4.0 COMPOSITION OF BIOLOGICAL COMMUNITIES

The determination of "unreasonable degradation" of the marine environment is to be based upon consideration of the ten criteria listed in Section 1.0. The following section provides information pertinent to consideration of the two ocean discharge criteria shown below:

- **Criterion #3:** "The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain"

- **Criterion #4:** "The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism".

This section is intended to provide an overview of the biological communities found within the Alaskan coastal waters covered under the proposed NPDES general permit. This overview will identify key species that are important from an ecological and economical standpoint, or for subsistence harvesting. Significant interspecies relationships, essential environmental requirements, seasonal distribution and abundance, and prominent areas or habitats where these species occur will also be discussed. The biological communities to be discussed in this section include the following:

- Plankton (both phytoplankton and zooplankton)

- Benthic Invertebrates

- Fishes

- Marine Birds and Waterfowl
- Marine Mammals.

4.1 PLANKTON

Phytoplankton and zooplankton are vital components of the pelagic plankton community as these two groups provide the food base for many other groups of marine organisms found within Alaskan coastal waters. In addition, larval stages of many benthic and fish species are temporary members of the zooplankton community (meroplankton) during early developmental stages. The distribution, abundance, and seasonal variation of these organisms is strongly influenced by the physical environment.

4.1.1 Phytoplankton

The seasonal cycle of phytoplankton productivity and standing stock throughout the area of coverage of the proposed NPDES general permit is typical of northern temperate waters. Both phytoplankton productivity and standing stock increase from April to early July with peaks in May and early July, respectively. Phytoplankton assemblages are dominated by pennate and centric diatoms, with dinoflagellates, microflagellates, and other classes and families of phytoplankton also being present. Phytoplankton biomass is controlled by light, nutrients, and density structure of the water column.

4.1.1.1 Important Species and Trophic Relationships. Diatoms are the most important group of phytoplankton found in high latitude seas (Raymont 1980, p. 242) and dominate the phytoplankton during spring and summer. Under-ice (epontic) algae, primarily diatoms, probably contribute significantly to production in areas of ice coverage. The most abundant species found in the Gulf of Alaska from April to August 1976, were *Thalassiosira* spp., *Melosira sulcata*, and *Chaetoceros* spp. (Larrance et al. 1977). A variety of herbivores are dependent upon phytoplankton, including zooplankton, benthic invertebrates, and waterfowl.

4.1.1.2 Important Habitats or Areas. Phytoplankton growth in Kachemak and Kamishak Bays is exceptionally high for a brief period in late spring. Peak productivity (5-10 mg C/m^2/day) occurred with the spring bloom in late May and intermediate levels (1-5 mg C/m^2/day) were measured in July (Larrance et al. 1977). Kachemak Bay is the most productive area in lower Cook Inlet. The peak level of primary productivity observed in this area (7.7 g C/m^2/day) is one of the highest values reported from a natural marine environment (SAIC 1977).

Macroalgae communities (macrophytes) are distributed throughout the coastal areas of appropriate habitat (Truett 1984, p. 142). *Laminaria saccharina* and *L. solidungula* are the primary kelp bed species. Macrophyte communities are also known to be supported in southeastern Cook Inlet and in Kachemak Bay (Dames and Moore 1978).

4.1.2 Zooplankton

Zooplankton include organisms which are planktonic throughout their entire life (holoplankton) and species that are planktonic only during a portion of their lifecycle (meroplankton). The meroplankton consist mainly of the larval stages of benthic invertebrates, which may outnumber the holoplankton for brief periods in shallow water. An abbreviated list of common zooplankton species in Cook Inlet and the southeastern Bering Sea is shown in Table 4-1. More detailed accounts of species found in Shelikof Strait, Cook Inlet, and the southeastern Bering Sea are provided by Seifert and Incze (1991), Damkaer (1977), and Cooney (1978), respectively.

Zooplankton abundance varies seasonally with maximums generally occurring in the summer. A considerable portion of the seasonal biomass variation that occurs in oceanic regions likely reflects the life histories of three large calanoid copepods: *Neocalanus cristatus, Neocalanus plumchrus, and Eucalanus bungii*. These copepods migrate vertically in the water column and various developmental stages occur in the upper 150 m for a minimum of 10 months of the year (Cooney 1987). Smaller copepods, such as *Calanus pacificus* and *Metridia pacificus*, are also abundant at various times of the year. Decapod larvae are present primarily in spring and summer and are more prevalent in bays and nearshore waters (Kendall et al. 1980). Fish eggs and larvae are found throughout the year, although abundance and spatial distribution is highly variable due to seasonal spawning. Euphausiids are most abundant in the summer and display vertical distribution near the surface prior to and during spawning.

Seasonal changes in zooplankton distribution are affected by biological factors such as vertical migration and physical factors such as local currents, wind, bathymetry, and fresh water input.

4.1.2.1 Important Species and Trophic Relationships. Zooplankton communities are similar in their composition and relative dominance structure in the southeastern Bering Sea, North Pacific, the northern Gulf of Alaska, and the northwestern Pacific Ocean (Cooney 1978). Copepods are the dominant zooplankton group, both in terms of numbers and biomass (Kendall et al. 1980). Greater than 70 percent of the oceanic biomass in lower Cook Inlet and upper Shelikof Strait is comprised of three species: *Neocalanus cristatus, Neocalanus plumchrus, and Eucalanus bungii* (Cooney 1987). These species are omnivores, feeding on phytoplankton, zooplankton, and detritus. Chaetognaths are uniformly abundant throughout most of the year whereas cnidaria are most numerous in nearshore and midshelf waters in summer and fall (Kendall et al. 1980). Species within the both of these groups are carnivorous, feeding on zooplankton and small fish. Amphipods are found throughout the year with the greatest abundance in the summer and fall.

Zooplankton serve as forage for fish (copepod nauplii are critical in the diet of most larval fish), shellfish, and marine birds and mammals. Euphausiids are essential organisms in the diets of yellow Irish lord and yellowfin sole, and mysids are the principal prey of walleye pollock and halibut (SAIC 1979). Copepods and euphausiids are important prey items for blue, bowhead, fin, humpback, minke, northern right, and sei whales.

4.1.2.2 Important Habitats or Areas. Important habitats as applied to zooplankton assemblages, is most appropriate for the temporary or meroplanktonic forms, such as the eggs and larvae of fishes and shellfishes. In the southeastern Bering Sea, zoea and megalops of spider crabs, of which snow crab was dominant, and larval walleye pollock were censused. Crab larvae were collected in all areas and seasons, pollock larvae were restricted to the early spring, in open oceans and outer shelf regions (Cooney 1978). The waters of lower Cook Inlet have a high standing stock of zooplankton in the spring and summer. In Shelikof Strait, walleye pollock spawn large concentrations of free-floating planktonic eggs near the seafloor during the spring and the resulting larvae have an 8 week planktonic phase (Schumacher and Kendall 1989).

4.2 BENTHIC INVERTEBRATES

Benthic organisms are generally sensitive to deposition of solids such as seafood waste, and can be considered indicators of the intensity of pollution. Benthic invertebrates are important as prey for higher trophic levels and are important mediators for nutrient recycling. Several benthic species are harvested commercially: Tanner crab, Dungeness crab, weathervane scallop, and shrimps. Razor clams are harvested from nearshore areas and bays. Benthic species frequently harvested for subsistence purposes include the following: clams (razor, butter, steamer), crabs (Tanner, Dungeness, red king), cockles, and shrimp.

In general, polychaetes, bivalves, and small crustaceans, primarily amphipods, are the most abundant organisms, with polychaetes often constituting the majority of the infauna. Benthic infauna are not uniformly distributed, but many infauna have broadly overlapping ranges. Approximately 165 epifaunal species and 264 infaunal species were collected by Feder (1981) in lower Cook Inlet. Arthropods, molluscs, and echinoderms were the most frequent epifaunal species accounting for 60, 59, and 23 of the total species respectively, as well as dominating the total biomass. Molluscs, arthropods, and echinoderms were the most frequent infaunal species accounting for 128, 54, and 26 of the total species, respectively (Feder 1981). Additional discussion of benthic epifaunal and infaunal species in lower Cook Inlet and Shelikof Strait including distribution and abundance may be found in U.S. EPA (1983, Section 5; 1984a, Appendix C).

In southeastern Alaska, polychaetes (*Nephthys cornuta, Owenia fusiformis, Mesochaetopterus, and Euclymene* sp.) and molluscs were found to be dominant taxa in two studies of the region (Meyers 1977; Hughes 1983). Other taxa found in this area included holothuroids, brachiopods, echiuroids, sipunculids, nemerteans, and epibenthic crustaceans. An average of 1,136 individuals/m^2, with an average biomass of 4,092 g/m^2 were documented in this area.

Stoker (1981) studied the benthic communities in the Bering and Chukchi Seas and recognized eight major faunal assemblages. The faunal composition for the Chukchi Sea area was noted as being similar to that found in the eastern Bering Sea. Two major faunal assemblages were identified in the Chukchi Sea that also occurred in the Bering Sea. One group was characterized by the polychaete *Maldae sarsi*, the echinoderm *Ophiura sarsi*, the sipunculid *Golfingia margaritacea*, and the bivalve *Astarte borealis*; the second group was characterized by the bivalves *Macoma calcarea*, *Nucula tenuis*, and *Yolida hyperborea*, and the amphipod *Pontoporeia femorata*. The Chukchi Sea fauna was dominated by detritus feeders. In examining the species distributions, sediment type was the environmental variable most directly correlated with the observed distributions (Stoker 1981).

4.2.1 Important Species and Trophic Relationships

The Tanner and Dungeness crabs and shrimp are the principal commercial benthic invertebrates harvested. Large populations of red king crab were previously found in lower Cook Inlet and around Kodiak Island, however, in recent years the numbers in these areas have been greatly reduced.

Many benthic species are important prey items for higher trophic level consumers [e.g., amphipods, molluscs (particularly *Spisula polynyma* and *Nuculana fossa*), Tanner crabs, ophiuroids, shrimps, barnacles, and hermit crabs (U.S. EPA 1983)]. As well as being prey for Pacific cod, sculpins, and halibut, the Tanner crab is also a major predator on infaunal and epifaunal benthos. Post-larval red king crabs consume detritus, bryozoans, foraminiferans, copepods, and ostracods, while adults feed on barnacles, molluscs, and hermit crabs. Pandalid shrimp feed primarily on benthic crustaceans, polychaetes, molluscs, diatoms, foraminiferans, and small fish.

4.2.2 Important Habitats or Areas

Kamishak Bay, Kachemak Bay, the area between Cape Douglas and the Barren Islands, and part of Shelikof Strait are nurseries for Tanner crab. Kamishak Bay, Kachemak Bay, and areas of Shelikof Strait are also important habitats for king crab and Dungeness crab (U.S. EPA 1983). Five species of pandalid shrimp (principally pink and humpback) are harvested commercially from Kachemak Bay. Populations of these shrimp are declining and current harvests are allowed over limited areas in Cook Inlet and Shelikof Strait (U.S. DOI/MMS 1992). Razor clams are harvested primarily from the Kenai Peninsula beaches between Anchor Point and Kasilof as well as Clam Gulch.

4.3 FISHES

Fish assemblages are dominated by demersal species, with walleye pollock, yellowfin sole, and halibut being the most abundant species. Anadromous fish including chinook, coho, sockeye, chum, and pink salmon are important commercial fish in terms of harvest volume and value. Other fish of commercial value include: walleye pollock, halibut, and herring. The five species of salmon and other anadromous fish such as steelhead trout and Dolly Varden are popular sport fish. Species important as prey for higher trophic levels include sand lance and capelin, as well as previously mentioned species. A review of these species abundances and distributions can be found in U.S. DOI/MMS (1992). Detailed life history information and distribution of the species discussed below can be found in the "Atlas to the Catalog of Waters Important to Spawning, Rearing, and Migration of Anadromous Fish" and "Alaska Habitat Management Guides" published by the Alaska Department of Fish and Game.

4.3.1 Important Species and Trophic Relationships

The following discussion will be divided into commercially harvested fish, such as Pacific salmon and halibut, and other species which are not commercially harvested, but are important as prey for higher trophic levels, such as sand lance and capelin.

4.3.1.1 Commercially Harvested Fish. Five anadromous species, two groundfish species, and one pelagic species constitute the bulk of the fish harvested commercially. A brief description of each of these species is provided below.

Pacific salmon is the major pelagic finfish group of the Alaska region; all five American species occur throughout this region. Only a few occasional salmon are found in the Chukchi Sea. The Bering Sea-Bristol Bay sockeye run is the largest run of this salmon species in the world, although there are more pink salmon in the Alaska region than the other salmon species. Pink salmon are also more widely distributed in the region than other species. All pacific salmon are anadromous, returning to freshwater from the ocean to spawn and then die. The progeny enter the Bering Sea and North Pacific Ocean to mature. Most salmon rear in the North Pacific Ocean; only a few rear in the eastern Bering Sea. Pacific salmon may migrate over long distances during the course of their maturation before returning to their natal spawning areas. Bering Sea salmon migrate from the rivers of southwest Alaska along the coastline and through Unimak and the eastern Aleutian Island passes. Alaska region salmon remain in the ocean for one to three years before returning to spawn. Bering Sea spawning salmon, other than the Bristol Bay and North Alaska Peninsula runs, migrate in broad bands across the eastern Bering Sea to the major (Yukon and Kuskokwim) and smaller rivers of southwest Alaska.

Pink salmon. Pink salmon spawn annually with substantially larger returns in even-numbered years. The spawners migrate to their natal streams in early summer and runs may continue into early August. The fry emerge from the stream gravel in spring and school in estuarine waters for approximately a month before beginning a gradual, irregular movement to the ocean where they usually remain for two years. In late summer and early fall, the large schools move offshore to deeper waters, while still remaining relatively close to shore until December when they move further offshore. Copepods, amphipods, tunicates, and euphausiids are the dominate prey of pink salmon.

Sockeye salmon. Sockeye salmon spend two to three years in the ocean before migrating to their natal streams to spawn from early June until late August. Young sockeye remain in coastal waters during their first year of life. Juveniles feed on copepods, fish eggs and larvae, and shrimp larvae. Sockeye salmon prey consists of copepods, amphipods, tunicates, and euphausiids.

Chum salmon. Chum salmon remain in the ocean for two to four years before migrating to their natal streams. They spawn from late July to late October and are the second most abundant species along the shoreline in lower Cook Inlet from May to September (KPB 1990). The fry spend several months in estuarine waters before beginning their offshore migration in early fall. Juveniles feed on zooplankton (primarily copepods) and aquatic insects; adults feed on zooplankton, small fish, and squid (U.S. DOI/ MMS 1984).

Coho salmon. Coho salmon spend one to two years in the ocean before migrating to their natal streams from late July to December. Young coho enter the ocean after one to four winters in freshwater and remain nearshore and near the surface where they feed on small fish and zooplankton crustaceans before moving further offshore (U.S. EPA 1983). Adult coho feed on squid, euphausiids, and small fish in the open ocean.

Chinook salmon. Chinook salmon spawn from mid-May to early August. Young chinook enter the ocean after spending one to two years in freshwater and remain nearshore for a short period before moving further offshore. Juvenile chinook feed primarily on fish larvae and aquatic insects whereas adults feed on herring, sand lance, squid, and crustaceans.

Walleye pollock. Walleye pollock predominates in the groundfish complex of the eastern Bering Sea and largely in the commercial harvest in the Gulf of Alaska. This demersal species is found in large schools. Annual spawning begins in early spring and may continue into early summer. The larvae form dense aggregations that appear to be strongly dependent on ocean dynamics (e.g., the Alaska Coastal Current) for transport (Schumacher and Kendall 1989). Pollock migrate seasonally, moving from deeper waters in the winter to more shallow water in the summer. The fish also undergo diurnal, vertical migrations from deeper to shallow waters in the evenings (U.S. DOI/MMS 1984). Pollock feed on numerous species including mysids, euphausiids, and small fish. In addition to being of great commercial value, pollock serves as food for other marine fishes, birds, and mammals.

Pacific halibut. Pacific halibut is the largest and most commercially valuable of the flounders. Halibut are slow growing and may live longer than 30 years. They spawn in deep waters where the larvae remain 4 to 5 months before entering the benthos. Adults feed on fishes, crabs, clams, squids, and other invertebrates. Larval halibut consume a wide variety of pelagic organisms including crustaceans, euphausiids, and amphipods. Halibut annually move to and from deeper waters but do not display obvious migratory patterns. Alaska populations of halibut are currently high, but are starting to decline (U.S. DOI/MMS 1992).

Pacific herring. Herring sac-roe is of high commercial value while adult herring are currently used mainly for bait in other fisheries. The Pacific herring populations in Alaska are generally on a downward trend. Bering Sea migrations are along the North Alaska Peninsula and out to the Aleutian Islands, then north toward the Pribilof Islands where herring overwinter in deeper waters. Pacific herring undergo annual spring migrations from pelagic waters to the coastal areas of southwest Alaska, lower Cook Inlet, Prince William Sound, and the islands and coast of southeast Alaska to spawn. The eggs are deposited on kelp, other seaweeds, rock substrate, and detritus in the shallower coastal zone. After spawning and hatching, both adult and larval herring remain in nearshore water until fall when the schools move to deeper and warmer waters to overwinter. Adults and larvae feed primarily on zooplankton (U.S. DOI/MMS 1992). Larvae and juveniles feed and grow in estuaries and embayments, thus making them vulnerable to changes in inshore habitats. Herring are important food fishes for other pelagic fishes, and marine birds and mammals. They are also important target species in the diets of communities participating in subsistence fishing.

Sablefish. The sablefish, or black cod is found in large numbers in the Gulf of Alaska; however, eastern Bering Sea populations of this species are smaller. Sablefish occur in deeper waters (200-500 fathoms) where they prey on a variety of crustaceans, worms, and small fishes. Sablefish reach 102 cm (40 in) length and attain a weight in excess of 57 kg (125 lb). The species spawns in winter and the eggs are pelagic; with larvae near the surface. Juveniles are sometimes found in large schools in nearshore waters. Sablefish migrate extensively over long distances, but without apparent timing or routing.

Pacific cod. Pacific cod is a benthic species that ranges throughout the North Pacific Ocean and eastern Bering Sea. Spawning occurs during winter and the eggs are demersal. Larval cod range from pelagic to benthic waters and they grow rapidly, reaching about 1 m (3.3 ft) in length within 2-3 yrs. Adult cod feed on a variety of worms, crabs, mollusks, shrimps, and herring. There is a high natural mortality for this species, although Alaska region populations are at high levels (U.S. DOI/MMS 1992).

4.3.1.2 Non-Commercially Harvested Species. There are three species of fish that are important as prey species for higher trophic levels: Pacific sand lance, capelin, and yellowfin sole. Dolly Varden is an important sportfish species recreationally harvested in Cook Inlet. A brief description of each of these species is provided below.

Pacific sand lance. Pacific sand lance are abundant in nearshore areas and bays and generally inhabit water less than 100-m (330-ft) deep. Sand lance lack a swim bladder and must actively swim, rest on the seafloor, or bury themselves in sand or fine gravel. They may form large pelagic schools during the day and return to the bottom at night. Sand lance spawn during winter in areas of strong current. The larvae are planktonic and feed on diatoms, copepods, shrimp, and barnacle nauplii (Blackburn 1979). Pacific sand lance are prey items for salmon, Pacific cod, halibut, other demersal fishes, marine birds and mammals.

