska's coastal islands their home for at least part of the year, taking advantage of protection from predators and abundant forage fish in the surrounding oceans.

Coastal Island and Sea Cliff-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Red-faced Cormorant, *Phalacrocorax urile*
Black-legged Kittiwake, *Rissa tridactyla*
Pacific Common Eider, *Somateria mollissima v-nigra*
Common Murre, *Uria aalge*
King Eider, *Somateria spectabilis*
Thick-billed Murre, *Uria lomvia*
Spectacled Eider, *Somateria fischeri*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Steller's Eider, *Polysticta stelleri*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Black Scoter, *Melanitta nigra Americana*
Least Auklet, *Aethia pusilla*
Surf Scoter, *Melanitta perspicillata*
Crested Auklet, *Aethia cristatella*
White-winged Scoter, *Melanitta fusca deglandi*
Black Swift, *Cypseloides niger*
Marbled Murrelet, *Brachyramphus marmoratus*
Sculpins (Cottid Hemipterid, Rhamphocottid, Stichaeid, Pholid families)
Kittlitz' Murrelet, *Brachyramphus brevirostris*
capelin, *Mallotus villosus*
Arctic Tern, *Sterna paradisaea*

eulachon, *Thaleichthys pacificus*
Aleutian Tern, *Sterna aleutica*
Gunnels
Pacific sand lance, *Ammodytes hexapterus*

Ecological Role of Coastal Islands and Sea Cliff Habitats


St. Lazaria Island USFWS

Abundant forage fish, such as Pacific sand lance, juvenile Pacific herring, juvenile walleye pollock, smelts, and juvenile salmonids, provide ample food supplies for the seabirds and marine mammals that make the coastal islands their home. Forage fish provide an important link in the marine food web by transferring energy from the ocean's rich plankton populations to top predators, such as seabirds and larger fish.

The many cliffs and islands serve as protected habitat for nesting seabirds and marine mammals. About 50 million seabirds nest in more than 2500 colonies on Alaska's coast each summer. This is 87% of all the seabirds in the United States. Most seabirds rest and sleep on the rolling waves, but some roost on land for a few hours a day. They gather their food from the sea either as individuals or in large feeding flocks. All seabirds lay their eggs and raise their young on land. The seas near Alaska supply rich sources of food for the birds and their offspring (USFWS 2005). Many bird species, such as Red-legged Kittiwakes, nest only in Alaska and nearby Siberia. The Pribilof Islands provide breeding habitat for virtually all of the world's 250,000 Red-legged Kittiwakes (*Rissa brevirostris*). The Aleutian Islands provide nesting habitat for more than 21 kinds of seabirds, including the Aleutian Cackling (Canada) Goose *(Branta canadensis leucopareia),* an endemic that nests only there. The Aleutians also host the world's largest nesting populations of Least Auklets and Northern Fulmars. The only northern fur seal breeding beaches in the United States are on the Bogoslof Island in the Aleutians and in the Pribilof Islands. Many of the Aleutian Islands also support the Pribilof Island shrew (*Sorex hydrodromus*) and the endangered Aleutian shield fern (*Polystichum aleuticum*), both of which are endemic to the islands.

Coastal Islands and Sea Cliffs Conservation Status

The Alaska Maritime National Wildlife Refuge (AMNWR) encompasses many of Alaska's coastal islands, headlands and reefs. Almost all of the Aleutian Islands are included in the refuge, and many areas are also included in the Aleutian Islands

Wilderness. Small areas already developed were excluded from AMNWR or wilderness designation. The Aleutian Islands, a group of more than 200 islands, were designated a Biosphere Reserve—an international recognition given by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1976. Despite the protected status of the land, many of the animal species that live on the islands are threatened by potential or actual threats to the surrounding marine environment on which they are intrinsically dependent. The conservation problem of most concern is the decline in almost all species of fish-eating seabirds in the Aleutians. Mortality and population declines of numerous fish-eating seabird populations has been linked to trophic changes in the Bering Sea ecosystem due to commercial harvests of fish and whales over the last 4 decades, according to a study by the National Research Council (1996). The recent oil spill resulting from the grounding of the Selendang Ayu, off of Unalaska Island in the Aleutians, reminds us of the real threats these remote islands face from marine pollution. Other threats to Alaskan coastal islands and cliff habitats include habitat degradation and conversion from cattle and reindeer introduced for ranching; and predation on seabird colonies by foxes, also introduced for ranching. ANMWR engages in continuing efforts to eradicate rats, which are introduced predators of seabird colonies. Pollutants, associated primarily with military development, are locally acute. According to studies conducted by Greenpeace in 1996, radioactivity persists from the nuclear testing on Amchitka Island in 1971.