Capelin. Capelin generally form large schools near the bottom and large concentrations may occur within the lease sale area. Spawning usually occurs from the end of May to about mid-July. Eggs are deposited on sandy beaches at night or on cloudy days following a high tide and are buried in the sand by wave action. Capelin consume copepods, amphipods, euphausiids, and shrimp and are important prey items for other fishes, marine birds and mammals (U.S. EPA 1983).

Yellowfin sole. Yellowfin sole are the second most abundant offshore demersal fish species found in lower Cook Inlet. This population of yellowfin sole is the largest reproducing population east of the Bering Sea (Blackburn 1979). Prey items include juvenile fishes, amphipods, euphausiids, and polychaetes.

Dolly Varden. Dolly Varden spawn mostly in the fall, with the majority of the spawners located in the Anchor River in mid-October. The eggs incubate over winter, generally four to five months. Many anadromous Dolly Varden are capable of repeated spawning, although they suffer a high post-spawning mortality and generally do not spawn in consecutive years.

4.3.2 Important Habitats or Areas

The nearshore areas of Cook Inlet, particularly Kachemak and Kamishak Bays, and other small inlets and bays, are important habitat for juvenile herring, salmon, Dolly Varden, capelin, rockfish, and sand lance (Blackburn 1979).

The distribution of the five salmon species differs between upper Cook Inlet (north of Anchor Point) and lower Cook Inlet (from Cape Douglas to Cape Fairfield). In upper Cook Inlet, sockeye is the most abundant salmonid, followed by pink, chum, coho, and chinook, respectively. In lower Cook Inlet, pink salmon is the most abundant salmonid, followed by chum, sockeye, coho, and chinook, respectively. The Kenai and Kasilof Rivers, which discharge into upper Cook Inlet, are major sockeye, pink, coho, and chinook salmon-producing streams. The Big Kamishak, Little Kamishak, and McNeil Rivers, which discharge into Kamishak Bay in lower Cook Inlet, are the major chum salmon-producing streams. Adult salmon are present in nearshore waters and estuarine waters adjacent to the Kenai Peninsula from late April to early November (KPB 1990). Salmon are generally found in the upper 10 m of the water column.

Pacific herring are abundant throughout the coastal waters of Cook Inlet and Shelikof Strait. Herring utilize the intertidal and subtidal zones in coastal areas to spawn (McGurk 1989).

Walleye pollock produce free-floating planktonic eggs in winter and spring with large concentrations found in Shelikof Strait. The larvae appear to be strongly influenced by upper-ocean dynamics (Schumacher and Kendall 1989). Pollock migrate seasonally, moving from deeper waters in the winter to more shallow water in the summer. The fish also undergo diurnal vertical migration from deeper to shallower waters in the evening (U.S. DOI/MMS 1984).

Large concentrations of yellowfin sole are located southeast of Augustine Island and in Kamishak Bay. Seasonal migrations may occur from Kamishak Bay to offshore waters during the winter. Juvenile yellowfin sole typically inhabit the nearshore environment.

4.4 MARINE BIRDS AND WATERFOWL

Marine birds and waterfowl are significant components of the marine ecosystems in Alaskan waters and ones that are highly vulnerable to human impacts. Over 100 species of marine and coastal birds with populations numbering several million occur throughout the area covered by the seafood general permit.

The American peregrine falcon and the short-tailed albatross may occasionally be found and are listed as endangered according to the Endangered Species Act (ESA). The Aleutian Canada goose, Arctic peregrine falcon, and the spectacled eider are listed as threatened species. These species are discussed in greater detail in Section 6.0.

4.4.1 Important Species and Trophic Relationships

The following discussion will be divided into marine birds, which spend at least a portion of their lives in the open ocean, shorebirds, and waterfowl, which are not typically found far from land.

4.4.1.1 Marine Birds. The most prominent and numerous avian group found in the Alaska Region are the pelagic (open ocean) seabirds. This group consists of birds such as shearwater, petrels, murrelets, auklets, and gulls. These seabirds exhibit a wide array of body forms, life history patterns, and strategies for obtaining food, reproducing, and avoiding predation. These birds developed in an environment relatively free from predation but with a less predictable food source. These factors have led to the development of long life spans, late attainment of sexual maturity, and small clutch sizes (U.S. DOI/MMS 1992).

Pelagic distribution of seabirds in the Bering Sea, as elsewhere in Alaskan marine waters, exhibits a patchy pattern of high and low densities (Piatt et al., 1988). Typically, greatest densities (e.g., 40-600 birds/km^2) occur in spring, summer, and fall over the outer continental shelf (OCS) and shelfbreak (100- to 200-m depth). Densities over the inner shelf, though generally lower, may reach high levels where shearwaters concentrate in huge flocks (ten of thousands to well over a million individuals) (U.S. DOI/MMS 1992). During the winter and early spring, most seabirds are widely dispersed over the southern Bering Sea, Aleutian Islands, and North Pacific Ocean south of the consolidated pack ice. Overwintering seabirds and spring migrants also tend to gather along the ice edge where prey may be concentrated. bird densities of 500 to 1,000/km^2 commonly occur in the ice front and 10,000/km^2 have been observed (Divoky 1983).

Common and/or thick-billed murres and black-legged kittiwakes are abundant in most Bering Sea colonies. In addition, fulmars are abundant on the Pribilofs and on St. Matthews Island; 88 percent of red-legged kittiwakes nest on the Pribilofs; immense numbers of auklets inhabit St. Matthews Island, St. Lawrence Island, Little Diomede Island, King Island, and Fairway Rock; and burrow-nesting species such as storm-petrels and tufted puffins, as well as auklets, are abundant in the Aleutian Islands. At least 9 to 10 million nonbreeding shearwaters occupy the Bering Sea and Gulf of Alaska annually in the summer and fall (U.S. DOI/MMS 1992).

Fifteen species of marine birds constitute 90 percent of the total seabird population in the Gulf of Alaska. Six of these species have populations over one million (fork-tailed storm petrel, tufted puffin, Leach's storm petrel, common murre, black-legged kittiwake, and horned puffin) (Baird and Gould 1983). Other common seabirds include shearwaters, fulmars, cormorants, gulls, terns, guillemots, murrelets, and auklets. Many birds such as shearwaters rarely come to land except to breed and others such as arctic terns and mew gulls may breed hundreds of miles inland. Most seabirds return to breeding colonies in April and lay eggs in May, June, and July. While seabirds are rearing young, foraging is limited to nearshore waters. Most seabirds leave their breeding colonies by October.

Seabirds feed primarily on marine invertebrates and fishes, although their diet varies according to body and bill size, age, season, prey size and availability. The major food source during spring and summer months include capelin, sand lance, euphausiids, squid, and pollock. Various benthic invertebrates and demersal fish are the main winter food sources (U.S. DOI/MMS 1984). Studies that have measured the food fed to seabird chicks have indicated that capelin and sand lance comprise 48-84 percent of their diets (Baird and Gould 1983). Most foraging of breeding birds occurs within 48 km (30 mi) of their colony and usually within 4.8 km (3 mi) of land.

4.4.1.2 Shorebirds. Shorebird is used to represent those birds generally restricted to coastline margins (beaches, mudflats, salt marshes, bays, and estuaries). Shorebirds encompass members of the plover, sandpiper, and avocet families.

An important characteristic of almost all shorebird species is their migratory behavior which is strongly developed. The vast majority of shorebirds that occur along the Pacific coast of North America breed in Alaska where important nesting concentrations are found on moist tundra and marshlands of the Arctic northslope and the west coast (e.g., Yukon-Kuskokwim River Delta). From May through September each year, millions of shorebirds may be found in these areas.

Hundreds of thousands of shorebirds use the coastal areas for feeding and resting as they migrate to breeding grounds in western and northwestern Alaska every year. These birds use gravel beaches, rocky shores, and intertidal mudflats as forage areas for clams and small invertebrates. The total world population of the Western sandpiper, most of the world population of surfbird and black turnstones, large numbers of dunlin, and short-billed dowitcher migrate along the coast of southcentral Alaska. The most common shorebirds found in the coastal habitats include; sandpipers, plovers, surfbirds, turnstones, whimbrels, dowitchers, dunlins, godwits, oystercatchers, and phalaropes.

4.4.1.3 Waterfowl. Waterfowl in Alaska include ducks and geese. During the fall migration, the numbers of ducks in saltwater marshes and tideflats increase dramatically as local populations are supplemented by ducks from the north and west. Eighteen species of diving ducks breed in Alaska. Most common are the oldsquaw (approximate population occurring in the North pacific and Alaskan water, 3.6 million), common eider (750,000), king eider (1.8 million), spectacled eider (_ 8,000) Steller's eider (_ 70-80,000 wintering, 2,000 breeding), black scoter (490,000), surf scoter (116,000), white-winged scoter (400,000), greater scaup (340,000), harlequin duck (1 million), Barrow's goldeneye (120,000), common goldeneye (110,000), and red-breasted merganser (20,000). Recent estimates of goose species include white-fronted goose (161,000), emperor goose (53,800), cackling Canada goose (69,900), Pacific black brant (1,238,000), tule goose (5,000), Taverner's Canada goose (100,000), Vancouver Canada goose (40-50,000), dusky Canada goose (10-15,000), lesser Canada goose (2,000), and lesser snow goose (40,000).

Areas of major importance to waterfowl populations occupying the Bering Sea include the Yukon-Kuskokwim River Delta and lagoons along the north side of the Alaska Peninsula, particularly, Izembek and Nelson. The eastern Aleutian Islands area, polynyas near major islands (e.g., St. Lawrence, St. Matthew, and Nunivak), and the ice front also provide important overwintering habitat for some waterfowl species.

Waterfowl breeding on the Yukon-Kuskokwim Delta include tundra swan, white-fronted goose, Taverner's Canada goose, cackling Canada goose, emperor goose, and Pacific black brant, and at least 13 species of ducks and loons. Ten to 50 percent of the population of these species nest in this region. Several of the goose and duck species nest in high densities throughout the coastal Bristol Bay area, on Nunivak island, and along the north side of the Alaska Peninsula.

Dabbling ducks (mainly American widgeon, mallard, northern pintail, and green-winged teal) comprise approximately 60 percent of the breeding waterfowl in Trading Bay, Redoubt Bay, and the Fox River Flats (KPB 1990). The initial nesting period for dabbling ducks usually begins in mid-April and extends through June. The molt and brood-rearing period occurring from late June to early August is a stressful period and demands considerable energy. Consequently, waterfowl are sensitive and vulnerable during this time. In Cook Inlet, dabbling ducks have two population peaks in the fall. The first is in mid to late August and the second is late September to early October. By November, most dabbling ducks have departed for wintering grounds. Dabbling ducks feed primarily on invertebrates and plant matter.

Most diving ducks arrive on their breeding grounds by late May, with the nesting period generally extending through June. Brood rearing and molting occurs throughout July and August. The majority of the diving ducks that breed in Alaska are residents of Alaskan coastal areas in winter. Diving ducks are the most sensitive birds to oil spills as they inhabit nearshore marine and estuarine waters most of the year and due to their feeding habits and methods.

4.4.2 Important Habitats or Areas

The following discussion will be divided into marine birds, shorebirds, and waterfowl.

4.4.2.1 Marine Birds. Major seabird colonies (100,000 or more individuals) in the Bering Sea occur at Diomede Island, St. Lawrence Island, King Island, Bluff (Norton Sound), St. Matthew Island group, Nuviak Island, the Pribilof Islands, three colonies in the Cape Newenham-Cape Peirce area, two in the Walrus Islands (Bristol Bay), and seven in the eastern Aleutian Islands (U.S. DOI/MMS 1992). There are 34 colonies with estimated summer populations of 10,000 to 100,000 individuals, and 35 colonies have an estimated 1,000 to 10,000 individuals. Most of these colonies are located in the Alaska Maritime National Wildlife, Yukon Delta National Wildlife, Togiak National Wildlife, or Walrus Islands Sate Game Refuges. Critical foraging area for most species lie within 50 km (31 mi) of the colony.

Major seabird colonies (100,000 or more individuals) in the Gulf of Alaska occur at Forrester, Petrel, and St. Lazaria Islands in southeast Alaska; Middleton Island in the northcentral gulf; East Amatuli in the Barren Island; six of the Semidi Islands; and four islands in the Sadman Reefs-Alaska Peninsula area (U.S. DOI/MMS 1992). There are 58 colonies with an estimated summer population of 10,000 to 100,000 individuals, and 138 colonies with 1,000 to 10,000 individuals estimated. The bulk of these colonies are located from the Prince William Sound area westward. Most are located in the Alaska Maritime Wildlife Refuge.

More than 60 seabird colonies are located in the lower Cook Inlet region and approximately 120 bird colonies have been identified in the Shelikof Strait region (U.S. DOI/MMS 1984). Many seabirds winter in offshore waters while others remain in Alaskan nearshore waters, particularly Kachemak Bay. In Cook Inlet, Shelikof Strait, and the Barren Islands, there are over one million nesting seabirds with the largest aggregation found in the Barren Islands (U.S. DOI/MMS 1984).

Afognak Strait (located at the north end of Kodiak Island), Kodiak Island, and Kachemak Bay are important winter congregation areas for murres and auklets in particular, as well as other species. There are four species of loon and several grebe species that overwinter in lower Cook Inlet, particularly Kachemak Bay.

4.4.2.2 Shorebirds. There are a limited number of mudflats in the migratory flyway between the Washington coast and the Alaska Peninsula. Critical habitat for migrating shorebirds include the Copper/

Bering River Deltas (near Valdez, Alaska), Fox River Flats, Mud Bay, and Kamishak Bay. The Yukon-Kuskokwim River Delta is an important nesting concentration area. A breeding colony of the rare Aleutian terns and more common Arctic terns nest along the mud flats in the Homer area.

4.4.2.3 Waterfowl. Areas of major importance to waterfowl include the Yukon-Kuskokwim Delta, Nunivak Island, bays and inlets along the Alaska Peninsula, Aleutian Islands, lower and upper Cook Inlet, Kodiak Island, and the eastern side of the Alaska Peninsula. In the Gulf of Alaska, important areas include the Copper River Delta, Prince William Sound, and several bays in Cook Inlet. The largest concentrations of waterfowl during spring and fall are found in the Kenai Lowlands, Susitna Flats, Trading Bay, Redoubt Bay, Chickaloon Bay, Fox River Flats, Tuxedni Bay, Chinitna Bay, and Kachemak Bay (KPB 1990). These locations are areas where waterfowl rest and feed en route to breeding grounds and overwintering areas. In 1984, over 30,000 breeding waterfowl were present at Trading Bay, Redoubt Bay, and Fox River Flats (KPB 1990). The primary nesting areas are located in the Kenai Lowlands, Susitna Flats, Trading Bay, Redoubt Bay, and Fox River Flats. Molting areas include Susitna Flats, Trading Bay, Redoubt Bay, Chickaloon Bay, and Chinitna Bay. In the fall, most waterfowl migrate south and east to overwintering areas along the Pacific Coast, however substantial numbers of ducks remain in the marine and estuarine waters of Cook Inlet, particularly Kachemak Bay.

Preferred marine habitats of diving ducks include protected estuaries, and other marine waters within the 18-m (60-ft) depth contour. The largest concentrations of geese are found in their preferred habitats; estuaries, lagoons, river deltas, marshes, and tidelands. High concentrations occur on the tidal salt marshes and the extensive mud flats of Cook Inlet during the spring and fall migrations. The only known nesting area of the tule white-fronted goose is on the west shore of Cook Inlet, primarily in Trading and Redoubt Bays. Snow geese congregate on the Kenai flats from mid-April to mid-May to feed and rest en route to their breeding grounds in Siberia. In 1988, 25,000 snow geese were observed using the Kenai flats (KPB 1990).

Along the Alaska Peninsula, as many as 100,000 king and Steller's eiders molt in Nelson Lagoon in August and September with the majority of the females molting in Izembek Lagoon (U.S. DOI/MMS 1992).

Canada geese nest on lakes and ponds, marshes. Nests are usually initiated in early May, dependent upon weather conditions. Molting flocks typically use large lakes and protected coastal waters away from nesting areas. On coastal marshes and tideflats, geese feed on molluscs, crustaceans, and other invertebrates as well as plants.

4.5 MARINE MAMMALS

Several species of marine mammals occur in Alaskan coastal waters. These species include cetaceans, pinnipeds, and sea otters. All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA also incorporates regulations and restrictions regarding the harvests of marine mammals. Additional protection is provided for blue, bowhead, fin, gray, humpback, right, sei, and sperm whales, and the Stellar sea lion (northern sea lion) under the Endangered Species Act of 1973. Additional regulations associated with the northern fur seal are provided by a 1957 treaty, the Interim Convention on Conservation of Northern Fur Seals. The endangered or threatened species occurring in Alaskan waters are discussed in Section 6.0.

Marine mammals in the Gulf of Alaska are important constituents of the Alaskan food web, annually consuming 7.55 x 10^6 metric tons of euphausiids, copepods, fish, cephalopods, and crustaceans (Calkins 1987). The most frequent prey for marine mammals in this region are; copepods, euphausiids, herring, cod, walleye pollock, capelin, salmon, cephalopods, and crustaceans. Fin and sei whales have the highest annual consumption rates followed by the Dall porpoise and Steller sea lion.

4.5.1 Important Species and Trophic Relationships

Most of the marine mammals occurring in Alaskan waters can be grouped into two categories: 1) pinnipeds (seals, sea lions, and walrus) that are ice associated during the winter and also reproduce during that time, and 2) whales that use Alaskan waters as summer feeding grounds.

4.5.1.1 Pinnipeds. Pinnipeds in Alaskan waters include the northern fur seal, ice seals (spotted, ribbon, bearded, and ringed), harbor seal, and Pacific walrus.

Northern fur seal. The northern fur seal has a range extending from the Bering Sea south to San Diego, California. The bulk of the fur seal population migrate east of Kodiak Island and the Kenai Peninsula although a very small portion of this population seasonally occurs in Shelikof Strait. This seal does not typically occur in Cook Inlet or Shelikof Strait (U.S. DOI/MMS 1984) and there are no breeding areas within this area (Loughlin 1989). These seals are migratory and widely dispersed throughout this range during the non-breeding season (November to May) in pelagic waters. During other times of the year, the majority of the entire population is concentrated in the Pribilof Islands. While most fur seals migrate southward from Alaskan waters, a portion of the population, principally young non-breeding males, remain in the Gulf of Alaska year-round.

Ice Seals. Four seal species in Alaska (spotted, ringed, bearded, ribbon) are ice-associated for much or all of the year. Although the general range of all four species extends from the Beaufort Sea to the southeastern Bering Sea, spotted and ribbon seals are concentrated in the Bering Sea, while the majority of bearded and ringed seals occupy areas farther north. Estimated populations of these seals in the Bering-Chukchi-Beaufort area are spotted 250,000, ribbon 110,000, bearded 300,000, ringed 1.5 million (Burns et al. 1985; Lentfer 1988). Winter/spring spotted seal densities are greatest east of the Pribilof Islands, while ribbon seals are most numerous west of the Pribilofs and St. Matthew. Ringed seals are abundant in shorefast ice areas of the Chukchi and northern Bering Seas. All four species breed and give birth in the spring and are associated with the ice pack in some way.

Harbor seal. The harbor seal has an extensive range extending from the Bering Sea southward to Baja California. Recent surveys of harbor seals suggest that there has been a 75 percent decline in harbor seal abundance over the past six years at Tugidak Island, the westernmost of the Trinity Islands. This location formerly held one of the world's largest concentrations of harbor seals (U.S. DOI/MMS 1992). The reason for this decline is not known at this time.

Harbor seals tend to frequent nearshore waters and haul out on offshore rocks, sandbars, and beaches of remote islands. These seals often move considerable distances between various haul out sites, although they tend to have a limited number of preferred sites which they return to repeatedly. The breeding and pupping season occurs from late May through July (KPB 1990). The diet of harbor seals is highly varied with prey primarily consisting of herring, eulachon, walleye pollock, octopus, salmon, shrimp, and flounder.

Pacific walrus. In Alaska, the Pacific walrus ranges from the Beaufort Sea to the southeastern Bering Sea. A large portion of the estimated 234,000 to 250,000 walruses migrate north and south with the seasonal pack ice (U.S. DOI/MMS 1992). During the winter months (January-March), most walruses occur in the drifting pack ice west and south west of St. Lawrence Island and in the Bristol Bay area. Beginning in April, nearly all the pregnant females and those with young (approximately 150,000) move north with the receding pack ice. By late June, the migrants have passed through the Bering Strait to occupy the area for the strait west to Wrangle island and north to the northeastern Bering Sea and western Beaufort Sea. Adult and subadult males that remain in the Bering Sea in summer most consistently haul out at several sites in the northern Bristol Bay (Walrus Islands State Game Sanctuary) and St. Matthew Island (Alaska Maritime National Wildlife Refuge) areas.

4.5.1.2 Sea Otters. In Alaska, sea otters have reoccupied most of their pre-exploitation range. They are at or near their carrying capacity throughout the Aleutian Islands and east to Prince William Sound. Few sea otters survive in the Pribilof Islands. Recent estimates place the Alaskan population at approximately 137,000. Approximately 6,000 sea otters are located in the Kodiak Island area and an estimated 3,500 are found in the Kenai Peninsula and Cook Inlet area. Otters tend to be non-migratory, moving relatively short distances between breeding and foraging areas (U.S. DOI/MMS 1992). Sea otters are extremely susceptible to marine pollution as their fur must remain clean to maintain its insulative qualities, and they seldom leave the water.

Sea otters consume large quantities of benthic invertebrates, including sea urchins, mussels, clams, chitons, and crabs. This species has been termed a "keystone" species by Estes and Palmisano (1974) due to the role it plays in determining the ultimate stable state of the nearshore community it inhabits. In Nanwalek and Port Graham, the sea otter population has expanded to the extent that otters have severely depleted some of the benthic invertebrate resources used by these two subsistence communities (KPB 1990).

Sea otter interactions with fisheries are limited to theft of bait from crab pots set in nearshore waters where commercial Tanner crab activities and sea otters overlap. Occasional drowning occurs as a result (MMC 1989).

4.5.1.3 Cetaceans. There are several nonendangered cetaceans within the Alaskan region. They include beluga, minke, and killer whales, and Dall and harbor porpoises.

Dall porpoise. The Dall porpoise is present year-round throughout the Gulf of Alaska, with the largest numbers occurring over the continental shelf in spring and summer from Kodiak Island east to Icy Strait. The Gulf of Alaska population was estimated to contain between approximately 152,280 to 246,900 porpoises in 1983 (Bouchet 1983). This species usually travels in groups of 2 to 20 animals, although large concentrations of over 1,000 porpoises infrequently occur. The majority of breeding and calving takes place from June to August. Dall porpoises feed on walleye pollock, sablefish, capelin, Pacific herring, sand lance, eulachon, and squid (Crawford 1981).

Harbor porpoise. The harbor porpoise occurs in the Kodiak Island region, Kachemak Bay, and in the Gulf of Alaska during the spring and summer. Although they are assumed to be year-round residents where they occur, sightings are much less frequent in fall and winter. They are generally observed in harbors, bays, and river mouths. Breeding occurs from June or July to October with peak calving in May and June (U.S. DOI/MMS 1984).

Killer whale. Killer whales prefer shallow areas of the continental shelf and are considered surface feeders preying mostly upon large fishes when available and marine mammals. They are found throughout lower Cook Inlet and Shelikof Strait during summer. Although they may move slightly south in the winter, they are considered to be a resident species.

Beluga whale. There are believed to be two separate stocks of beluga whales in Alaska: the western Arctic stock and the Cook Inlet stock. The western Arctic stock numbers about 18,000 individuals and is distributed from Yakutat in the Gulf of Alaska to the eastern Beaufort Sea. The Cook Inlet stock has a population of approximately 1,300 whales centered in Cook Inlet and occupies the northern Gulf of Alaska from Kodiak Island to Yakutat Bay. This beluga stock is listed as a candidate species for threatened listing under the ESA. The National Marine Fisheries Service is currently conducting studies to determine population abundance and life history parameters. DNA studies are also currently underway to determine if the Cook Inlet stock is genetically distinct from the western arctic stock (Morris, R., 16 August 1993, personal communication).

Major concentrations of belugas occur in Bristol Bay, Yukon River-Norton Sound, Kotzebue Sound, and Kasegaluk Lagoon in the Bering and Chukchi Seas. These areas are used during migration and throughout the summer. The Cook Inlet area is used throughout the year by belugas. Concentrations usually occur in the upper northwestern inlet in the spring and early summer (April-June). They use the lower inlet more often in the winter. Movement and seasonal distribution of belugas in Cook Inlet are strongly influenced by fish availability, especially smelt and salmon smolt. In winter, movements are restricted by the combination of ice and spring tides (U.S. DOI/MMS 1984). The beluga feeds on salmon, smelt, flounder, sole, sculpin, cephalopods, and shrimp. Calving takes place during the summer from July to August (Calkins 1989, U.S. DOI/MMS 1992).

Minke whale. The minke whale is the smallest of the baleen whales. It is a coastal species, usually occurring within the 200 meter depth contour. In spring, most minke whales are located over the continental shelf, especially in shallow nearshore waters. During summer, the season of greatest abundance, they are distributed all along the Alaska coast and into the Bering and Chukchi Seas. They are concentrated near Kodiak Island, and in the northeast Gulf of Alaska during the summer. Most whales probably leave the region by October as they are seldom observed in the fall or winter. It is likely that they migrate northward in early spring and southward in the fall (U.S. DOI/MMS 1984). Breeding occurs throughout the year with peaks in January and June. Their prey consists mainly of euphausiids and copepods (U.S. DOI/MMS 1992).

4.5.2 Important Habitats or Areas

The following discussion will be divided into pinnipeds (seals and sea lions), sea otters, and cetaceans (whales).

4.5.2.1 Pinnipeds. Harbor seals usually inhabit marine, estuarine, and freshwater environments from the coast to a few miles offshore. They prefer gently sloping or tidally exposed habitats including reefs, offshore rocks and islets, mud and sand bars, and sand and gravel beaches. They are typically found in water depths less than 55 meters (U.S. EPA 1984a). The west shore of lower Cook Inlet is the most utilized region of Cook Inlet, although there are rookeries and haul out sites located throughout the coastal zone of lower Cook Inlet and Shelikof Strait. There are also high concentrations of seals on Augustine Island, the Barren Islands, and several areas of Kodiak Island (U.S. DOI/MMS 1984).

4.5.2.2 Sea Otters. Sea otters are found in bays, lagoons, estuaries, and most commonly inhabit waters of less than 90 m (295 ft) depth along the coast. The highest densities are found within the 40 m (131 ft) isobath where young animals and females with pups forage. When otters haul out, they rest on land and in kelp beds (Calkins and Schneider 1985). Sea otter populations occur in the Barren Islands, northern and southern Kodiak Island, southwestern Kenai Peninsula, Kamishak Bay, along the shoreline of lower Cook Inlet, and the Trinity Islands (U.S. DOI/MMS 1984).

4.5.2.3 Cetaceans. Cook Inlet and Kachemak Bay are important areas for killer whales, beluga whales, Dall's porpoises, and harbor porpoises. The waters surrounding Kodiak Island are particularly important to minke whales.

Shelikof Strait is a known route for gray whales migrating north to the Bering sea as well as a possible migratory route for fin and humpback whales.

4.6 SUMMARY

Phytoplankton communities are dominated by diatoms, with dinoflagellates, microflagellates, and other classes and families of phytoplankton also being present. Kachemak Bay is the most productive area in lower Cook Inlet. Several herbivores, including zooplankton, benthic invertebrates, and waterfowl, are dependent upon phytoplankton.

Copepods are the dominant zooplankton species. Fish eggs and larvae quantities vary throughout the year and euphausiids are most abundant in the summer. Zooplankton communities are similar in composition and relative dominance structure in the southeastern Bering Sea, north Pacific, the northern Gulf of Alaska, and the northwestern Pacific Ocean. Zooplankton are prey for fish, shellfish, marine birds and mammals. Euphausiids are essential prey in the diets of yellowfin sole and minke whales, whereas mysids are the principal prey of walleye pollock and halibut.

Several benthic species are harvested commercially: Tanner crab, Dungeness crab, weathervane scallop, and shrimp. Species frequently harvested for subsistence purposes include clams, crabs, cockles, and shrimp. Kamishak Bay, Kachemak Bay, and areas of Shelikof Strait are important habitats for Tanner, Dungeness, and king crabs. Five species of shrimp are commercially harvested from Kachemak Bay, although populations of shrimp and king crab have been declining in recent years. Amphipods, molluscs, crabs, ophiuroids, shrimp, and other benthic species are important prey items for higher trophic levels as well as mediators for nutrient recycling.

The fish assemblages are dominated by demersal species, with walleye pollock, yellowfin sole, and halibut being the most abundant species. Commercially harvested fish include chinook salmon, coho salmon, chum salmon, sockeye salmon, pink salmon, walleye pollock, halibut, and Pacific herring. Salmon, steelhead trout, and Dolly Varden are important sport fish. Shelikof Strait is an important spawning area for walleye pollock. Species important as prey for higher trophic levels include sand lance and capelin, as well as previously mentioned species.

Pelagic seabirds are the most prominent and numerous avian group found in the Alaska region. The most abundant species are fork-tailed storm petrel, tufted puffin, Leach's storm petrel, common murre, black-legged kittiwake, and horned puffin. Other common seabirds in the area include shearwaters, fulmars, cormorants, gulls, terns, guillemots, murrelets, and auklets. Seabirds feed primarily on marine invertebrates and fishes, although their diet can vary. Major seabird colonies (100,000 or more individuals) occur in the Bering Sea [at Diomede Island, St. Lawrence Island, King Island, Norton Sound, St. Matthew Island group, Nuviak Island, the Pribilof Islands, three colonies in the Cape Newenham-Cape Peirce area, two in the Walrus Islands (Bristol Bay), and seven in the eastern Aleutian Islands (U.S. DOI/MMS 1992)]; Gulf of Alaska (at Forrester, Petrel, and St. Lazaria Islands in southeast Alaska); more than 60 seabird colonies are located in Cook Inlet and approximately 120 colonies have been identified in the Shelikof Strait region.

Waterfowl in the area include ducks and geese. Eighteen species of diving ducks breed in Alaska. Many diving ducks overwinter in Kachemak Bay. Other areas of importance to waterfowl include the Yukon-Kuskokwim Delta, Izembek, and Nelson lagoons in the Bering Sea; eastern Aleutian Islands; lower and upper Cook Inlet; Kodiak Island; the eastern side of the Alaska Peninsula; and the Copper River Delta and Prince William Sound in the Gulf of Alaska. Waterfowl feed primarily on crustaceans, molluscs, aquatic insects, and fish.

Several species of marine mammals occur in Alaskan coastal waters including cetaceans (Beluga, Minke, killer whales; Dall and harbor porpoises), pinnipeds (northern fur seals, ice seals, harbor seals, walrus), and sea otters. Many are found year round in the coastal areas, or use these areas as potential migratory routes. Frequent prey for marine mammals in the Gulf of Alaska include copepods, euphausiids, herring, cod, walleye pollock, capelin, salmon, cephalopods, and crustaceans. Important habitats or areas include the Pribilof Islands for northern fur seals and the Walrus Islands for Pacific Walrus.

5.0 POTENTIAL IMPACTS OF SEAFOOD WASTE DISCHARGES ON ALASKAN MARINE ORGANISMS

The determination of "unreasonable degradation" of the marine environment is to based upon consideration of the ten criteria listed in Section 1.0. The following section provides an assessment pertinent to consideration of the ocean discharge criteria shown below:

- **Criterion # 1:** "The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged"
- **Criterion # 2:** "The potential transport of such pollutants by biological, physical, or chemical processes"
- **Criterion # 6:** "The potential impacts on human health through direct or indirect pathways"

The potential adverse effects of seafood processing waste include direct and indirect impacts of the solid and liquid waste discharges to marine organisms. Solid wastes consist of unused portions of the fish and shellfish that have been processed and may include heads, skin, scales, viscera, fins, and shells discarded during cleaning and butchering. Liquid wastes include solubilized organic matter and nutrients leached from fish and shellfish during processing. The liquid wastes may also include waste from process disinfectants, sanitary wastes, and other waste waters (i.e., cooling water, boiler water, gray water, fresh-water pressure relief water, refrigeration condensate, water used to transfer seafood to the facility, and live tank water). Both solid and liquid wastes are authorized discharges under the proposed NPDES general permit.

Potential direct impacts of solid waste discharges include alterations in the benthic community due to burial, alteration of the sediment texture, and chemical changes effected within the sediments due to the decay of organic matter accumulations. The decay of accumulations of solid waste may also result in depletion of dissolved oxygen in the overlying water column and releases of potentially toxic decay byproducts like unionized ammonia and undissociated hydrogen sulfide. Nutrients (particularly nitrogen and phosphorus) are also released during the decay of solid waste which may enhance phytoplankton productivity and alter the phytoplankton community species composition (i.e., eutrophication). The solid waste discharge may also result in water column turbidity which has the potential to decrease photosynthetic production by phytoplankton. Potential direct impacts of liquid wastes include depletion of dissolved oxygen in the water column due to the decay of soluble oxygen demanding substances in the wastewater. Nutrients dissolved in the liquid waste can also potentially enhance the production of phytoplankton and alter phytoplankton species composition. Residual concentrations of chlorine disinfectants in the liquid wastestream, and additional oxidants produced by the reactions of chlorine with other compounds, also potentially impact marine organisms.

Potential indirect impacts of seafood waste discharges involve effects on marine mammals and birds due to their attraction to seafood waste discharges. The attraction of marine mammals to seafood waste discharges may make them easier prey for predators. Birds that are attracted to surface plumes of seafood waste (especially floating particulates) may become oiled due to accumulation of waste fish oils on the water surface. Another potential indirect impact involves the development of dependence on an anthropogenic food supply that may result in concentration and growth of marine mammal and bird populations that could be adversely affected if this food supply was reduced or eliminated. Eutrophication of marine waters may also indirectly result in enhancement of phytoplankton species that are toxic to marine organisms and humans. Bacteria associated with the decaying seafood waste may also adversely impact marine mammals and birds.

Although a number of potential impacts to marine organisms are outlined above, few studies specific to seafood processing waste discharges have been conducted to assess the importance of the direct impacts, and no studies have been conducted to determine whether the potential indirect impacts of seafood processing waste discharges occur. Most studies conducted to date have focused on the direct effects of solid waste accumulations on benthic organisms, the effect of decaying waste on water column dissolved oxygen concentrations, and the potential toxic effect of waste decay byproducts (i.e., unionized ammonia and undissociated sulfide) on marine organisms. The potential direct and indirect impacts of seafood waste discharges are discussed in more detail below. Information specific to seafood processing waste discharges is reviewed and summarized where possible. Literature relevant to potential impacts associated with eutrophication and residual chlorine are necessarily from studies conducted of other types of waste discharges (e.g., municipal wastewater facilities). Most of the discussion of the potential indirect impacts of seafood processing discharges relies on personal communications from scientists and regulatory agency personnel familiar with seafood processing activity in Alaska.

5.1 IMPACTS DUE TO SOLID SEAFOOD PROCESS WASTES

During discharge of seafood processing waste, biological impacts are most likely to occur as a result of the discharge of seafood waste particulates (both direct and indirect effects). Liquid waste discharges are typically of low volume, nonpolluting, or treated prior to discharge to remove pollutants (i.e., sanitary wastes). These are discussed below in Section 5.2.

The following discussion briefly summarizes the effects of discharges on biota by major type of physical effect.

5.1.1 Exposure to Suspended Solids

As discussed in Section 3.0, deposition of the majority of discharged solids is expected to be rapid and localized. Therefore, adverse physical effects to biota from ground seafood discharge should be limited to the nearfield vicinity of the outfall. Within this region, zooplankton and fish larvae near the discharge may experience altered respiratory or feeding ability due to stress, or clogging of gills and feeding apparatus. Phytoplankton entrained in the discharge plume may have reduced productivity due to decreased light availability. Although these potential impacts may be offset in the farfield by increases in nutrient concentrations (see Section 5.2). These impacts should result in negligible impacts to populations in the region, as impacts should be restricted to the immediate vicinity of the discharge. Mobile invertebrates, fish, birds, and mammals presumably will avoid the discharge plume if conditions become stressful. However, these biota may also be attracted to the discharge plume to feed on the discharged particulates. Secondary impacts associated with attraction are discussed in Section 5.3. Therefore, impacts are also expected to be negligible to these organisms.

Infaunal or sessile organisms near the discharge are not likely to be impacted by the suspended solids but will most likely be adversely impacted by deposition of seafood waste. However, the area affected should be limited to the region in the immediate vicinity of the discharge.

5.1.2 Exposure to Deposited Solids

Disposal of seafood waste solids will have the greatest impact on less mobile benthic organisms such as polychaetes and bivalves, and on demersal fish eggs that cannot move away from the accumulating waste. Potential impacts to benthos and demersal eggs are discussed in the following sections.

5.1.2.1 Smothering of Benthos. Many benthic invertebrates are relatively sedentary and sensitive to environmental disturbance and pollutants. Short- and long-term effects of seafood waste on benthic invertebrates are expected to include smothering of biota, especially by ground particulates in the area near the discharge. Deposition is likely to reduce and possibly eliminate abundances of infaunal benthos such as polychaetes, molluscs, and crustaceans, and may affect demersal eggs of various benthic species and fish. The greatest impact would be expected downcurrent along the plume's median axis.