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Featured Species-associated Marine Water Habitats: Nearshore, Shelf, Oceanic and Benthic

Marine water habitats are typically subdivided into pelagic, meaning the water column from the surface to the greatest depth, and benthic, encompassing the sea floor. The pelagic environment can be further divided into the nearshore, which includes everything inshore from 20 m depth; the shelf, which includes everything from 20 to 200 m in depth; and the oceanic, which encompasses the ocean deeper than 200 m. Alaska’s vast offshore waters are located in subpolar and polar regions; these areas are characterized by extreme seasonal variation in light availability, generally low surface water temperatures, and seasonal variability of sea ice cover. At the low temperatures found off Alaska, salinity generally controls the density structure. Cooling of surface water temperatures and vigorous wind mixing caused by storms promote vertical mixing. This creates an environment where nutrients are generally abundant, especially in surface waters of upwelling regions.

Phytoplankton, or microscopic marine plants, are the driving force of marine productivity, providing 99% of the direct food consumed by marine organisms. There are tens of thousands of species of phytoplankton. A sampled phytoplankton assemblage always consists of many species; however, one species is often dominant. Individual phytoplankton species favor slightly different light intensity levels, temperatures, and nutrient concentrations. Under favorable conditions, one or more species may reproduce rapidly (within hours or days) and become dominant. When conditions change, another species may prosper, so that phytoplankton communities can vary dramatically in composition and density within very short time frames. With nutrients generally available due to upwelling, phytoplankton are able to grow quickly and are abundant when light is available. However, in Alaska light availability exhibits extreme seasonal variability in intensity and duration so that the period of ideal growing conditions for phytoplankton may be limited to a few weeks or months. The upwelling and wind mixing that supply the nutrients to surface waters may also be a limiting factor for the residence time of phytoplankton in the surface waters, by dispersing patches of phytoplankton.

The unique physical characteristics of polar marine environments have resulted in many species of fish, marine mammals, and birds sharing certain life-history characteristics. Many animals migrate seasonally, taking advantage of the highly productive short summer season and moving to other environments during the winter. Many polar marine animals are long-lived and have only 1–2 offspring per year. This ensures that the species will persist during periods of low food supply, even if no offspring survive. Another common characteristic of Alaskan marine animals is the capacity to store energy, commonly as fat, to survive periods when food is unavailable.

This section of Alaska’s CWCS focuses on 4 main types of pelagic habitat: the nearhore, shelf, and oceanic environments; and the benthic environment.

Nearshore habitat is the water column between the sea surface and seafloor in water depths up to 20 m. It includes the subtidal area adjacent to the intertidal zone. Nearshore areas have greater variability in salinity, temperature, suspended sediment concentrations, and ice scouring than shelf or oceanic habitats. Wave energy is generally higher in the nearshore than in the deeper ocean because of breaking waves. Winds, freshwater input, ice current patterns, and tides drive seasonal cycles of mixing and turnover in the water column; the column may be strongly stratified during one season and strongly mixed during another, depending on environmental conditions. Fresh water from glacial rivers carries a heavy load of fine sediments that decreases light penetration and biological productivity in turbid areas. Where waters with contrasting density, salinity, and other characteristics meet, floating debris and kelp may mark a rip line. Such boundary areas often contain a greater abundance of fish, birds, and marine mammals.

Nearshore kelp forest ADF&G/KBRR

Kelp forests growing in the nearshore habitat provide habitat structure, living substrate, cover, and microhabitats, as well as primary productivity to fuel growth. Some kelp species are perennials; however, many are annuals that die back during the dark, long winters. Although the extent of these forests varies from year to year, kelp contributes substantial primary productivity and habitat complexity to the marine ecosystem. The seasonal die-off contributes a strong pulse of detritus to the ecosystem during low-light winter months, supporting detritivores and upper trophic levels when primary productivity in the water column wanes. Eelgrass beds, which may also be considered part of the nearshore habitat, are discussed in the Intertidal Section of this appendix.