Little information is presently available concerning the direct effects of various deposition depths on benthic communities. Most studies that have investigated deposition impacts on benthos have examined deposition of dredged materials (Hale 1972; Kranz 1974; Mauer et al. 1978; Oliver and Slattery 1973; Saila et al. 1972; Schafer 1972; Schulenberger 1970, Wilber 1992). These studies indicate that the response to deposition and survival following such an event is species-specific. Of the species examined, burial depths from which organisms were able to migrate to the surface ranged from 1 to 32 cm (0.4 to 12.6 in). If it is assumed that most benthos are not adversely affected by deposition of seafood waste less than 1 cm (0.4 in), benthos in the vicinity of the discharge receiving deposition in excess of this amount are likely to be adversely impacted. However, the seafood solids are highly organic material. Potential impacts to benthos could occur at depths < 1 cm if this was a steady state condition and the sediments turned anoxic. Unfortunately, no data are available to evaluate this potential impact question.

The "zone-of-deposit" concept incorporated into the proposed NPDES general permit and authorized by ADEC under 18 AAC 70.033, permits adverse impacts to benthic communities within the zone-of-deposit. For the purposes of the seafood general permit, the authorized zone-of-deposit has been defined as a one (1) acre area. Adverse impacts to benthic communities outside the zone-of-deposit are not permitted. If it is assumed that solids deposition of greater than 1 cm (0.4 in) depth represents an "adverse impact" to benthos, solids deposition outside the zone-of-deposit should be less than 1 cm (0.4 in) to avoid potential adverse impacts to benthic organisms.

It is not possible to accurately predict the area within the entire area covered by the seafood general permit receiving deposition exceeding 1 cm (0.4 in) due to the uncertainty of seafood discharge locations and site-specific oceanographic conditions. However, a "worst case" scenario can be developed by determining the area that would be affected if all the potential seafood dischargers covered under the general permit created seafood waste piles that equalled one acre. According to the 1993 EPA permit files, there were 321 Alaskan seafood processors permitted under the existing NPDES general permit. This included 237 floating processors and 84 shore-based facilities. Assuming the number of permitted facilities would be similar under the proposed general permit, a worst case estimate of adversely impacted bottom would be 321 acres. This represents < 1 mi^2 of the benthic environment and is much less than 0.0001 percent of the area covered under the proposed general permit. These values should be considered overestimates because, as discussed in Section 3.0, the discharges from *offshore floating processors* are not expected to result in significant deposition of seafood waste piles. In addition, as discussed in Section 2.0, the median amount of waste discharged annually from shore-based and floating processors was 2-3 million pounds. The model predictions in Section 3.0 do not indicate significant accumulations of seafood waste in most locations until waste production is significantly higher than the median (see Section 3.0). The conclusion that the impacted area is extremely small relative to the entire area is supported, given the extremely small percentage of the area of coverage expected to be impacted by greater than 1 cm (0.4 in) of deposited solids.

5.1.2.2 Demersal Fish Eggs. A number of important species, including most cottids, walleye pollock, Pacific cod, rock sole, and sand lance release demersal eggs. Demersal eggs require oxygen for development. Seafood waste discharges resulting in waste piles are typically anoxic due to decay and decomposition of the waste. Thus, demersal eggs could be smothered if located beneath a discharge. Smothering of demersal eggs could have a substantial adverse impact on these demersal species and other aquatic organisms that prey upon these fish. Seafood wastes that are discharged during spawning and egg production periods, have the most potential to adversely affect these species. *Shore-based* and *nearshore* seafood operations in Alaskan coastal waters have a greater likelihood to adversely impact demersal fish spawning activities than *offshore* operations because spawning grounds are more commonly found in these waters.

A number of studies have been conducted regarding effects of suspended solids on egg mortality, but the effect of waste deposition on egg mortality is not well documented (U.S. EPA 1984b). It is not known at what depth of deposition egg survival would be impaired. However, it seems reasonable to assume impairment could occur at waste depths < 1 cm, especially if anoxic conditions were present. A "worst case" scenario similar to the benthic community scenario discussed above, except that the area of potential impact is doubled (i.e., 2 acre areas of impact for each of 321 discharges), indicates that roughly 1 mi^2 of bottom would be impaired. This area is only a small fraction of the area covered under the proposed NPDES general permit and is not expected to have a significant impact on fish assemblages.

5.1.3 Alteration of Sediment

Alteration of sediment characteristics is expected to impact the benthic community structure more subtly, but at greater distances from the point of discharge, than smothering. Benthos would be the group most affected by changes in the sediment, but other organisms may be affected as well. Impacts to benthic communities could conceivably affect epibenthic and pelagic invertebrates, fish, birds, and mammals that rely on benthic invertebrates for food.

The general changes in benthic community structure and function that occur under conditions of increasing organic enrichment of the sediments (such as occurs as a result of seafood waste discharges or municipal sewage effluent discharges) have been well documented (see Pearson and Rosenberg 1978). Slight to moderate enrichment results in slight increases in numbers of species, abundances, and biomass of benthic communities (Figure 5-1), while species composition remains essentially unchanged. As enrichment increases, numbers of species decline because less tolerant species are eliminated. The total abundance of organisms increases as a few species adapted to disturbed environments and/or high organic content of the sediments become very abundant. When the enrichment levels are optimal for those few species, they become extremely abundant, and overwhelmingly dominate the benthic community (i.e., they reach the "peak of opportunists" as shown in Figure 5-1). Biomass generally decreases, however, because many of these opportunistic species are very small. Further organic enrichment of the sediments drastically reduces the number of species and abundances of benthic organisms, as conditions become intolerable for most taxa.

These changes in benthic community variables are accompanied by a progressive reduction in the depth of the oxygenated surficial sediment layer, and changes in the predominant trophic groups of benthic organisms. Mixed assemblages, or assemblages dominated by suspension feeders, are first replaced by assemblages dominated by surface deposit feeders, and then replaced by assemblages dominated by subsurface deposit feeders. Under very highly enriched conditions, such as would likely exist within the waste piles generated by seafood waste discharges, the sediments may be anoxic and macrobenthic organisms may be entirely absent.

The absence of macrobenthic organisms has been documented by divers on several seafood waste piles in Alaskan coastal waters during compliance diver surveys conducted by U.S. EPA and in diver surveys submitted by permittees performing monitoring of their waste piles. In a study of a major seafood processor in Akutan, Alaska, U.S. EPA (1984b) documented that anoxic conditions in the sediments and severe impacts to benthic infaunal communities were confined to the area under the seafood waste pile. A zone of less impact extending outward around the actual waste pile deposits ranged from approximately five to a few hundred meters from the edge of the pile. These results were based on sediment chemical composition and benthic infaunal analyses. Characteristics of the benthic community in the impact zone around the pile included low species richness, and dominance by polychaetes typically associated with high organic inputs and bottom disturbance (U.S. EPA 1984b).

5.1.4 Decay of Solid Wastes

As alluded to above, the decay of organic matter accumulations can effect chemical changes within the sediments and may lead to anoxic conditions within the waste pile. The decay of solid waste accumulations may also result in depletion of dissolved oxygen in the overlying water column and releases of potentially toxic decay byproducts like unionized ammonia and undissociated hydrogen sulfide. Benthic infaunal communities and demersal eggs would be directly adversely affected by anoxic conditions within the waste pile. Most infauna would either migrate out of the area or be killed due to lack of oxygen. A few species may be able to survive within the upper thin sediment layer of the waste pile (e.g., *Capitella* spp.). Anoxic sediments conditions are expected to destroy any demersal eggs that might be present. Reductions of dissolved oxygen in the overlying water column is not expected to result in a significant impact to other mobile marine organisms. The layer of reduced dissolved oxygen above a waste pile is not expected to be large enough to affect these organisms because they are able to avoid these areas.

Releases of potentially toxic decay byproducts like hydrogen sulfide and methane also have the potential to impact marine organisms in the vicinity of the waste pile. However, the potential for impacts is very slight due to the rapid mixing with the overlying water column rich in dissolved oxygen.

Judging from impacts observed in other areas, the magnitude of the observed impact from decaying organic wastes depends on the total area receiving organic waste deposits, the depth of deposition, the difference between native sediments and deposited waste, the degree to which the deposits are anaerobic, and the length of time during which detectable changes in sediment composition occur. Existing data summarized from other areas indicate that impacts may occur, but are likely to be localized. The greatest effect is expected in the area under the waste pile. It is unlikely that sediment alteration from seafood processors in offshore areas will significantly impact populations of benthos in the deeper areas of coverage.

Indirect impacts could also occur with respect to ecosystem interrelationships resulting from behavioral changes, but these would be difficult to observe and correlate with seafood waste disposal. Altered sediment composition may inhibit larval recruitment or feeding and survival of benthic species in some areas.

5.1.5 Cumulative Impacts of Solids Deposition

Impacts of any kind from a single seafood processing facility are likely to be localized. Although benthic organisms may be smothered or community composition altered in localized areas, the benthic communities in Alaskan coastal waters would not be expected to decline significantly. However, no data exist to evaluate the potential impact to benthic communities for several seafood processors that would be located close enough to each other that dispersion of the discharged seafood wastes from all of the sites would cumulatively cover a large contiguous portion of the area. Areas where this may be of concern due to concentrations of seafood processing facilities could include Petersburg, Cordova, and Seward in Southeast Alaska; St. Paul Harbor and Gibson Cove on Kodiak Island.

Impacts from toxicity due to anoxic conditions and changes in community structure could be cumulative spatially and over time. Although more complete knowledge would be of value in assessing the magnitude and significance of cumulative environmental impact, available data indicate that unreasonable degradation is not likely to occur in areas of adequate dispersion and dilution (U.S. EPA 1984a).

5.1.6 Indirect Effects Through Food Supply Reduction

The quantity of benthic organisms preyed upon by other species could be reduced in the area of the discharge if benthos migrate from the area, or experience increased mortality or decreased recruitment, through smothering, toxicity, or alteration of sediment grain size characteristics. Issues affecting temporal or areal extent of such impacts are discussed by U.S. EPA (1984a).

The degree of food supply reduction caused by discharges of seafood waste is unknown, as the size of the affected area and severity of impacts are by necessity speculative. However, a significant reduction of food supplies (benthic organisms) is judged unlikely, given that under a worst case scenario, only a small portion the Alaskan coastal waters [(approximately <0.0001 percent of the area)] would receive deposition depths greater than 1 cm (0.4 in).

5.2 IMPACTS DUE TO LIQUID SEAFOOD PROCESS WASTES

During the discharge of liquid or soluble seafood processing waste, biological impacts are most likely to occur as a result of the discharge of soluble oxygen demanding substances (i.e., BOD), nutrients, and disinfectants. Other liquid discharges associated with seafood processing activity, but that do not come into direct contact with seafood waste (e.g., bailwater, cooling water, boiler water, etc.) are not expected to impact marine organisms because they are considered to be non-toxic, do not contain significant amounts of oxygen demanding substances and nutrients, or in the case of soluble sanitary wastes, are treated prior to discharge. The potential impacts to marine organisms due to the discharge of BOD, nutrients, and disinfectants are discussed below.

5.2.1 Biochemical Oxygen Demand/Dissolved Oxygen

Soluble wastes discharged from seafood processing facilities include relatively high concentrations of BOD_5 (see Section 2.0). Bacterial oxidation of the soluble organic matter discharged to receiving waters from seafood processors results in the consumption of water column dissolved oxygen. Relatively low dissolved oxygen concentrations or the complete absence of dissolved oxygen is lethal to a number of marine organisms, with the exception of obligate and facultative anaerobic bacteria. The State of Alaska has established marine water quality standards for the protection of marine life. The state standard for coastal waters is 6.0 mg/L and the standard for estuarine and tidal tributary waters is 5.0 mg/L. The potential for exceedance of the Alaska marine dissolved oxygen standards is evaluated in detail in Section 9.0. In general, the coastal waters of Alaska are well oxygenated which provides a considerable buffer for the assimilation of soluble organic wastes. In areas of restricted circulation or relatively low ambient dissolved oxygen concentrations due to natural processes, the potential for adverse effects on marine organisms due to depletion of dissolved oxygen is increased. Nonetheless, modeling studies presented in Section 9.5 indicate that typical seafood discharges to well-oxygenated open coastal waters or semi-enclosed embayments will not likely result in exceedances of state dissolved oxygen standards. Therefore, significant biological impacts are not expected to occur due to the regulated discharge of seafood processing waste under the new NPDES general permit. However, exceedance of state dissolved oxygen standards is a possibility for discharges to areas of limited water exchange (e.g., enclosed embayments) or low ambient dissolved oxygen concentrations.

5.2.2 Nutrients/Eutrophication

Seafood processing waste discharges contain relatively high concentrations of soluble nitrogen and phosphorus compounds that are often associated with increases in phytoplankton biomass, productivity, and changes in phytoplankton community species composition (United Nations 1990). Secondary or indirect impacts may occur if certain phytoplankton species become toxic or if toxic phytoplankton become more abundant. Since phytoplankton form the base of the food chain, impacts to the phytoplankton community could have significant effects on the marine ecosystem as a whole (Legendre 1990). Although enhanced phytoplankton growth would not necessarily be an adverse effect since phytoplankton form the base of the marine food chain, a large increase in phytoplankton standing crop or changes in species composition, particularly to toxic species, could have adverse effects on dissolved oxygen concentrations, other marine organisms, aesthetic water quality, and impacts to humans. These potential impacts are discussed below.

*5.2.1.1 **Enhanced Biomass and Productivity***. There are several factors which control the rate of phytoplankton productivity and the accumulation of algal biomass. These include temperature, light intensity, mixing depth, and the supply of other nutrients such as nitrogen, phosphorus, silica, and a number of other essential elements (e.g., iron, manganese, zinc, copper, and cobalt). Other factors influencing phytoplankton productivity and biomass that are still poorly understood include inhibitory and stimulatory substances (e.g., vitamin B-12, chelating agents) (Aubert 1990; United Nations 1990). Factors influencing changes in phytoplankton community composition are also poorly understood, but are generally related to adaptations of certain species to specific combinations of the factors identified above. For example, diatoms (a group of marine and freshwater algae) appear to be favored when available nutrient concentrations (especially silica) are high and turbulent water column mixing is adequate to maintain these algae in the upper water column layer where light is available. An additional factor that controls the biomass and species composition of phytoplankton is the grazing activity of zooplankton that may feed selectively on certain species of phytoplankton.

The potential for adverse impacts of nutrient discharges from seafood processing facilities would necessarily depend on whether or not the nutrients nitrogen or phosphorus limit phytoplankton growth in the vicinity of the discharge or if other influencing factors are contained in the waste discharge that could significantly influence phytoplankton production. Other relevant factors to consider include water exchange, mixing depth, zooplankton grazing activity, and the depth of light penetration in the water column. Therefore, it is difficult to predict the potential impact of nutrient rich waste discharges from seafood processors on Alaskan marine phytoplankton communities. However, there appear to have been no studies or reports on impacts of seafood waste discharges on marine phytoplankton in Alaska. Therefore, it is difficult to make a general assessment of the potential for enhancement of phytoplankton productivity and biomass in the vicinity of seafood processing discharges. Nonetheless, these impacts are most likely to occur in relatively shallow areas of restricted water circulation when nitrogen or phosphorus limitation of phytoplankton growth occurs. Therefore, discharges to relatively well-flushed coastal areas have a lower potential to cause enhanced phytoplankton growth and biomass. Directed scientific studies are recommended in Section 11.0 that would provide the scientific basis needed do address this concern more thoroughly.

5.2.1.2 Alterations in Phytoplankton Species Composition/Toxic Phytoplankton. Alterations in phytoplankton species composition is another potential impact of nutrient rich discharges on marine phytoplankton. Concerns regarding alterations in phytoplankton community composition are primarily related to indirect effects due to the production of phytoplankton species that have adverse effects on marine organisms and humans. These effects include physical damage to marine organisms (e.g., diatom species of *Chaetoceros* which have caused mortality of penned salmon), toxic effects to marine organisms (e.g., a raphidophyte flagellate species of *Heterosigma*), and toxic effects to humans due to the concentration of algal toxins in marine fish and shellfish [e.g., Paralytic Shellfish Poisoning (PSP), Diarrheic Shellfish Poisoning (DSP), Neurotoxic Shellfish Poisoning (NSP), Amnesic Shellfish Poisoning (ASP), and ciguatera] (Taylor 1990; Haigh and Taylor 1990). Concerns regarding toxic phytoplankton have been heightened in recent years due to suspicions that the frequency of toxic phytoplankton blooms has increased due to human activities, especially due to agricultural runoff and the discharge of municipal and industrial wastewater to marine coastal areas (Smayda 1990; Smayda and White 1990; United Nations 1990; Anderson 1989).

Although there have been several reports linking mortalities of relatively large numbers of marine mammals (e.g., O'Shea et al. 1991; Anderson and White 1989; Geraci 1989; Geraci et al. 1989; Gilmartin et al. 1980), fish and shellfish (e.g., Cosper et al. 1990; Harper and Guillen 1989; Smayda and Fofonoff 1989), and aquatic plants (e.g., Cosper et al. 1990) to the occurrence of toxic phytoplankton in other parts of the U.S., no such episodes have been reported for the coastal waters of Alaska. However, the occurrence of human intoxication due to PSP has been recorded at locations in Southeast Alaska (Sundström et al. 1990). PSP is caused by the consumption of shellfish that have concentrated toxins from dinoflagellate algae of the species *Protogonyaulax* (Shimizu 1989). However, direct links between the occurrence of PSP and eutrophication have not been established (Anderson 1989).

Although there is a potential for the discharge of seafood processing waste to cause at least localized changes in phytoplankton species composition, there is currently no documented evidence that the current discharge of seafood processing waste has resulted in toxic or harmful phytoplankton blooms that have caused significant mortality of marine organism. Although the occurrence of PSP has been noted in Southeast Alaska, there is currently no evidence that would suggest a link between seafood processing waste discharges and the occurrence of PSP. Therefore, based on the available data, it does not appear that the regulated discharge of seafood processing waste will result in significant changes in phytoplankton species composition that would lead to adverse effects on marine organisms and humans. However, directed scientific studies are recommended in Section 11.0 that would provide the scientific basis needed do address this concern more thoroughly.

5.2.3 Disinfectants/Residual Chlorine

Soluble wastes from seafood processing discharges may contain residual concentrations of chlorine-based disinfectants. Residual chlorine and chlorine-produced oxidants have been shown to be toxic to marine organisms at relatively low concentrations (U.S. EPA 1985; Thatcher 1980). Thatcher (1980) conducted 96-hr LC_{50} continuous-flow bioassays on a number of species of fishes and invertebrates typical of the

Pacific Northwest and determined that juvenile species of salmon were particularly sensitive. The lowest LC_{50} was determined for coho salmon (32 $\mu g/L$). The State of Alaska has established a marine water quality standard for salmonid fish of 2.0 $\mu g/L$ and 10.0 $\mu g/L$ for other organisms. The recommended federal criteria for residual chlorine concentrations in marine waters states that saltwater and their uses should not be affected unacceptably if the 4-day average concentration (i.e., chronic criterion) of chlorine-produced oxidants does not exceed 7.5 $\mu g/L$ more than once every 3 years on the average and if the one-hour average concentration (acute criterion) does not exceed 13 $\mu g/L$ more than once every 3 years on the average (U.S. EPA 1985).

The new NPDES general permit proposes an effluent limit concentration of 2.0 mg/L of residual chlorine in process wastewater discharged from seafood processing facilities covered under the permit. The available data on measured residual chlorine concentrations in seafood processing effluent summarized in Section 2.7 indicates that residual chlorine concentrations are frequently below analytical detection limits. However, the analytical detection limits achieved and the method used to measure the chlorine residual were not provided. Nonetheless, these data, coupled with the assumption that the disinfectants are effectively diluted in the process wastewater prior to discharge, and the relatively large concentrations of easily oxidized organic matter in the wastestream effectively consume the majority of the residual chlorine and chlorine-produced oxidants prior to discharge, indicate that the potential for harmful effects to marine organisms due to chlorine-produced oxidants is unlikely to occur. These arguments are discussed in more detail in Section 9.6.1 in the assessment of compliance with water quality criteria. Because some uncertainty exists concerning the quality of the available data, recommendations for effluent monitoring of residual chlorine or chlorine-produced oxidants is made in Section 11.0.

5.3 SECONDARY IMPACTS DUE TO SEAFOOD PROCESSING WASTES

Although a number of potential secondary impacts to marine organisms are outlined below, no studies have been conducted to determine whether the potential impacts of seafood processing waste discharges occur. Most of the discussion of the potential secondary impacts of seafood processing discharges relies on personal communications from scientists and regulatory agency personnel familiar with seafood processing activity in Alaska.

Potential secondary impacts of seafood waste discharges involve effects on marine mammals and birds due to their attraction to seafood waste discharges. Eutrophication of marine waters may also indirectly result in enhancement of phytoplankton species that are toxic to marine organisms and humans. Potential impacts from toxic phytoplankton are discussed in Section 5.2.1.2. Bacteria associated with the decaying seafood waste may also adversely impact marine mammals and birds.

5.3.1 Attraction of Organisms to the Discharge

The attraction of marine mammals to seafood waste discharges may make them easier prey for predators. As discussed above, there are no documented studies relating seafood processing waste discharges with marine mammal concentrations. However, there is anecdotal information from the National Marine Fisheries Service indicating a very strong attraction to processors by sea lions both at sea and shore-based. As seafood processing moved onshore, observations of sea lions were made in Kodiak Harbor. Occasional observations of killer whales feeding on sea lions in Kodiak were also made. NMFS personnel observed a possible linkage of sea lion observations with fishing activity--fish processing, sea lions in Kodiak, fishery closed (no processing), no sea lion observations (Loefflad, M., 1 April 1994, personal communication). It should be stressed that this information is anecdotal.

Another potential secondary impact involves the development of dependence on an anthropogenic food supply that may result in the concentration and growth of marine mammal and bird populations that could be adversely affected if this food supply was reduced or eliminated. Although there are no documented studies, it is evident that a large number of birds (e.g., gulls) are attracted to seafood processing waste discharges. They are most likely feeding on the discharged floating particulates. Artificial food sources, such as seafood process wastes, may increase the gull populations in Alaska by providing food throughout winter months when food is less abundant and survival is the most difficult. Large gulls (herring, glaucous, and glaucous-winged) and parasitic birds (jaegers and skuas) interfere with the reproductive success in waterfowl and in seabirds by preying on ducklings and chicks, displacing other species from nests, and harassing adult birds (Giger, M., 6 April 1994, personal communication). Several studies which have documented gulls and other parasitic birds preying on waterfowl and seabirds include Andersson (1974), Tyler (1975), Nettleship (1977), Munro and Bedard (1977), Martin and Barry (1978), Mendenhall and Milne (1985), Barry and Barry (1990), Lloyd et al. (1991), and Mendenhall (1993). Seafood waste discharges may increase localized populations of gulls and parasitic birds which may adversely affect the breeding success of some bird species. The significance of this potential indirect impact from seafood waste discharges is unknown, although it is thought to be minor in most locations throughout coastal Alaskan waters. Other than the anecdotal information described above, there is no information on potential marine mammal impacts. However, it is more likely that the marine mammals return to their normal feeding grounds.

Birds that are attracted to surface plumes of seafood waste (especially floating particulates) may potentially become oiled or their feathers fouled due to accumulation of waste fish oils on the water surface. There are no documented studies indicating that this has been a problem. Other studies on effects of oil spills on birds have shown adverse impacts, fish oils are different in composition from petroleum products but the potential impacts may be similar. However, unless the volume of floating oils was significant and the birds were constantly diving through it, it is unlikely that fouling of the feathers would occur.

5.3.2 Bacteria from Decaying Onshore Waste Accumulations

Bacteria associated with the decaying seafood waste may potentially adversely impact marine mammals and birds. The potential for impact is hypothesized to be from animals eating, rubbing, or rolling in decaying seafood that has accumulated on the shoreline and has a strain of bacteria that may be harmful to the organism. There are no studies or anecdotal information to suggest that this is a major potential problem. In addition, the new NPDES general permit prohibits the accumulation of seafood waste on shore as a result of the discharge and if this does occur it would likely be limited to a few individuals and would not likely impact the general bird population.

5.4 SUMMARY

The potential adverse effects of seafood processing waste include direct and indirect impacts of the solid and liquid waste discharges to marine organisms. Potential direct impacts of solid waste discharges, including alterations in the benthic community due to burial, alteration of the sediment texture, and chemical changes effected within the sediments due to the decay of organic matter accumulations are expected to be confined to relatively limited areas within the permit-defined zone-of-deposit. The decay of accumulations of solid waste may also result in depletion of dissolved oxygen in the overlying water column and releases of potentially toxic decay byproducts like unionized ammonia and undissociated hydrogen sulfide. Permitted discharges of seafood waste to oxygenated well-flushed areas are not expected to cause levels of dissolved oxygen or toxic substances beyond the zone-of-deposit that would have an adverse effect on marine organisms. Eutrophication of coastal marine waters is not expected to occur in locations where water exchange is adequate to dilute nutrient inputs from seafood processing waste discharges. Residual concentrations of chlorine disinfectants in the liquid wastestream, and additional oxidants produced by the reactions of chlorine with other compounds, also are not expected to adversely impact marine organisms.

Potential indirect impacts of seafood waste discharges involve effects on marine mammals and birds due to their attraction to seafood waste discharges. At present the data regarding these effects are mostly circumstantial and anecdotal. Therefore, a thorough assessment of the potential for these impacts to occur can not be made. However, the extent of these impacts if they occur is considered to be limited to the immediate vicinity of the processing discharges. Eutrophication of marine waters may also indirectly result in enhancement of phytoplankton species that are toxic to marine organisms and humans. Although toxic phytoplankton species occur in marine waters of Alaska, no simple link between the occurrence of toxic phytoplankton and seafood processing waste discharges can be made. It is unlikely that the regulated discharge of seafood processing waste will result in significant changes in phytoplankton species composition that would lead to adverse effects on marine organisms and humans. Due to the uncertainties associated with the assessment of these potential indirect impacts of seafood processing waste discharges on marine organisms, directed scientific studies have been proposed in Section 11.0. These studies would provide a better information base to assess the potential for indirect impacts on marine organisms.

6.0 ENDANGERED AND THREATENED SPECIES

The determination of "unreasonable degradation" of the marine environment is to be made based upon consideration of the ten criteria listed in Section 1.0. This section provides information pertinent to consideration of the criterion shown below:

- **Criterion #3**: "The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain"

This section will assist in evaluating criterion #3 by identifying those species which have been listed as threatened or endangered and are located in areas with the potential to be exposed to seafood processing waste discharges. In addition, the potential impacts seafood waste discharges may impose on these species is discussed.

6.1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973 requires federal agencies, in consultation with the agencies responsible for administering the ESA, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (U.S. FWS), to ensure that any action they authorize is not likely to jeopardize the continued existence and recovery of any species listed as threatened or endangered or result in the destruction or adverse modification of critical habitat. An endangered species is defined as a species which is in danger of extinction throughout all or a significant portion of its range whereas a threatened species is defined as a species which is likely to become endangered within the near future throughout all or a significant portion of its range. A species may also be classified as a candidate species in one of two categories. A species is designated as a Category 1 candidate species when the administering agency has sufficient data to warrant listing as threatened or endangered. Category 2 status is assigned when the best available scientific and commercial information indicates that the species may qualify for protection under the ESA, however, the administering agency requires further information before the need for listing can be determined (Ambrose, S. 2 February 1994, personal communication). Critical habitat is defined as the specific areas within and outside the geographical area currently occupied by a species at the time it is listed in accordance with the ESA, on which are found those biological or physical features essential to the conservation of the species and which may require special management considerations or protection (50 CFR 424.02). Designation of critical habitat contributes to the conservation of a species primarily by identifying critically important areas and by describing the features within the area that are essential to the species.

The action under discussion is the discharge of seafood wastes associated with offshore and nearshore floating processing facilities as well as shore-based facilities in Alaska. The primary waste to be evaluated for potential effects to threatened and endangered species is from seafood processing wastes. Although a minor wastestream in terms of quantity discharged, sanitary wastes will also be considered in this evaluation. Specific information detailing quantities and composition of process disinfectant wastes are not available for the entire area covered by the proposed general permit, therefore, a general discussion will be presented for the potential effects associated with these wastes. A detailed discussion characterizing seafood processing wastes and sanitary wastes may be found in Section 2.0 of this document.

The proposed NPDES general permit is applicable for seafood wastes discharged to all Alaskan state waters and federal waters adjacent to state waters. Identification of all threatened and endangered species found in these waters with the potential to be impacted by the discharges stated above will be discussed in this section. Marine mammals and waterfowl which have been identified as candidate species by NMFS or U.S. FWS will be identified but not discussed further in this chapter as Section 7(a)(2) of the ESA is not applicable to species receiving this designation. However, a general discussion of potential impacts to candidate species from seafood waste discharges is presented in Section 5.0.

Two groups of marine mammals, cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals, sea lions, and walruses) contain species that are presently considered by NMFS to be either threatened or endangered species. Cetaceans currently identified as endangered include the following: blue, bowhead, fin, gray, humpback, northern right, sei, and sperm whales. There are no cetaceans currently identified as a threatened species (Zimmerman, S., 1 April 1994, personal communication). The Cook Inlet beluga whale stock is currently identified as a candidate species for threatened listing (Morris, R., 16 August 1993, personal communication). NMFS has proposed to remove the eastern Pacific gray whale stock from the Endangered Species List due to the recovery of this stock to a population level equal to that prior to commercial whaling. Until U.S. FWS concurs with this proposal, the eastern Pacific gray whale stock will continue to be listed as an endangered species (NMFS 1993a). The Steller sea lion is the only pinniped currently identified as a threatened species. No pinnipeds are presently listed as endangered species (Zimmerman, S., 1 April 1994, personal communication).

Marine birds currently considered to be endangered species by the U.S. FWS include the following: American peregrine falcon and the short-tailed albatross. Marine birds and waterfowl presently identified by the U.S. FWS as threatened species include the Aleutian Canada goose, Arctic peregrine falcon, and the spectacled eider (Ambrose, S. 2 February 1994, personal communication). The U.S. FWS has proposed to remove the Arctic peregrine falcon from the Threatened Species List due to the increase in abundance following restrictions placed on the use of organochlorine pesticides. Until NMFS concurs with this proposal, however, the Arctic peregrine falcon will continue to be listed as a threatened species (U.S. FWS 1993). The Steller's eider is currently identified as a candidate species receiving Category 1 status pursuant to the ESA. Although warranted, this species has not been listed as a threatened or endangered species due to higher priority species awaiting listing action. The bristle-thighed curlew, Evermann's rock ptarmigan, harlequin duck, Kittlitz's murrelet, marbled murrelet, northern goshawk, olive-sided flycatcher, red-legged kittiwake, and the Yunaska rock ptarmigan are currently identified as Category 2 candidate species (Ambrose, S. 2 February 1994, personal communication). By September 1996, the U.S. FWS must either propose or reject for formal listing all species currently classified as candidate species (Alaska Biological Research 1993).

The Snake River sockeye salmon is the only marine fish currently identified by NMFS as endangered. Snake River spring/summer and fall chinook salmon are presently considered threatened by the NMFS (Zimmerman, S., 1 April 1994, personal communication).

6.2 ABUNDANCE AND DISTRIBUTION OF THREATENED AND ENDANGERED SPECIES

The following section presents a brief description of the abundance and distribution of threatened and endangered species. The section is separated into three general categories: marine mammals, marine birds and waterfowl, and fish. Marine mammals are further divided into cetacean and pinniped categories.

6.2.1 Marine Mammals

The following marine mammals are discussed below: blue, bowhead, fin, gray, humpback, northern right, sei, and sperm whales, and Steller sea lion.

6.2.1.1 Cetaceans.

Blue Whale. Blue whales (*Balaenoptera musculus*) range from southeast Alaska to the Bering Strait. The species is pelagic and is rarely seen in coastal waters, with the exception of polar waters where they follow the retreating ice flows as summer progresses (Zimmerman, S., 1 April 1994, personal communication). Blue whales tend to concentrate in an area just south of the Aleutian Islands. These whales generally begin a southward migration out of the Gulf of Alaska in September to southern North American waters. The abundance of blue whales in the North Pacific has been estimated at 1,600 whales and the population shows no evidence of recovering from depletion by commercial whaling activities (U.S. DOI/MMS 1992).

Blue whales feed primarily on euphausiids in the upper water column.

Bowhead Whale. The population of bowhead whales (*Balaena mysticetus*) was drastically reduced due to commercial whaling. This species is protected from commercial whaling, however, whales are allowed to be taken for subsistence purposes by nine Alaskan whaling villages. The Bering-Chukchi-Beaufort Sea population of bowhead whales contains between approximately 6,400 to 9,200 whales with a most likely estimate of 7,500. The US intends to seek a quota of a total of 48 whales landed per year for the years 1995 through 1997. Assuming a 75 percent efficiency in landing whales, the U.S. will seek International Whaling Commission (IWC) approval to strike up to 64 bowheads in order to land 48 (Baird, R, 15 April 1994, personal communication). Summer feeding grounds are located in the Canadian Beaufort Sea. After leaving feeding grounds, these whales migrate westward into Alaskan waters. Wintering areas are located in the Bering Sea. The majority of bowheads migrate through water depths ranging from 10 to 50 m (32.8 to 164.0 ft) (U.S. DOI/MMS 1992).

Bowhead whales feed throughout the water column, although they capture prey primarily near the surface or near the bottom in shallow waters. They feed on euphausiids and other invertebrates (U.S. DOI/MMS 1992).

Fin Whale. The fin whale (*Balaenoptera physalus*) has been protected from commercial whaling since 1976 when the IWC designated fin whales in the north Pacific as a protected stock. The population of fin whales in the Pacific Ocean has been estimated to contain between 14,600 and 18,600 whales (NMFS 1989). Concentrations occur from May to August in the summer feeding range in the Gulf of Alaska. Peak occurrences during the spring migration occur in the Kodiak Island/northern Gulf of Alaska region beginning in May. Although the fall migration begins in September, most whales remain in the Aleutian Islands and Gulf of Alaska waters until November with some possibly wintering in the southeastern Aleutian Islands (U.S. DOI/MMS 1992).

Fin whales feed primarily on euphausiids which are abundant in the summer feeding grounds. Other prey items include small fish, cephalopods, and other invertebrates.

Gray Whale. The gray whale (*Eschrichtius robustus*) now occurs only in the North Pacific and adjacent waters of the Arctic Ocean. The eastern Pacific gray whale stock migrates through the Gulf of Alaska area during April, May, and June and again during the fall migration in November and December. They generally migrate along the eastern side of Kodiak Island from the Kenai Peninsula to Unimak Pass on their way to the Bering Sea. Summer feeding grounds are located in the northern Bering Sea and southern Chukchi Sea off St. Lawrence Island. This species usually migrates close to shore, within 1 km (0.6 mi), and little food is consumed during migration and winter months. The gray whale is a bottom feeder moving along the seafloor while sifting the sediments through baleen to capture prey. The principal prey is amphipods, however, their diet also includes other benthic invertebrates, small fish, and herring eggs (Breiwick and Braham 1984).

The eastern Pacific gray whale stock has been proposed for delisting by the NMFS (1993a) due to the recovery of the population to numbers equal to or exceeding levels prior to commercial whaling. Until the U.S. FWS concurs with this proposal, however, the gray whale will continue to be listed as endangered.

Humpback Whale. The current North Pacific humpback whale (*Megaptera novaeangliae*) population is estimated to contain between 1,200 to 2,100 whales. This population was severely depleted due to commercial whaling activities. In 1966, the IWC listed the North Pacific humpback whale population as a protected stock. Summer feeding grounds in Alaska extend from southeast Alaska and the Aleutian Islands to the Bering Sea and southern Chukchi Sea. In the Bering Sea, most sightings have been recorded near Unimak Pass, the eastern Aleutian Islands, and the outer shelf east of the Pribilof Islands. In the Gulf of Alaska, concentration areas include the Portlock and Albatross Banks and west to the eastern Aleutians, Prince William Sound, and the inland waters of southeastern Alaska (U.S. DOI/MMS 1992). Data for individually identified humpback whales in southeast Alaska have been collected since 1981 by the National Park Service, Glacier Bay National Park, University of Hawaii, and independent researchers (Straley et al. 1994).

Humpback whales feed on euphausiids, amphipods, and small schooling fishes. They capture their prey at the water surface or in the midwater regime.

Northern Right Whale. The northern right whale (*Eubalaena glacialis*) has been depleted to near extinction due to commercial whaling. The exact abundance and distribution of this species in the eastern North Pacific is not known due to limited sightings, however, population estimates of 100-200 whales are often cited (Carretta et al. 1994). Areas of probable importance to this species include the Gulf of Alaska (particularly south of Kodiak Island) and in the eastern Aleutian Islands.

Right whales feed primarily on copepods, and to a lesser extent, euphausiids. Although surface feeding has been observed, these whales generally feed below the surface and occasionally at or near the bottom (Zimmerman, S., 1 April 1994, personal communication).

Sei Whale. The sei whale (*Balaenoptera borealis*) has been protected from commercial whaling since 1966 when the IWC designated the north Pacific population as a protected stock. This population has been estimated to contain approximately 9,100 whales (NMFS 1991a). The largest population of sei whales occur just east of Portlock Bank in summer. The eastern Pacific stock migrates northward east of Kodiak Island during April through June. The whales migrate through the area again during the fall southward migration in November and December. In spring, substantial numbers of whales occur in the waters off the northeast coast of Kodiak Island, although the location of seasonal concentrations varies dependent upon prey availability.

Sei whales are surface feeders and capture prey by skimming the water surface. Principal prey items include copepods, euphausiids, small schooling fishes, and cephalopods (Breiwick and Braham 1984).

Sperm Whale. Sperm whales (*Physeter macrocephalus*) have been protected from commercial whaling since 1976. The population of these whales in the North Pacific comprised of males 11 years and older and females 10 years and older has been estimated to contain 930,000 individuals (U.S. DOI/MMS 1992). In Alaskan waters, sperm whales range from southeast Alaska to the Bering Sea and only large males are found north of 45^{0} N latitude. An estimated 40 to 60 percent of the mature males spend the summer months in the Bering Sea (U.S. DOI/MMS 1992). In the Bering Sea, sperm whales frequent the shelf break between the Pribilof Islands and Cape Navarin. This species is generally located in waters 200 m (660 ft) or greater and does not migrate close to shore. Summer feeding grounds are located in the Gulf of Alaska, the Alaska Peninsula, and the Aleutian Islands.