Nearshore Marine-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Red-faced Cormorant, *Phalacrocorax urile*
Black-legged Kittiwake, *Rissa tridactyla*
Pacific Common Eider, *Somateria mollissima v-nigra*
Common Murre, *Uria aalge*
King Eider, *Somateria spectabilis*
Thick-billed Murre, *Uria lomvia*
Spectacled Eiders, *Somateria fischeri*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Steller's Eider, *Polysticta stelleri*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Surf Scoter, *Melanitta perspicillata*
Least Auklet, *Aethia pusilla*
White-winged Scoter, *Melanitta fusca deglandi*
Crested Auklet, *Aethia cristatella*
Pacific sand lance, *Ammodytes hexapterus*
Marbled Murrelet, *Brachyramphus mamoratus*
Capelin, *Mallotus villosus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish, *Trichodon trichodon*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Leatherback Seaturtle, *Dermochelys coriacea*
Northern abalone, pinto abalone, Alaskan abalone, Japanese abalone, *Haliotis kamtschatkana*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Gunnels
Prowfish, *Zaprora silenus*
Arctic cod, *Boreogadus saida*
Copepods: *Neocalanus* spp., *Calanus* spp., *Acartia* spp., *Psuedocalanus* spp., *Metridia* spp., *Podon* spp., *Evadne* spp., *Oithona* spp.
Euphausiids
Amphipods
Cladocerans
Cnidarian medusae
Ctenophores
Gray whale, *Eschrichtius robustus*
Northern sea otter, *Enhydra lutris*
Cook Inlet beluga whales, *Delphinapterus leucas*
Polar bear, *Ursus maritimus*
Walrus, *Odobenus rosmarus*
Bearded seal, *Erignathus barbatus*

Shelf habitat refers to the continental shelf that lies at the edge of the continent; it includes waters greater than 20 m but less than 200 m deep. Continental shelves are nearly flat borders of varying widths that slope very gently toward the ocean basins. The width of the continental shelf varies. Shelf widths are typically greater in areas of passive continental margins, where there is little seismic or volcanic activity, because these areas are where continents are rifted apart, creating an ocean basin between them. Narrower continental shelves occur in areas of active continental margins, where plate convergence and subduction are occurring. Alaska has relatively narrow continental shelf habitat from Southeast to the southern boundary of the Aleutian Islands, and relatively wide continental shelf habitat in the Bering, Chukchi and Beaufort Seas. Shelf habitats are characterized by high productivity that supports a wide range of animals.

Continental Shelf-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Black-legged Kittiwake, *Rissa 'tridactyla*
Common Murre, *Uria aalge*
Thick-billed Murre, *Uria lomvia*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Least Auklet, *Aethia pusilla*
Crested Auklet, *Aethia cristatella*
Marbled Murrelet, *Brachyramphus mamoratus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Myctophids (lantern fish), Myctophidae
Prowfish, *Zaprora silenus*
Arctic cod, *Boreogadus saida*
Copepods:
Neocalanus spp.
Calanus spp.
Acartia spp.
Metridia spp.
Oithona spp.
Psuedocalanus spp.
Chaetognaths:
Sagitta elegans
Euphausiids
Polar bear, *Ursus maritimus*
Cnidarian medusae
Walrus, *Odobenus rosmarus*

Jellyfish under Arctic ice
Oceanic and Atmospheric Research (OAR)
National Underseas Research Program

Pteropods
Bearded seal, *Erignathus barbatus*
Amphipods
North Pacific right whale, *Eubalaena japonica*
Ctenophores
Ringed seal, *Phoca hispida*
Blue whale, *Balaenoptera musculus*
Spotted seal, *Phoca largha*
Humpback whale, *Megapetera novaeangliae*
Gray whale, *Eschrichtius robustus*
Sei whale, *Megaptera novaeangliae*
Bowhead whale, *Balaena mysticetus*

Oceanic habitats begin at the abrupt change in slope that occurs at the boundary of the continental shelf on the ocean side. The steep slope extending to the ocean basin floor is called the continental slope. Oceanic habitats include several layers of water that each has distinct characteristics of salinity, temperature, and light intensity. The epipelagic zone, which extends between the surface and 200 m depth, is the only area where food can be directly produced by photosynthesis in the open ocean. Below this, the source of food is primarily from detritus falling from the epipelagic zone. Minor additional food sources include vertically migrating animals and chemosynthesis at hydrothermal vents. Alaska has vast oceanic habitats associated with its extensive coastline.