Sperm whales feed on fish and cephalopods in Alaskan waters (Zimmerman, S., 1 April 1994, personal communication).

6.2.1.2 Pinnipeds. The Steller sea lion (*Eumetopias jubatus*) is the only pinniped found in Alaska listed as a threatened species. No pinnipeds are listed as endangered. The justification for the Steller sea lion listing in 1990 was due to an 82 percent decline in the population since 1960 and a 63 percent decline since 1985 for the population located from the Aleutian Islands to the Kenai Peninsula (U.S. DOI/MMS 1992). Steller sea lion population abundance was estimated at 105,289 sea lions in the mid 1950s, decreasing to 20,675 in 1992 (Calkins 1992). Steller sea lions are found in Alaska from the Aleutian Islands and southern Bering Sea to the Gulf of Alaska and south throughout southeast Alaska. The highest densities of sea lions are located in the Gulf of Alaska and Aleutian Islands (Zimmerman, S., 1 April 1994, personal communication).

In December of 1986, the National Marine Mammal Laboratory convened a workshop to review information on the Steller sea lion to identify possible causes for the decline in their abundance. Potential causes identified were: incidental take associated with fisheries, deliberate shooting by fishermen, reduction in important prey species due to fishery development, entanglement in lost and discarded fishing gear and other marine debris, disease, environmental pollution, and natural changes in the marine ecosystem. The workshop concluded that information was insufficient at that time to determine the cause(s) of the decline (Marine Mammal Commission 1987).

The best supporting evidence to date for the cause of the decline in Steller sea lion abundance suggests that the sea lions are nutritionally stressed, most likely due to reduced walleye pollock abundance. From 1981 to 1988 an intense fishery existed in Shelikof Strait for walleye pollock spawners, although the harvest has been severely restricted since 1986 (Kendall and Nakatani 1992). Sea lions collected in the Kodiak area during the 1980s had significantly smaller body size than individuals monitored in 1970 and were in anemic condition (Calkins 1992). Numbers of pups produced has also declined, which likely contributes to the population decline. The reduction in fecundity may be correlated with the nutrition stress evidenced by the adult females (Calkins and Goodwin 1988).

On 27 August 1993, the NMFS published the final rule designating critical habitat for the Steller sea lion under the ESA. Designated critical habitat includes; all Steller sea lion rookeries and major haulouts (>200 sea lions) located within state and federally managed waters off Alaska, including a zone that extends 0.9 km (3,000 ft) landward and vertical of each rookery and haulout boundary, and that extends 0.9 km (3,000 ft) seaward from rookeries and major haulouts located east of 144° W longitude, or 20 m seaward from rookeries and major haulouts west of 144° W longitude, and one aquatic foraging zone located exclusively in the Gulf of Alaska, and two aquatic zones located in the Bering Sea/Aleutian Islands area. All of Shelikof Strait has been designated as critical habitat. Air zones extending 0.9 km (3,000 ft) above these terrestrial and aquatic zones have also been designated as critical habitat (NMFS 1993b).

6.2.2 Marine Birds and Waterfowl

The American peregrine falcon, short-tailed albatross, Arctic peregrine falcon, Aleutian Canada goose, and the spectacled eider are discussed below.

6.2.2.1 Marine Birds. The American peregrine falcon (*Falco peregrinus anatum*) is currently listed as an endangered species. The use of organochlorine pesticides beginning in the late 1940s greatly affected these falcons. In 1978, six years after the United States restricted the use of these pesticides, the peregrine falcon population began to increase, and the trend has continued to the present. Based upon 1991 surveys, the Alaskan population of American peregrine falcons is estimated to be 225 pairs (U.S. DOI/MMS 1992).

Migration routes of the American peregrine falcon are not well defined. It has been suggested that birds from the North Slope and eastern interior approximately follow the central flyway and birds from the western interior follow the Pacific flyway. Migrating birds have been observed in the vicinity of the Gulf of Alaska (U.S. DOI/MMS 1992).

The short-tailed albatross (*Diomeda albatrus*), a pelagic surface-feeding seabird, is currently listed as an endangered species. This species was extensively exploited for its feathers, thus the world population was depleted to less than 100 individuals by the 1930s. Since this time, the population has increased to approximately 400 individuals (U.S. FWS, 3 July 1989, personal communication).

Prior to the short-tailed albatross's near extinction, this species was abundant in the North Pacific, including the coastal areas of Alaska. Surveys from recent years indicate that although the numbers are greatly reduced, this species still occupies most of its original range. Other than Torishima Island off Japan, the only known breeding and nesting ground, the majority of short-tailed albatross sightings have occurred in the Gulf of Alaska west to the Aleutian Islands from May through November (Gould et al. 1982; U.S. DOI/MMS 1992).

As stated previously, the U.S. FWS has proposed to remove the Arctic peregrine falcon (*Falco peregrinus tundrius*) from the Threatened Species List due to the increase in abundance following restrictions placed on the use of organochlorine pesticides. However, until this action is finalized, this species will continue to be listed as threatened. Based upon 1991 surveys, the Arctic peregrine falcon population is estimated to contain 160 pairs which produced approximately 220 young (U.S. DOI/MMS 1992).

Arctic peregrine falcons are present in Alaska from mid-April to mid-September and egg-laying on the North Slope begins in the mid-May. Although this species has been observed along the east coast of the Colville River, nest sites generally occur inland approximately 40 km (21.6 nmi) (U.S. DOI/MMS 1990).

6.2.2.2 Waterfowl. The Aleutian Canada goose (*Branta canadensis leucopariea*) is currently identified as a threatened species. These birds nest in the Aleutian and Semidi Islands and then migrate south, mainly to northern coastal California, before wintering in the upper San Joaquin Valley. Fall and spring migrating birds are assumed fly across the Gulf of Alaska (Springer 1993). Aleutian Canada goose populations were severely reduced after the introduction of Arctic and red foxes on most nesting islands between Kodiak Island and the southern Kuril Islands north of Japan. A recovery program initiated in the 1960s, which included the removal of foxes and introduction of captive-reared and wild geese to nesting islands, has led to an increase in the numbers of this species. An additional protective measure which has led to the increase in abundance has been the prohibition of goose hunting in Aleutian Canada goose wintering areas since 1982. There are currently three widely separated breeding populations, of which one is increasing at a high rate and may contain over 7,000 birds. The other two populations are estimated to contain less than 150 birds each (Byrd 1992). These birds feed in mainland areas on grasses, wheat, corn, beans, and rice in harvested fields and roost offshore on islands, lakes, and ponds.

The spectacled eider (*Somateria fischeri*), which is listed as a threatened species, nests near islands, ponds, meadows, or along the coast, primarily across the North Slope from Demarcation Point to Point Hope. After breeding the eiders leave to molt and winter in unknown locations, possibly in the Chukchi or Bering Seas (U.S. FWS, no date). The coastal fringe of the Yukon-Kuskokwim Delta is the primary location of the spectacled eider in Alaska (Dau and Kistchinski 1977, Gould et al. 1982). An estimated 1,721 spectacled eider pairs were observed nesting on the Yukon-Kuskokwim Delta in 1992. Also observed is a population decline of 14 percent per year, although the causes are unknown (Stehn et al 1993).

6.2.3 Fish

Snake River sockeye salmon and Snake River spring/summer and fall chinook salmon are briefly discussed below.

6.2.3.1 Snake River Sockeye Salmon. The stock of Snake River sockeye salmon (*Oncorhynchus nerka*) was listed as endangered in November 1991. Snake River salmon spend one year in freshwater before migrating to the ocean to reside from one to four years. The ocean distribution of this salmon is not known, although they are assumed to migrate into the Gulf of Alaska.

The decline of this stock has been attributed to several factors, including hydropower development, over-utilization, disease and predation, inadequate regulatory mechanisms, and other factors such as drought conditions (NMFS 1991b). Hydropower development along the Snake and Columbia Rivers has resulted in the blockage of habitat, mortality of juvenile fish in the hydropower turbines, delay of migration through the rivers, and increased predation on juveniles due to containment in reservoirs. Water withdrawal and storage and irrigation diversions have also contributed to the destruction of habitat for this salmon stock. The number of Snake River sockeye salmon in the ocean is likely to be less than 100 and the return of this stock at Ice Harbor Dam in the lower Columbia River has been less than 25 fish annually since 1985 (Faris 1993).

6.2.3.2 Snake River Spring/Summer Chinook Salmon. Snake River spring/summer chinook salmon (*Oncorhynchus tshawytscha*) were listed as a threatened species in June 1991. Snake River spring/summer chinook salmon spend one year in freshwater before migrating to the ocean to reside from one to four years. Based upon fish released from hatcheries assumed to have parallel life histories and migration routes of naturally spawned salmon, the ocean distribution of Snake River spring/summer chinook salmon is primarily along the northern Oregon and Washington coast. Only one hatchery fish originating from the Snake River spring/summer chinook salmon run has been recovered from the Alaska groundfish fisheries since 1981 (Faris 1993).

The decline of this stock has been attributed to several factors, including destruction and modification of habitat due to hydropower development, over-utilization, disease and predation, inadequate regulatory mechanisms, and other natural factors (NMFS 1991b). This species will not be considered further in this evaluation as these fish are not presumed to migrate into Alaska waters with regularity, if at all.

6.2.3.3 Snake River Fall Chinook Salmon. Snake River fall chinook salmon (*Oncorhynchus tshawytscha*) were listed as a threatened species in April 1992. Snake River fall chinook salmon migrate to the ocean within a few weeks of emergence from gravel spawning beds where they spend from one to four years.

Based upon released hatchery fish (Lyons Ferry) which are assumed to have parallel life histories and migration routes of naturally spawned salmon, the ocean distribution of Snake River spring/summer chinook salmon is extensive and subject to harvest by Alaskan fisheries. Approximately 40 fish from the Lyons Ferry Hatchery were recovered in southeast Alaska salmon troll fisheries from 1987-1992 (Faris 1993).

The decline of this stock has been attributed to several factors, including destruction and modification of habitat due to hydropower development, over-utilization, disease and predation, inadequate regulatory mechanisms, and other natural factors (NMFS 1992).

6.3 EFFECTS OF PERMITTED DISCHARGES AND OTHER ACTIVITIES ON THREATENED AND ENDANGERED SPECIES AND CRITICAL HABITAT

Endangered or threatened species have the potential to be adversely impacted by seafood waste discharges either directly by the discharged process wastes and other permitted discharges, or indirectly through effects such as reduction in prey availability, bioaccumulation, bacteria and nutrient enrichment, alteration of habitat, and increased predation. Potential adverse effects associated with seafood process waste discharges are of primary concern due to the volume of wastes discharged. Potential direct and indirect effects to threatened and endangered species are discussed in detail below.

6.3.1 Cetaceans

6.3.1.1 Direct Effects. The blue, bowhead, fin, gray, humpback, northern right, sei, and sperm whales are not likely to be adversely impacted directly by seafood process waste discharges. Although the blue, bowhead, humpback, northern right, sei, and sperm whales feed in Alaskan waters during the summer months, they are not likely to be exposed to discharges which may accumulate on the seafloor. The bowhead whale feeds in the Beaufort and Chukchi Seas where commercial seafood processing activities have not historically occurred, and thus are not expected to be exposed to the discharges. The other six whales generally feed near the surface or in the midwater regime, therefore, they would also not be expected to be exposed to seafood process wastes. Although the gray whale may come into contact with seafood waste accumulations while feeding, this species is not expected to be adversely impacted by the discharges due to the chemical constituents of the discharge. Although studies for potential toxic effects from seafood processing wastes have not been conducted on marine mammals, the discharges are not expected to contain components which exhibit toxicity (see Section 2.0).

Adverse impacts from sanitary waste discharges are not expected to occur due to the transitory nature of the eight whale species, the use of approved marine sanitation devices, limited discharge quantities, and the exclusion of discharges to specified waterbodies (see Section 1.0). It is not likely that these species would be exposed to the discharges, however, if contact does occur, the required use of marine sanitation devices is deemed sufficient to prevent adverse effects.

6.3.1.2 Indirect Effects. The following indirect effects will be discussed separately: reduction in prey availability, bioaccumulation, bacteria and nutrient enrichment, and increased predation.

Reduction in Prey Availability. Many benthic invertebrates are relatively sedentary and sensitive to environmental disturbance. The deposition of seafood process waste may reduce the abundance of benthos such as polychaetes, mollusks, crustaceans, and may affect demersal eggs of various benthic species and fish.

Most studies that have investigated deposition impacts on benthos have examined the deposition of dredged materials (Hale 1972; Saila et al. 1972; Schafer 1972; Oliver and Slattery 1973; Kranz 1974; Mauer et al. 1978; Wilber 1992). These studies indicate that the response to depths from which organisms were able to migrate to the surface ranged from 1 to 32 cm (0.4 to 12.6 cm). If it is assumed that most benthos are not adversely affected by deposition of seafood process wastes less than 1 cm, then benthic populations in the vicinity of the discharge receiving deposition in excess of 1 cm may be reduced.

Whales with the potential to be adversely affected due to reduction in prey include the humpback, fin, and sperm whales. Although not exclusively, these whales feed on fish species having demersal eggs which may be impacted by the discharges. The gray whale feeds primarily on benthic invertebrates, however, summer feeding grounds are located in the northern Bering Sea and southern Chukchi Sea where discharges are not expected to occur. The northern right, sei, blue, and bowhead whales are also not expected to be affected by reduced prey availability.

Bioaccumulation. Seafood process waste discharges are not expected to contain toxicologically important constituents with the potential to bioaccumulate, therefore, none of the eight whale endangered whales are expected to be affected due to bioaccumulation.

Bacteria and Nutrient Enrichment. Sanitary wastes are not expected to affect any of the endangered whales as potentially harmful bacteria, such as fecal coliforms, are reduced before the waste is discharged. Information concerning nutrients contained in the discharges with the potential to create harmful effects, such as algal blooms, is limited. However, based on the limited areal extent of potential impacts in relation to the area where whales are located, the impact due to nutrient enrichment is judged to be minimal.

Increased Predation. Increased predation is not likely to occur for any of the eight whale species.

6.3.2 Pinnipeds

6.3.2.1 Direct Effects. Steller sea lions and designated critical habitats are not likely to be adversely impacted directly by seafood process waste or sanitary discharges. NMFS has established sea lion protection areas around major haulout and rookeries in Alaska where vessels are prohibited within 5.6 km (3 nmi) and trawling is prohibited within 18.5 km (10 nmi) of these areas. Critical habitat has also been established for Steller sea lions which includes three major foraging areas and all major rookeries and haulouts within Alaskan state and federal waters. In addition to the protective measures stated above, the proposed general permit is expected to exclude seafood processing activities from the areas stated above.

6.3.2.2 Indirect Effects. Steller sea lions are not likely to be adversely impacted indirectly by seafood process waste or sanitary discharges for the reasons stated in Section 6.3.2.1. In addition, the fish that Steller sea lions frequently consume do not possess demersal eggs. Therefore, the possibility of prey reduction due to smothering of eggs and oxygen depletion from deposition of process wastes is minimal.

6.3.3 Marine Birds and Waterfowl

6.3.3.1 Direct Effects. American and Arctic peregrine falcons are assumed to occur sporadically in areas where seafood processing activities are present as these species generally are located on the North Slope and in the eastern and western interior. Therefore, it is not likely that these birds would be adversely affected by seafood processing or sanitary waste discharges. It is also unlikely that the short-tailed albatross would be affected by permitted discharges as this species nests on islands off Japan and infrequently occurs in Alaskan waters.

The Aleutian Canada goose and the spectacled eider are not expected to be adversely impacted directly by the permitted discharges. Discharges are expected to be prohibited in areas: with depths of less than 18.3 m (60 ft) MLLW that are likely to have poor flushing [mean water currents less than 5 cm/sec within 30 m (98.4 ft) of the outfall], within 1.8 km (1 nmi) of a nesting area of a colony of one thousand or more spectacled eider from May 1 through September 30, and within 1.8 km (1 nmi) of a state game sanctuary, refuge, critical habitat area, national park, preserve, or wildlife refuge. The areas stated above are those where the Aleutian Canada goose and spectacled eider are expected to occur, therefore, exposure to discharges is expected to be minimal. In addition, although studies for potential toxic effects from seafood process wastes to marine birds and waterfowl have not been conducted, discharges are not expected to contain components which exhibit toxicity (see Section 2.0).

6.3.3.2 Indirect Effects. The following indirect effects of discharges to marine birds and waterfowl will be discussed below: reduction in prey availability and increased predation. Adverse effects due to bio-accumulation and bacteria and nutrient enrichment are not likely to occur as most nesting and foraging habitats are not expected to receive discharges.

Reduction in Prey. Many marine birds and waterfowl feed on benthic invertebrates. Benthic invertebrate communities have the potential to be adversely affected by deposition of wastes (smothering and depletion of oxygen), however, the previously mentioned exclusion zones should prevent adverse impacts to threatened species. Endangered species (American peregrine falcon and the short-tailed albatross) are not expected to occur in the vicinity of seafood processing activities.

Increased Predation. Artificial food sources, such as seafood processing wastes, may increase the gull populations in Alaska by providing food throughout winter months when food is less abundant and survival is the most difficult. Large gulls (herring, glaucous, and glaucous-winged) and parasitic birds (jaegers and skuas) interfere with the reproductive success in waterfowl and in seabirds by preying on ducklings and chicks, displacing other species from nests, and harassing adult birds (Giger, M., 6 April 1994, personal communication). Several studies which have documented gulls and other parasitic birds preying on waterfowl and seabirds include Andersson (1974), Tyler (1975), Nettleship (1977), and Martin and Barry (1978). Seafood waste discharges may increase localized populations of gulls and parasitic birds which may adversely affect the breeding success of the Aleutian Canada goose. Of particular concern to the Aleutian Canada goose is the glaucous-winged gull which overwinters in the Aleutian Islands. Increased abundance of these gulls from either amplified breeding success or attraction to the process wastes may adversely impact the Aleutian Canada goose. Bald eagles are known to prey on Aleutian Canada geese chicks (Byrd 1992), and although there is no documentation to suggest that seafood waste discharges may increase localized bald eagle populations, an increase in bald eagles would likely decrease the breeding success of the Aleutian Canada goose. The American and Arctic peregrine falcons, short-tailed albatross, and spectacled eider are not likely to be impacted by increased predation as nesting and rearing do not occur where seafood processing activities have historically been located.

6.3.4 Fish

Snake River sockeye salmon and Snake River fall chinook salmon are not expected to be adversely impacted by seafood process waste or sanitary discharges. Although the distribution of these fish in Alaskan waters is not well documented, given the numbers of fish potentially present and the mobility of the fish, it is not likely that these fish would be exposed to discharges.

6.4 SUMMARY

Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize is not likely to jeopardize the continued existence and recovery of any species listed as threatened or endangered under the ESA or result in the destruction or adverse modification of critical habitat. The following species found in Alaskan waters are currently identified as either a threatened or endangered species:

- <u>Threatened</u>- Steller sea lion, Aleutian Canada goose, Arctic peregrine falcon, spectacled eider, and Snake River spring/summer and fall chinook salmon

- <u>Endangered</u>- blue, bowhead, fin, gray, humpback, northern right, sei, and sperm whales, American peregrine falcon, short-tailed albatross, and Snake River sockeye salmon.