Oceanic-associated Species

Underwater humpback whale
OAR, National Undersea Research Program; University of South Carolina at Wilmington

Red-legged Kittiwake, *Rissa brevirostris*
Black-legged Kittiwake, *Rissa tridactyla*
Common Murre, *Uria aalge*
Thick-billed Murre, *Uria lomvia*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Least Auklet, *Aethia pusilla*
Crested Auklet, *Aethia cristatella*
Marbled Murrelet, *Brachyramphus mamoratus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Leatherback Seaturtle, *Dermochelys coriacea*
Copepods:
Neocalanus spp
Calanus spp.
Psuedocalanus spp.
Acartia spp.
Metridia spp.
Oithona spp.
Amphipods
North Pacific right whale, *Eubalaena japonica*
Baird’s beaked whale, *Berardius bairdii*
Chaetognaths: *Sagitta elegans*
Bowhead whale, *Balaena mysticetus*
Sagitta elegans
Ctenophores
Euphausiids
Blue whale, *Balaenoptera musculus*
Humpback whale, *Megapetera novaeangliae*
Cnidarian medusae
Cuvier’s beaked whale, *Ziphius cavirostris*
Sperm whale, *Physeter macrocephalus*
Sei whale, *Megaptera novaeangliae*
Fin whale, *Balaenoptera physalus*
Stejneger’s beaked whale, *Mesoplodon stejnegeri*

Benthic habitats include all of the seafloor environments, extending from edge of the land to the deepest ocean trench. For the purposes of the CWCS, we are only including the benthic environment between the continental shelf break, (200 m water depth) and the low-tide zone. This part of the benthic area is called the “sublittoral zone” by oceanographers. The benthic area between low tide and the high tide line is covered under the Intertidal section of this plan. The habitat of the sublittoral zone environment can be soft-bottom (mud, sand, shell, gravel) shell debris or rocky. Benthic communities include infauna, which are organisms that live within sediments, and epifauna, which are organisms that live on sediments. In general, benthic mapping information for Alaska is very limited.

Cold-water corals form important benthic habitat in the Gulf of Alaska and off the coast of the Aleutian Islands. These coral gardens include more than 100 species of coral and are comparable in size and structure to tropical coral reefs. The Aleutian Islands have the highest coral diversity of Alaska’s waters. Some of these corals have a tree-like structure and can reach heights of 3 m and widths of 7 m. Unlike many other corals, deep-sea Alaska corals don't need light to grow. Growing on the ocean floor in depths of 200 m or more, the corals acquire all the nutrients they need directly from the water column.

Benthic Habitat–associated Species

Pacific sand lance, *Ammodytes hexapterus*
Capelin, *Mallotus villosus*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish, *Trichodon trichodon*
Sculpins (Cottid, Hemipterid, Rhamphocottid,
Stichaeid, and Pholid families)
Pricklebacks
Class Bivalvia:
- *Macoma* spp.
- *Clinocardium* spp.
- *Serripes* spp.

Corals, Tunicates and Sponges:
- Phylum Porifera
  - *Mactromeris* spp.
- Phylum Cnidaria:
  - Octocoral Families: Corallidae, Isididae, Paragorgiidae, Pennatulidae, Primnoidae
  - Hexacoral Families: Antipathidae, Oculinidae, Caryophylliidae
  - Hydrocoral Family: Stylasteriidae

Typical bottom view of urchins and mussels at 25 m.
Yury A. Zuyev, Hydrometeorological Institute, St. Petersburg, Russia

Ecological Role of Marine Water Habitats

The pelagic open water environment of nearshore, shelf, and oceanic habitats provides important nursery, feeding, and resting habitat for numerous seabirds, fishes, marine mammals, and of course, plankton. In the shallower waters of the nearshore, photosynthesis may take place on the seafloor. In both locations, primary production by benthic organisms creates some food, but the vast majority of food in the pelagic zone is produced by phytoplankton through the act of photosynthesis. These phytoplankton are grazed upon by zooplankton, which in turn are consumed by carnivores and omnivores. Common zooplankton in these habitats include species of *Neocalanus*, *Metridia*, *Acartia, Pseudocalanus, Calanus,* plus euphausiids, amphipods, cnidarians, ctenophores, and cladocerans. The chaetognath *Sagitta elegans* occurs mainly in the shelf environment (K. Coyle, pers. comm.). Fish such as Pacific sand lance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), eulachon (*Thaleichthys pacificus*), Pacific sandfish (*Trichodon trichodon*), sculpin (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families), lantern fish (myctophids), prowfish (Myctophidae), and Arctic cod (*Boreogadus saida*) are common. These fish are eaten by seabirds such as Red-legged Kittiwake, (*Rissa brevirostris*), Black-legged Kittiwake (*Rissa tridactyla,* Common Murre (*Uria aalge*), Thick-billed Murre (*Uria lomvia*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Fork-tailed Storm-Petrel (*Oceanodroma furcata*), Least Auklet (*Aethia pusilla*), Crested Auklet (*Aethia cristatella*), Marbled Murrelet (*Brachyramphus mamoratus*), Kittlitz' Murrelet (*Brachyramphus brevirostris*), Arctic Tern (*Sterna paradisaea*) and Aleutian Tern (*Sterna aleutica*). Some marine mammals (e.g., whales) feed directly on plankton, while others, such as seals, feed on fish.

The water column community changes constantly as species move in to follow feeding, spawning, and seasonal migration patterns. Some species remain in the same general area, while others migrate on daily and seasonal cycles. In general, summer is the peak of fish activity and fish abundance in nearshore areas. Even species that remain in the same general location throughout the year are more active and may be more conspicuously colored during summer mating or nest-guarding periods. Over longer time scales, community composition also varies in response to prey availability, water temperatures, fishing, and other factors.

Benthic habitats are diverse. The grain size of the substrate is a significant factor in determining which communities develop. Along the continental shelf in the eastern Bering Sea and much of the Gulf of Alaska, the seafloor is soft and covered with sand, mud, silt, bits of broken shell, and other fine materials. These soft sediments are rich in life and often inhabited by many organisms living within the upper layers of the seafloor (infauna) or on the surface of these seafloor substrates (epifauna). Typical benthic communities contain a diversity of deposit and suspension feeders, as well as predators and scavengers, but suspension feeders dominate. Prominent species include barnacles, king crab, bryozoan and other hydroids, shrimp, ascidians, anemones, sea pens, sea whips, brittle stars, sea cucumbers, sponges, gastropods, urchins, and shrimp. Soft-bottom communities recycle nutrients from the water column and rocky habitats. Organic detritus from kelp and other macroalgae, dead animals, zooplankton, phytoplankton, and other sources of nutrients and carbon rain to the bottom. Contaminants in the water column also settle and accumulate in soft sediments; therefore, benthic communities are often used to the assess presence of pollution in the water column. As burrowing species churn the sediments, they incorporate nutrients into the sediments that feed deposit feeders. Bottom-dwelling fish, invertebrates, decomposers, and microbial life consume the contaminants and other organic materials, converting it to living biomass. These processes link the health and productivity of the soft and hard substrate communities with those communities living in the water column. In addition to physical factors—such as light penetration, depth, and temperature—predators influence the community by selectively targeting certain prey species. Some large fish such as rays (Raja spp.) physically disturb the sediments by digging pits. This behavior can smother or expose other buried infauna and open new areas for species to colonize, influencing community composition through disturbance.

The deep-sea coral reefs, composed of cold-water corals, black coral, gorgonian corals, stony corals, sea whips, sea pens, and sponges (Corallidae, Isididae, Paragorgiidae, Pennatulidae, Primnoidae; Antipathidae, Oculinidae, Caryophylliidae, Stylasteriidae) near the Aleutians provide nurseries, places to feed, shelter from currents and predators, and spawning areas for fish and many other species of marine life (NOAA 2005). Corals have a calcium carbonate skeleton that supports colonies of individual polyps. The polyps use stinging cells to capture plankton. Many of the cold-water corals are believed to be hundreds of years old, with very low reproductive and growth rates, making them especially vulnerable to disturbance. Sea stars, basket stars, polychaetes, snails, sponges, anemones, rockfish, shrimp, and crabs are known to inhabit Alaska's cold-water coral gardens.

Marine Water Habitat Conservation Status

Alaska's marine waters and associated habitats are generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and provide suitable areas of quality habitat important to the sustainability of species.