The Steller sea lion is the only species for which critical habitat has been designated (see Section 6.2.1.2 for specific locations).

The discharge of seafood processing and sanitary wastes are not likely to adversely effect the following species: blue, bowhead, gray, northern right, and sei whales, Steller sea lion (species and critical habitat), American and Arctic peregrine falcons, short-tailed albatross, Snake River sockeye salmon, and Snake River spring/summer and fall chinook salmon.

Whales with the potential to be adversely affected by seafood processing waste discharges due to reduction in prey include the humpback, fin, and sperm whales. These whales feed on fish species having demersal eggs which may be impacted by the discharges. Although the gray whale feeds primarily on benthic invertebrates, summer feeding grounds are located in the northern Bering Sea and southern Chukchi Sea where commercial discharges are not expected to occur.

Seafood waste discharges may increase localized populations of gulls and parasitic birds which may adversely affect the breeding success of the Aleutian Canada goose. The American and Arctic peregrine falcons, short-tailed albatross, and spectacled eider are not likely to be impacted by increased predation as nesting and rearing do not occur where seafood processing activities have historically been located.

7.0 COMMERCIAL, RECREATIONAL, AND SUBSISTENCE HARVEST

The determination of "unreasonable degradation" of the marine environment is to be made based upon consideration of the ten criteria listed in Section 1.0. This section provides information pertinent to consideration of the two ocean discharge criteria shown below:

- **Criterion #7**: "Existing or potential recreational and commercial fishing, including finfishing and shellfishing"

- **Criterion #8**: "Any applicable requirements of an approved Coastal Zone Management Plan".

This section will assist in evaluating criterion #7 by briefly describing the commercial, recreational, and subsistence fisheries in Alaskan waters, and discussing the potential impacts seafood waste discharges may impose on these activities.

Several district Coastal Zone Management Plans include provisions for the continuance of subsistence resources and harvesting within their jurisdiction. Therefore, discussions on subsistence harvests in this chapter are applicable to considerations of criterion #8.

7.1 COMMERCIAL HARVESTS

Alaskan waters sustain several commercially important fisheries. Major fisheries exist for salmon, groundfish, crab, herring, and shrimp (Figure 7-1). Other minor fisheries include invertebrates, such as scallops, clams, sea cucumbers, and abalone.

A discussion concerning the commercial fisheries located in areas where seafood discharges have historically occurred is presented in Section 2.0. This information is also presented below with additional data regarding specific areas.

7.1.1 Salmon

The State of Alaska manages the salmon fishery, the largest fishery in terms of pounds harvested and employment. Five species of salmon are harvested: pink (*Oncorhynchus gorbuscha*), sockeye (*O. nerka*), chinook (*O. tshawytscha*), coho (*O. kisutch*), and chum (*O. keta*). This fishery is separated into four management regions: Southeastern, Central, Arctic-Yukon-Kuskokwim, and the Westward Management Region (see Figure 2-3).

The most abundant salmon species harvested in Alaskan waters is the pink salmon. The majority of pink salmon are harvested from southeast Alaskan waters followed by Prince William Sound. A smaller fraction is taken in the area around Kodiak in the Westward Region. Pink salmon constitute the largest proportion of the salmon harvested in lower Cook Inlet and outer coasts, with yields accounting for 79 percent (approximately 7.6 million salmon in 1986 with an ex-vessel value of 37.6 million dollars) of the total salmon harvested (Kenai Peninsula Borough 1990).

The Bering Sea-Bristol Bay sockeye run is the largest run of this species in the world. Approximately 88 percent of the Bristol Bay commercial harvest from 1981 to 1990 consisted of sockeye salmon. Major salmon runs for this area occur in the Togiak, Nushagak, Kvichak, Egegik, Ugashik, Meshik, and Chignik river drainages (Bristol Bay Coastal Resource Service Area 1992).

The five salmon species are located in several different habitats in any given location. Cook Inlet may be used as an example of salmon habitat utilization. Adult salmon are present in nearshore and estuarine waters adjacent to the Kenai Peninsula from late April to early November and begin migrations to freshwater from May to November. Juvenile salmon emerge from bottom substrates in freshwater from April to June. Pink and chum salmon move immediately downstream to estuarine areas while chinook, coho, and sockeye remain in freshwater for one to four years before moving to marine waters. Chum salmon remain within 48.3 km (30 mi) of the shore during July through September and young chinook remain in nearshore waters during their first year at sea. A life history summary for each of the five species is given in Table 7-1.

7.1.2 Groundfish

The commercial groundfish fishery consists chiefly of walleye pollock, Pacific cod, Pacific halibut, rockfish, flounder, and sablefish with walleye pollock and Pacific cod being the primary target species.

The majority of groundfish harvested in Alaskan waters are taken in the Gulf of Alaska, Bering Sea, and offshore waters of the Aleutian Islands (Figure 7-2).

The groundfish fisheries in the Gulf of Alaska and Bering Sea are managed by the North Pacific Fisheries Management Council in the Fisheries Conservation Zone, which extends from 4.8 to 321.9 km (3 to 200 mi) offshore, and by Alaska Department of Fish & Game within 4.8 km (3 mi) of shore. For both the Gulf of Alaska and Bering Sea fisheries, walleye pollock comprise the largest proportion of the catch. In these two areas, commercial fishing is concentrated along the outer continental shelf and upper slope, although recent efforts have occurred in shallower waters closer to shore [Aleutians East Coastal Resource Service Area (CRSA) 1984].

The groundfish fishery is managed by imposing catch limits on target and bycatch species for specific management regions and by restricting fishing activities from specified areas (which may include important spawning and marine mammal habitats). The groundfish commercial fishery commences on the first of January and continues throughout the year until the fishery in a particular management region is closed due to catch or bycatch quotas having been reached. A regulatory closure of the Bering Sea fishery for the protection of marine mammals from April through September results in a fishery that is concentrated in the first and last three months of the year in the Bering Sea.

In 1985, the Fisheries Oceanography Coordinated Investigations (FOCI) program of applied research was implemented as a long-term cooperative effort between scientists at the Pacific Marine Environmental Laboratory and the Alaska Fisheries Science Center. The goal of FOCI is to gain an understanding of the biotic and abiotic factors influencing recruitment of various commercially important fish and shellfish stocks in Alaskan waters. The majority of the FOCI research to date has been concentrated on walleye pollock spawning in Shelikof Strait.

Walleye pollock is the most abundant groundfish species in the Bering Sea and Aleutian Islands and constitutes the majority of the total groundfish harvested. Over one million metric tons are harvested annually from the Bering Sea and Aleutian Islands.

Pacific cod are harvested by foreign and domestic fisheries in the Bering Sea. The 1989 catch of this species was 170,928 mt. Extremely large year classes in 1977 and 1984 resulted in high harvests for the past several years, however, as these year classes are removed from the fishery, harvests are expected to decline (U.S. DOI/MMS 1990).

The Pacific halibut fishery in the Gulf of Alaska has been an important fishery since the 1910s and the Bering Sea halibut fishery began in 1928. Halibut were traditionally harvested by Canadian and U.S. fishermen and Japanese and Soviet fishermen were allowed to fish in the Bering Sea from 1962 to 1976. In 1981, however, the fishery was restricted to domestic vessels only, although significant quantities continue to be taken by foreign fisheries as bycatch (Aleutians East CRSA 1984).

7.1.3 Herring

The Pacific herring fishery is managed by the Alaska Department of Fish & Game. Pacific herring stocks occur throughout southeast Alaska. The commercial food and bait herring fishery occurs during the winter months and the sac roe fishery occurs during the spring spawning season (from late April to mid-June), as does the herring roe on kelp pound fishery in Hoonah Sound. In southeast Alaska, herring spawning grounds are located in the intertidal and shallow subtidal waters along the shores of Chichagof Islands. Lisianski Inlet is a major spawning area. Herring typically spawn on eelgrass, kelp, rockweed, and other marine vegetation (Pelican Coastal Management Program 1994).

7.1.4 Shellfish

Shellfish fisheries are composed chiefly of crab (Tanner, Dungeness, and king), shrimp, scallops, clams, sea cucumbers, and abalone. These fisheries are managed by the Alaska Department of Fish & Game in state waters and the North Pacific Fisheries Management Council in the Fisheries Conservation Zone. The crab fishery is the largest shellfish fishery and the fishing season varies with location, species harvested, and allowable catch. Large crab fisheries are located in the Bering Sea and Bristol Bay. In most areas, the king and Tanner crab fishing seasons have been shortened due to decreased stocks.

In Cook Inlet, the commercial crab fishery consists of two species: Tanner and Dungeness crabs. The greatest number of Tanner crabs are harvested from Kachemak Bay , the eastern portion of lower Cook Inlet, the northern portion of Shelikof Strait, and the eastern side of Shelikof Strait. The Tanner crab fishery has been closed for the past year due to a depressed breeding stock (Spallinger, A., 27 July 1993, personal communication). The Dungeness crab season remains open most of the year with few regulated closures. The king crab fishery has been steadily declining since 1980, therefore, there has not been a commercial opening in the Cook Inlet area and Shelikof Strait since 1983 (Spallinger, A., 27 July 1993, personal communication). There is a large population of red king crab in the outer waters of Bristol Bay that currently supports a short season commercial fishery.

Shrimp fisheries are concentrated in southeast Alaska, Cook Inlet, Prince William Sound, and in the vicinity of Kodiak and the Alaska Peninsula. Shrimp fisheries occur throughout the year in various regions of Alaska (see Figure 2-6).

Fisheries for scallops, clams, sea cucumbers, and abalone are generally on a much smaller scale than for other harvested invertebrates. Fisheries occur throughout most of the year in various locations, depending upon species harvested, and are generally concentrated near coastal areas.

7.2 RECREATIONAL HARVESTS

Alaskan residents as well as non-residents participate in Alaskan recreational fisheries in all areas of Alaska. In 1991, 59 percent of the anglers who fished in Alaskan waters were residents (Mills 1992). The majority of the fishing effort occurs in the southcentral region (includes Cook Inlet, Kenai Peninsula, Prince William Sound, and Kodiak), followed by the southeast region (includes area from Ketchikan to Yakutat), and to a much lesser extent, the Arctic-Yukon-Kuskokwim region. Cook Inlet contained 52 percent of the state's total sport fishing in 1991 and the Kenai Peninsula had 35 percent of the total. The Kenai River, located in upper Cook Inlet, is the location where the largest sportfish harvest of chinook salmon occurs. The predominant species harvested are salmon, trout, Dolly Varden, and Pacific halibut (Table 7-2). Other species commonly harvested include herring, cod, clams (razor and steamer), crab, and shrimp.

The 1991 marine fish harvested in all areas of Alaska included 73,662 chinook salmon, 176,056 coho salmon, 12,460 sockeye salmon, 119,591 pink salmon, 7,378 chum salmon, 2,468 trout (cutthroat and steelhead), 30,481 Dolly Varden, 266, 523 halibut, and 1,207,520 razor clams. The number of fish caught is higher than the number harvested as many sport fishermen catch and release their fish. Data for marine fish caught in 1991 include 131,694 chinook, 213,812 coho, 16,049 sockeye, 206,538 pink, 13,732 chum, 3,738 trout, 55,641 Dolly Varden, 379,220 halibut, and 1,207,520 razor clams (Mills

1992). The recreational harvests for salmon and Pacific halibut have increased while harvests have decreased for smelt.

7.3 SUBSISTENCE HARVESTS

Subsistence, as defined by state and federal law, is the customary and traditional non-commercial use of wild resources for a variety of purposes such as food, clothing, fuel, arts, crafts, sharing, and customary trade. Subsistence resources are important to the economy and culture of many Alaskan communities, especially for the residents of rural areas with limited road access. Subsistence harvests in many of these communities constitute a major proportion of the daily diets for these residents.

Approximately 110,000 people in about 225 communities participated in subsistence practices to some extent in the 1980s. Of the 110,000 people, approximately 50,000 were Alaskan natives. Subsistence harvesting occurs in all regions of the state with the largest annual harvest occurring in the western and Arctic regions of the state, from the tip of southern Norton Sound to Kuskokwim Bay and from southern Norton Sound to the North Slope, respectively (Wolfe and Bosworth 1990).

Subsistence harvesting generally occurs in rivers and nearshore waters on a year round basis for shellfish and other marine invertebrates, and seasonally for salmon and halibut. Species harvested include salmon, halibut, cod, rockfish, clams, crabs, various other fish and invertebrates, marine mammals, and terrestrial mammals. Fish constitute the majority of the subsistence harvest, accounting for approximately 59 percent by weight of the total harvest (Wolfe and Bosworth 1990). The proportion of each species harvested varies among households and between communities (Table 7-3). Marine mammals are allowed to be used as a subsistence resource by regulation and the numbers taken vary substantially among communities.

Waterfowl, particularly year round residents such as white-winged scoters, mallards, and goldeneyes, are harvested in winter months in coastal areas. Other ducks and geese are taken in the spring and fall when they are in coastal areas, rivers, and lakes.

7.4 EFFECTS OF SEAFOOD WASTE DISCHARGES ON HARVEST QUANTITY

Commercial, recreational, and subsistence fisheries have the potential to be adversely impacted by seafood waste discharges either directly by the discharged processing wastes, or indirectly through effects such as alteration of habitat and increased predation. Potential direct and indirect effects to these fisheries are discussed below.

7.4.1 Commercial Fisheries

Seafood waste discharges may adversely impact commercial groundfish fisheries in areas proximal to the discharges by decreasing fish stocks of walleye pollock and Pacific cod. However, it is unlikely that these fisheries will be impacted on a district, regional, or statewide level. Salmon, herring, other groundfish species, and shellfish fisheries are not expected to be adversely impacted.

Shelikof Strait, the eastern side of the Aleutian Islands, and a region southeast of the Kenai Peninsula in the western Gulf of Alaska are significant spawning areas for walleye pollock, the principal species harvested by the groundfish fishery as well as the largest single species fishery in the world. Walleye pollock form dense aggregations, particularly on the Alaska Peninsula side of Shelikof Strait and in the western Gulf of Alaska, during a spawning period from mid-March to early-May (Picquelle and Megrey 1993) (Figure 7-3). Spawning produces a large concentration of eggs (ranging from 3,004 to 23,171 m^2) that generally remain below 150 m (492 ft) for two weeks until hatching. Once hatched, the larvae tend to concentrate in the upper 50 m (164 ft) and drift southwestward (Incze et al. 1989). The proposed NPDES general permit is expected to prohibit discharges within 1.8 km (1 nmi) of designated critical habitat. All of Shelikof Strait has been designated as Steller sea lion critical habitat, therefore, walleye pollock in this area are not expected to be impacted. However, discharges to spawning grounds in the western Gulf of Alaska and eastern Aleutian Islands may potentially impact walleye pollock abundance. Eggs have the potential to be smothered by the deposition of solids and larvae may be affected by increased predation from the attraction of fish and waterfowl to the discharges. The extent to which impacts could occur is dependent upon the type of wastes (e.g., species that is processed), the amount of wastes generated, and the location of the discharge. Overall, the potential impacts from seafood processing wastes are judged to be minimal. As discussed in Section 5.0, a worst case scenario where all permitted facilities generated enough waste to form a 0.40 ha (1.0 ac) waste pile indicated that the entire bottom area covered by the discharges represented less than 0.0001 percent of the total bottom area covered by the proposed general permit.

Pacific cod produce large concentrations of demersal eggs which hatch after a 10 to 20 day incubation period. They are believed to spawn during the winter mainly in coastal areas with rocky bottoms. Although it is not likely, discharges during this time could adversely affect both egg and larvae survival for the reasons listed above for walleye pollock. These effects are discussed further in Section 5.0.

Salmon and herring fisheries are not expected to be adversely affected by seafood waste discharges as the potential for discharges to impact these species is minimal. Adult fish are mobile and the locations of various life history stages (eggs, larvae, and juvenile) are not in areas where discharges are likely to occur.

Although accumulations of discharged processing wastes on the seafloor could result in the smothering of shellfish species or produce anoxic conditions which may deplete populations, the proposed NPDES general permit is expected to prohibit discharges in areas where shellfish species generally occur. Discharge exclusion zones where shellfish are typically located include habitats likely to have poor flushing (such as bays, harbors, inlets, and coves) and within 1.8 km (1 nmi) of state or national game refuge, sanctuary, or critical habitat area.

7.4.2 Recreational and Subsistence Fisheries

Seafood waste discharges are not expected to adversely affect recreational or subsistence activities. These activities typically occur in nearshore areas where seafood processing discharges are prohibited and species harvested in these fisheries are not expected to be impacted by the discharges.

7.5 SUMMARY

Alaskan waters sustain several commercially important fisheries. Major fisheries exist for salmon, groundfish, herring, and crab. Other minor fisheries include invertebrates, such as shrimp, clams, and scallops.

The salmon fishery is the largest fishery in Alaska in terms of pounds harvested and employment. Five species of salmon are commercially harvested in Alaskan waters: pink, sockeye, chinook, coho, and chum, with pink salmon being the most frequently harvested species. The Bering Sea Bristol Bay sockeye salmon run is the largest run of the this species in the world. The commercial groundfish fishery consists chiefly of walleye pollock, Pacific cod, Pacific halibut, rockfish, flounder, and sablefish with walleye pollock and Pacific cod being the primary target species. The majority of groundfish harvested in Alaskan waters are taken in the Gulf of Alaska, Bering Sea, and offshore waters of the Aleutian Islands.

Alaskan residents as well as non-residents participate in Alaskan recreational fisheries in all areas of Alaska. The majority of the fishing effort occurs in the southcentral region (includes Cook Inlet, Kenai Peninsula, Prince William Sound, and Kodiak), followed by the southeast region (includes area from Ketchikan to Yakutat), and to a much lesser extent, the Arctic-Yukon-Kuskokwim region. Cook Inlet contained 52 percent of the state's total sport fishing in 1991. The primary species harvested are salmon, trout, Dolly Varden, and Pacific halibut. Other species commonly harvested include herring, cod, clams (razor and steamer), crab, and shrimp.

Subsistence, as defined by state and federal law, is the customary and traditional non-commercial use of wild resources for a variety of purposes such as food, clothing, fuel, arts, crafts, sharing, and customary trade. Subsistence resources are important to the economy and culture of many Alaskan communities, especially for the residents of rural areas with limited road access. Subsistence harvests in many of these communities constitute a major proportion of the daily diets for these residents. Approximately 110,000 people in about 225 communities participated in subsistence practices to some extent in the 1980s.

Seafood waste discharges may potentially adversely impact commercial groundfish fisheries in areas proximal to the discharges by decreasing fish stocks of walleye pollock and Pacific cod. Walleye pollock and Pacific cod eggs have the potential to be smothered by the deposition of solids and larvae may be affected by increased predation from the attraction of fish and waterfowl to the discharges. The extent of potential impacts is dependent upon the type of wastes, the amount of waste generated, and the location of the discharge. However, as discussed in Section 5.0, a worst case scenario where all permitted facilities generated enough waste to form a 0.40 ha (1.0 ac) waste pile indicated that the entire bottom area covered by the discharges represented less than 0.0001 percent of the total bottom area covered by the proposed general permit. Therefore, even with a worst case scenario, the potential impact to these species is judged to be minimal. Salmon, herring, other groundfish species, and shellfish fisheries are not expected to be adversely impacted.