Alaska marine habitats provide food for marine plants and animals, shelter from predators, and a refuge in which to reproduce. The extensive and seamless nature of marine ecosystems puts them at risk for water pollution, which can travel far from its original source, making it difficult to regulate. Pollution from the oil industry is a major concern in Alaskan marine waters, especially since the oil tanker Exxon Valdez spilled 11 million gallons of oil, causing extensive damage to marine habitats in the Gulf of Alaska. The Exxon Valdez spill resulted in the death of thousands of marine mammals and seabirds and long-term damage to coastal marine habitats. The recent oil spill from the shipping vessel Selendang Ayu in the Aleutian Islands (January 2005) reminds us that the threat of oil contamination is always near because of extensive coastal shipping. Other threats to marine waters from oil exploration include the disposal of toxic drilling muds, and noise pollution.

Increases in marine water transport activities related to recreational, commercial and industrial uses place additional stress on the health of Alaska's marine waters. The growing presence of large cruise ships, bulk cargo ships, and oil carriers to Alaska's developing port facilities poses concerns related to the proper disposal of solid waste and gray water. Gray and black water disposal from recreational boating activities into marine waters goes essentially unregulated.

Proliferation of invasive species is a significant concern relating to Alaska's marine environment. Several species, including Atlantic salmon (*Salmo salar*), Chinese mitten crab (*Eriocheir sinensis*), and the European green crab, (*Carcinus maenas*), have been identified as real or potential threats to Alaskan ecosystems in Alaska's *Aquatic Nuisance Plan* (ADF&G 2002). Southern marine areas are generally in more danger of invasive species than northern marine areas because most invasive species originate from southern areas, and there is more commerce (shipping, ports, etc) in the south (ADF&G 2002). However, climate change will bring greater levels of coastal shipping to and through the Arctic in coming decades, increasing the likelihood of such problems as invasive species and spills. Biological regime shifts leading to ecological shifts as a result of a warming climate are increasingly being documented for marine species from phytoplankton to marine mammals (Mantua and Hare 2002).

Other conservation concerns for Alaska's marine environment include adverse impacts from fishing techniques, in particular on-bottom trawling (NRC 2002). Some marine habitats under federal jurisdiction are protected by the Marine Protected Areas (MPAs) initiative. MPAs are year-round closures designated to enhance conservation of marine or cultural resources. In Alaska, MPAs in federal waters include the Nearshore Bristol Bay Crab Protection Zone, the Pribilof Islands Habitat Conservation Area, and the Southeast Alaska Trawl Closure. Since 1987, the North Pacific Fishery Management Council has closed 2 areas around Kodiak Island to bottom trawling and scallop dredging because of their designation as important rearing habitat and migratory corridors for juvenile and molting crabs. The closures are intended to assist rebuilding severely depressed Tanner and red king crab stocks. In addition to crab resources, the closed areas and areas immediately adjacent to them have rich stocks of groundfish, including flathead sole, butter sole, Pacific halibut, arrowtooth flounder, Pacific cod, walleye pollock, and several species of rockfish (NMFS 2005). In 1996 Congress added new habitat provisions to the Magnuson-Stevens Fishery Conservation and Management Act, the federal law that governs U.S. marine fisheries management. The new provisions require each fishery management plan to describe and identify essential fish habitat for the fishery, minimize to the extent practicable the adverse effects of fishing on those habitats, and identify other actions to encourage the conservation and enhancement of those essential habitats (NMFS 2005). An area known as the Sitka Pinnacles, located off Cape Edgecumbe in the Gulf of Alaska, has been closed to all bottomfishing and anchoring since 1999 to protect lingcod, rockfish, and corals (NMFS 2005). Steller sea lion critical habitat has been defined as 20 nautical mi from 39 rookeries and 83 haulouts, it also includes 3 foraging areas: Seguam Pass, Bogoslof Island, and Shelikof Straits. These areas are off limits for commercial fishing.

Activities that might affect Alaska's marine waters and submerged lands are regulated by both state and federal agencies. Marine waters and submerged lands that are under state jurisdiction extend from the mean high tide line of the state's coastline to 3 nautical mi seaward. Beyond this 3-mi limit, marine waters and habitats are under federal jurisdiction for another 197 nautical mi, the full extent of our nation's Exclusive Economic Zone (EEZ). International law extends the OCS to 200 nautical mi seaward form the coastline, but does not take into account the state/federal boundary. Generally referred to as "federal waters," the federal OCS begins at the state submerged lands line and extends seaward to the 200-mi legal limit.

While coastal states have primary jurisdiction and control over the first 3 mi of the EEZ and the federal government has primary jurisdiction over and controls the remaining 197 mi, the Coastal Zone Management Act (CZMA) provides Alaska with substantial authority to influence federal actions beyond 3 nautical mi. The CZMA is the federal legislation that authorized the Alaska's Coastal Management Program (ACMP).

DNR is responsible for implementing the CZMA within state waters and submerged tidelands. DNR develops statewide standards for the ACMP and coordinates individual project review among natural resources agencies to facilitate responsible development within Alaska's coastal zone.

DEC administers the state's water quality laws. DEC has broad authority to adopt pollution standards and to determine what water properties indicate a polluted condition. In addition, DEC establishes marine water quality criteria for 7 aquatic uses: aquaculture; seafood processing; industry; contact recreation; non-contact recreation; growth and propagation of fish, shellfish, other aquatic life and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life.

Federal authority regarding discharges to marine waters from marine vessels are regulated by EPA. In addition to DEC and the EPA, the International Convention for the Prevention of Pollution from Ships, known as MARPOL (for "marine pollution"), establishes standards for protecting the marine environment from ship pollution. MARPOL regulations are aimed at preventing pollution from oil, chemicals, harmful substances in packaged form, sewage and garbage (IMO 2002).

The United States Coast Guard (USCG) enforces MARPOL standards and also regulates surface activities on marine waters, while both the USCG and the COE are responsible for activities affecting navigable waters. Activities pertaining to the marine bed are jurisdictional to the U.S. Department of Interior's Minerals Management Service. The USFWS regulates activities regarding marine mammals, and NMFS has authority over activities pertaining to marine fish.

One of NMFS's primary responsibilities is implementing and enforcing the Magnuson-Stevens Act. The Magnuson-Stevens Fishery Conservation Act is the governing authority for all fishery management activities that occur in federal waters within the United States 200 nautical mi limit, or EEZ.

The Magnuson-Stevens Act mandates the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary for fish to complete their life cycles. Congress has defined EFH as waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity. The Magnuson-Stevens act requires that federal agencies consult with NMFS and consider NMFS conservation recommendations for any action they fund, authorize or undertake that may reduce the quality or quantity of designated EFH (NOAA 2001).

Marine waters conservation actions that focus on the protection of habitats and biota, water quality, sound science, partnering, and education and outreach will be most efficient at sustaining Alaska's marine habitats. Conservation recommendations for marine habitats include protecting habitats from human activities that cause degradation and habitat loss; designing and implementing local and regional projects that sustain natural processes; surveying and mapping marine resources and physical characteristics of marine habitats via GIS; and making policy and scientifically based recommendations regarding appropriate management tools to protect marine habitats.

Conservation recommendations for marine biota include making efforts to sustain healthy populations and carrying out actions to protect and restore species of concern, including mammals, birds, fish, shellfish, and other invertebrates; designing and implementing projects that sustain native marine plant and animal populations and prevent the introduction and spread of invasive species; rebuilding depleted populations of fish species, particularly bottomfish, shellfish and forage fish; and making policy and scientifically based recommendations about appropriate management tools to sustain species.

Protecting Alaska's marine water quality is essential to the sustainability of its aquatic resources. Conservation actions that promote maintaining water quality include reducing the input of contaminants, such as toxic substances, to Alaska's marine waters; promoting management actions to restore areas of degraded water quality; and designing and supporting projects that will sustain healthy and functioning marine waters.

The continued development and implementation of sound science to promote understanding of marine waters and habitats are priorities for Alaska. Recommended conservation actions toward this end include collecting high quality data and encouraging its use and dissemination through the development of protocols for collection, analysis and use of scientific data that support Alaska's goals; identifying and striving to fill data gaps that limit protection and restoration efforts; promoting the development of comprehensive, accessible, marine resource databases; promoting the consistent collection and coordination of data to assist the efforts of Alaska and its partners to protect marine habitats and species of concern; and circulating scientific information about local marine resources to management agencies, as well as to the public.

Education and outreach efforts that promote stewardship and understanding of Alaska's marine resources are needed to inform the public about threats to the state's marine resources, and provide practical measures to prevent additional impacts. This should include coordinating outreach and education programs with other organizations and monitoring their effectiveness, and engaging the public in active stewardship opportunities through workshops, restoration projects, citizen-science and educational programs. Lastly, communication regarding the status of Alaska's habitats and resources to regional policymakers and resource managers and property owners is crucial to acquiring support for programs that help protect marine habitats and its resources.

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