Nearshore habitats used for recreational and subsistence fisheries are not expected to be impacted by seafood process waste discharges as the proposed NPDES general permit is expected to exclude these areas from receiving discharges. Thus, the impacts to these fisheries is expected to be minimal.

8.0 COASTAL ZONE MANAGEMENT AND SPECIAL AQUATIC SITES

The determination of "unreasonable degradation" of the marine environment is to be made based upon consideration of the ten criteria listed in Section 1.0. The following section provides information pertinent to consideration of the two criteria shown below:

- **Criterion #8**: "Any applicable requirements of an approved Coastal Zone Management Plan"

- **Criterion #5:** "The existence of special aquatic sites including, but not limited to, marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs".

Information relevant to the two criteria presented in this chapter include coastal zone management policies implemented by the State of Alaska and boroughs within the state. All NPDES permitted discharges governed by Section 403(c) of the Clean Water Act must adhere to these policies. Areas where seafood process waste discharges have the potential to affect locations identified as a: national refuge or sanctuary, state refuge or sanctuary, national park or monument, and critical habitat, are indicated in this section. Additionally, areas designated by boroughs as areas meriting special attention (AMSA) are included due to the recognition of these locations as either sensitive to alteration or containing valuable resources.

8.1 COASTAL ZONE MANAGEMENT

8.1.1 Requirements of the Coastal Zone Management Act

The Coastal Zone Management Act requires that states make consistency determinations for any federally licensed or permitted activity affecting the coastal zone of a state with an approved Coastal Zone Management Program (CZMP) [16 USC Sec. 1456 (c)(A) Subpart D]. Under the Coastal Zone Management

Act, applicants for federal licenses and permits must submit a certification to the Alaska Coastal Policy Council (ACPC) that the proposed activity complies with the state's approved CZMP. The state then has the responsibility to either concur with or object to the consistency determination. For general NPDES permits, the U.S. EPA is considered an applicant submitting the general permit to the state for a consistency determination.

Consistency certifications are required to include the following information (15 CFR 930.58):

- A detailed description of the proposed activity and its associated facilities.
- A brief assessment relating the probable coastal zone effects of the proposal and its associated facilities to relevant elements of the CZMP.
- A brief set of findings indicating that the proposed activity, its associated facilities, and their effects are consistent with relevant provisions of the CZMP.
- Any other information required by the state.

8.1.2 Relevance of Requirements

Consistency determinations are required if a federally licensed or permitted activity "affects" the coastal zone. Seafood processing waste from *offshore*, *nearshore*, and *shore-based* seafood processors are expected to occur inside the 5 km (3 mi) territorial sea limit. These discharges have the potential to affect Alaska's coastal waters, therefore, a consistency assessment has been prepared (Section 8.6).

8.1.3 Status of Coastal Zone Management Planning

The Alaska Coastal Management Program (ACMP) was approved by the U.S. Department of Commerce in 1979. The State coastal management policies and guidelines included in the ACMP are intended to be refined by local districts preparing district Coastal Management Programs (CMPs). Completed district CMPs must be approved first by the ACPC and then by the U.S. Department of Commerce, either as a routine program implementation or as an amendment to the ACMP. Once approved by the U.S. Department of Commerce, the district CMPs become the basis for federal consistency determinations. The State of Alaska has 33 district CMPs of which 27 have authority over waters where seafood processing facilities occur or waste discharges have the potential to occur (Table 8-1). Although the state has absolute authority only for waters extending to the 5 km (3 mi) limit, the CMPs are applicable for all land and water activities which may affect the boroughs' coastal areas or resources.

8.1.4 Relevant Policies

Policies of the ACMP that are potentially relevant to waste discharges from seafood processing activities are set forth in the ACMP standards (6 AAC 80). Article 2 sets forth standards related to a number of uses in the Alaska coastal zone, including fish and seafood processing activities. The following policy is set forth for subsistence uses: "Districts and state agencies shall recognize and assure opportunities for subsistence usage of coastal areas and resources" (6 AAC 80.120[a]). This policy is implemented in the district CMPs.

Article 3 sets forth standards for resources and habitats relevant to discharges associated with seafood processing activities. The following habitats are identified as being potentially affected by seafood process wastes: offshore pelagic and benthic areas, estuaries, wetlands and tideflats, rocky islands and seacliffs, barrier islands and lagoons, and exposed high energy coasts. The ACMP defines offshore areas as submerged lands and waters seaward of the coastline (6 AAC 80.900[a][11]). The fundamental management standards for these habitats states that they "must be managed so as to maintain or enhance the biological, physical, and chemical characteristics of the habitat which contributes to its capacity to support living resources" (6 AAC 80.130[b]).

In addition, the following standards apply to specific habitats:

- "Offshore areas must be managed as a fisheries conservation zone so as to maintain or enhance the state's sport, commercial, and subsistence fishery (6 AAC 80.130[c][1]).

- Estuaries must be managed so as to assure adequate water flow, natural circulation patterns, nutrients, and oxygen levels, and avoid the discharge of toxic wastes, silt, and destruction of productive habitat (6 AAC 80.130[c][2]).

- Wetlands and tideflats must be managed so as to assure adequate water flow, nutrients, and oxygen levels, and avoid the adverse effects on natural drainage patterns, the destruction of important habitats, and the discharge of toxic substances (6 AAC 80.130[c][3]).

- Rocky islands and seacliffs must be managed so as to avoid the harassment of wildlife, destruction of important habitat, and the introduction of competing or destructive species and predators (6 AAC 80.130[c][4]).

- Barrier islands and lagoons must be managed so as to maintain adequate water flow of sediments, detritus, and water, avoid the alteration or redirection of wave energy which would lead to the filling in of lagoon or the erosion of barrier islands, and discourage activities which would decrease the use of barrier islands by coastal species, including polar bears and nesting birds (6 AAC 80.130[c][5]).

- High energy coasts must be managed by assuring the adequate mix and transport of sediment and nutrients and avoiding the redirection of transport processes and wave energy (6 AAC 80.130[c][6])."

8.2 DISTRICT COASTAL MANAGEMENT PLANS

The proposed NPDES general permit for seafood processing wastes encompasses all Alaskan state waters, therefore, evaluation of the relevant policies included in the 26 applicable district CMPs is warranted. The district CMPs incorporate the state policies and generally contain additional enforceable policies. Examples of district CMPs' policies regarding seafood processing activities which provide the basis for the determination of whether various uses are proper or improper are outlined below.

- "The construction of new facilities or the modification of existing seafood processing facilities shall avoid the discharge of processing wastes into marine waters in areas: a) which do not have circulation characteristics or biological assimilation capacity to accept these discharges without causing significant adverse impact on water quality or marine habitat productivity; and b) which create an "attractive" nuisance situation (attract wildlife to waste disposal areas in a manner that creates a threat to fish and wildlife or human health and safety)" [Aleutians West Coastal Resource Service Area (CRSA) CMP F-3].

- "Projects in areas traditionally used for subsistence shall be located, designed, constructed, and operated to minimize impacts to subsistence resources and activities, including access" (Aleutians West CRSA CMP D-2).

- "Seabird colony sites and haul-outs and rookeries used by marine mammals shall not be physically altered or disturbed by structures or activities in a manner that would preclude or significantly interfere with continued use of these sites by wildlife for the habitat functions which they provide" (Aleutians West CRSA CMP B-9).

- Processing facilities and mariculture facilities shall be designed, sited, and operated in accordance with state and federal requirements to assure water quality and to prevent or minimize significant adverse impact upon surrounding habitats and resources [Thorne Bay CMP VI (a); Pelican CMP 6.2; Hydaburg CMP 1, Juneau CMP E(d)].

- "Require adequate design and control of processing facilities, including solid waste disposal, in accordance with state and federal requirements, to prevent negative impacts on surrounding coastal habitats" (Hoonah CMP).

- "Fish processors, including those based offshore, will conduct their operations in compliance with all state and federal water quality regulations. Those that cannot will not be permitted to operate in the district" (Bristol Bay CRSA CMP 6.2).

- "Land-based and floating fish processors shall conduct their operations in compliance with all state and federal water quality regulations pertaining to discharge of effluent and disposal of seafood processing wastes" (Aleutians East Borough CMP E-1).

- "To the extent feasible and prudent, land-based and floating seafood processors should maximize the recovery and efficient utilization of processing waste through methods such as fish meal or fish oil production" (Aleutians East Borough CMP E-4).

- "Uses and activities within and adjacent to coastal waters shall not interfere with migration or feeding of whales. Interference refers to conduct or activities that disrupt an animal's normal behavior or cause a significant change in the activity of the affected animal" (Kenai Peninsula Borough CMP 12.8).

- "Floating facilities shall be prohibited in the following areas, unless a significant public benefit results from the proposed use and there are no feasible and prudent alternatives for the proposed use:

  --*Habitat or Harvest Areas*- Areas identified by the Alaska Department of Fish and Game as having significant concentrations of shellfish, waterfowl, shorebirds, marine mammals; extensive productive tideflats, salt marshes, kelp or eel grass beds; conflicts with eagle trees; and heavily used harvest sites.

  --*Anadromous Fish Streams*- No floating facility shall be located within 500 linear feet of the mouth of any anadromous stream, defined by the Alaska Department of Fish and Game as the seaward limits of the stream at MLLW. In no case shall the floating facility moor directly in front of the mouth of the stream, unless the facility is an integral part of an approved fisheries project meeting all agency requirements" [Angoon CMP K(1)(4)].

8.3 SPECIAL AQUATIC SITES

Special aquatic sites are locations designated as national and state refuges, national and state sanctuaries, national parks or monuments, and national seashores as defined by 40 CFR 125.122 (a)(5) (Table 8-2). In addition, critical habitat and areas meriting special attention (AMSA) are also considered as special aquatic sites. The Pribilof Islands, including St. Paul, St. George, Walrus, and Otter Islands are considered to be special aquatic sites as these islands are essential not only for northern fur seal mating, pupping, and pup rearing, but also contain important feeding grounds extending to a minimum of 200 to 300 km (124 to 186 mi) from these islands (NMFS 1993c). Refer to Figure 8-1 for exact locations of the sites discussed below.

8.3.1 National Refuge and Sanctuaries

The Alaska Maritime National Wildlife Refuge (NWR), established in 1980, contains approximately 20,000 km^2 (4.9 million acres) and includes over 2,500 islands, islets, rocks, and headlands distributed throughout the state (U.S. FWS 1988). The majority of the refuge is comprised of the Aleutian Islands. Approximately 75 percent of Alaska's marine birds use the refuge (U.S. FWS 1987).

The Alaska Peninsula NWR is located on the Pacific side of the Alaska Peninsula. Populations of sea lions, seals, sea otters, and migratory whales are found in coastal habitats and offshore waters. The refuge provides habitat for migratory waterfowl and shorebirds.

The Becharof NWR is located between the Alaska Peninsula NWR and the Katmai National Park. Becharof Lake, which covers one-fourth of the refuge, and its tributaries contribute over four million salmon annually to the Bristol Bay fishery. Waterfowl are found in the refuge wetlands and estuaries and nesting eagles, peregrine falcons, and large concentrations of seabirds are found in the refuge's cliffs and islands (U.S. FWS 1987).

The Izembek NWR is located on the tip of the Alaska Peninsula facing the Bering Sea. Izembek Lagoon contains one of the worlds largest eelgrass bed. Migratory birds, such as the world's population of black brant and other waterfowl, concentrate to feed in the lagoon. The majority of the waterfowl arrive on the refuge in late August and early September and usually by early November northern waterfowl arrive to winter on Izembek. The Steller's eider is the most common wintering duck in the lagoon (U.S. FWS 1987).

The Kenai NWR is located on the western side of the Kenai Peninsula bordering Cook Inlet. The refuge was established primarily to conserve large game animals, such as moose and caribou. The refuge provides spawning habitat for Cook Inlet salmon.

The Kodiak NWR, located on the western side of Kodiak Island, was established in 1941 in order to protect brown bear habitat. Bald eagles are year-round residents and an estimated two million seabirds inhabit the bays, inlets, and shores of the refuge (U.S. FWS 1987).

The Togiak NWR is located between Bristol and Kuskokwim Bays in southwestern Alaska. The refuge is a breeding and resting area for waterfowl and shorebirds returning from wintering areas. many seabirds inhabit the offshore waters and cliffs near Cape Newenham and Cape Peirce during the summer months. Spotted seals, walrus, and seven species of whales use the offshore waters. The refuge provides more than 2,414 km (1,500 mi) of stream and river salmon spawning habitat (U.S. FWS 1987).

The Yukon Delta NWR is located between Kuskokwim Bay and Norton Sound in southwestern Alaska. The refuge, the largest in Alaska, provides nesting and foraging habitat for waterfowl and over 100 million shore and water birds (U.S. FWS 1987).

There are several other NWRs located in Alaska (Arctic, Innoko, Kanuti, Koyukuk, Nowitna, Selawik, Tetlin, and Yukon Flats), however, shore-based and floating seafood processing facilities are not expected to occur in the vicinity of these refuges, and thus, the refuges are unlikely to be impacted by seafood waste discharges.

8.3.2 State Refuges And Sanctuaries

The majority of the state refuges and sanctuaries were established for the protection of waterfowl , fish, and marine mammals, although several were created in order to protect brown bear populations and habitat. The state refuges and sanctuaries described briefly below have the potential to be impacted by seafood waste discharges due to their locale. Refuge and sanctuaries not expected to be impacted by the discharges under discussion have been excluded.

The Anchorage Coastal Wildlife Refuge, located in upper Cook Inlet, was established in 1988 in order to protect waterfowl, shorebirds, salmon, and other fish and wildlife populations and habitats.

The Cape Newenham, Goose Bay, Mendenhall Wetlands, and Palmer Hay Flats State Game Refuges were established in 1960, 1975, 1976, and 1975 respectively, to protect natural habitat and wildlife populations, particularly waterfowl.

The McNeil River State Game Sanctuary located adjacent to Kamishak Bay was established in 1967 and expanded upon in 1993 to provide permanent protection for brown bear as well as other fish and wildlife populations and habitats.

The McNeil River State Game Refuge was established in 1993 for the same objectives as the above sanctuary. The refuge substantially increases the habitat for brown bear.

Established in 1990, the Stan Price State Wildlife Sanctuary is located on the coast of Admiralty Island just north of Windfall Harbor and west of Swan Island. The sanctuary provides protection for brown bears and other fish and wildlife.

The Susitna Flats and Trading Bay State Game Refuges, located in upper Cook Inlet, were established in 1976 to protect the following: fish and wildlife habitat, waterfowl nesting, feeding and migration, moose calving areas, spring and fall bear feeding areas, and salmon spawning and rearing habitats.

The Walrus Islands State Game Sanctuary established in 1960 is located southeast of Togiak Bay and consists of three main areas: Summit Island, High and Crooked Islands, and Round Island. The sanctuary also includes the waters surrounding each of the three areas. The sanctuary was created primarily to protect walrus populations and habitat.

The Yakataga State Game Refuge located between Cape Suckling and Cape Yakataga in the Gulf of Alaska was established in 1990 in order to protect fish and wildlife populations and habitat, particularly for commercial, sport, and subsistence purposes.

8.3.3 National Parks and Monuments

Refer to Figure 8-1 for exact locations of the national parks and monuments described briefly below. Detailed descriptions of these parks are provided in U.S. DOI/ MMS (1992).

Located on the central and eastern region of the Alaska Peninsula, the Aniakchak National Monument and Preserve was established in order to protect the Aniakchak volcano caldera and surrounding area, as well as protect populations and habitat of sea lions, seals, other marine mammals and wildlife.

The Bering Land Bridge National Preserve, located on the northeastern tip of the Seward Peninsula, was created in order to preserve a portion of the land which intermittently connected Asia and North America thousands of years ago. The preserve also protects populations and habitat of migratory birds, fish, and marine and terrestrial mammals.

The Cape Krusenstern National Monument is located approximately 16.1 km (10 mi) north of Kotzebue Sound. The monument was established, in part, to protect biological resources such as; seals and other marine mammals, birds, fish, and other wildlife. The monument was also established with the purpose of protecting subsistence resources.

The Katmai National Park and Preserve is located on the western shore of Shelikof Strait and protects the populations and habitat of red salmon, marine mammals, and other wildlife.

The Kenai Fjords National Park is located on the southeastern tip of the Kenai Peninsula and the park protects populations and habitat of sea lions, seals, other marine mammals, and marine birds.

The Lake Clark National Park and Preserve located on the western shore of upper Cook Inlet protects populations and habitat of red salmon, bald eagles, peregrine falcons, and other fish and wildlife.

The Wrangell-St. Elias National Park and Preserve located in the northeastern region of the Gulf of Alaska and the Glacier Bay National Park and Preserve located in southeastern Alaska were established to maintain the scenic attributes of the regions and to protect populations and habitat of fish and wildlife.

There are several other national parks and preserves in Alaska, however, shore-based and floating seafood processing facilities do not occur in the vicinity of these parks, and thus, they will not be impacted by seafood waste discharges.

8.3.4 Critical Habitat

State critical habitat areas, as defined by the Alaska State Legislature, are considered as discrete areas which support essential fish or wildlife life history requirements. A requirement deemed essential for the continued propagation of a species includes one or more of the following: concentrated breeding, nesting, rearing, pupping, calving, important foraging, wintering, migration, or haul-out areas (Aleutians

West CRSA 1991). Additionally, critical habitat for a threatened or endangered species listed under the ESA is defined as the specific area(s) within and outside the geographical area currently occupied by a species at the time it is listed, on which are found those biological or physical features essential to the conservation of the species and which may require special management considerations or protection [50 CFR 424.02 (d)]. Refer to Figure 8-1 for exact locations listed below.

8.3.4.1 State Critical Habitat Areas. The Clam Gulch State Critical Habitat Area (CHA), established in 1976, is located south of Kasilof on the Kenai Peninsula and comprises approximately 121.7 km^2 (30,080 acres) of tide and submerged lands above the 1.5 m (5 ft) elevation due to important razor clam habitat.

Established in 1978, the Copper River Delta CHA located in northern Gulf of Alaska originated to ensure the protection of habitat vital to fish and wildlife populations, particularly waterfowl and shorebirds.

The Egegik CHA located between Bristol Bay to the west and Egegik Bay to the northeast and the Pilot Point, Cinder River, and Port Heiden CHAs located in eastern Bristol Bay were established in 1972 in order to protect habitat vital to the continued existence of fish and wildlife, particularly waterfowl.

The Fox River Flats CHA instituted in 1972 is located on the east end of Kachemak Bay and contains approximately 23.3 km^2 (5,750 acres). This area is critical shorebird and waterfowl habitat.

Approximately 870 km^2 (215,000 acres) in Kachemak Bay were designated as a CHA in 1974 in order to protect crucial fish, shellfish, crab, and wildlife spawning and habitat areas.

Established in 1972, the Kalgin Island CHA in Cook Inlet encompasses approximately 11.6 km^2 (2,880 acres) due to vital tidal marsh and migrating waterfowl areas.

The Port Moller CHA located on the northern side of the Alaska Peninsula in southwestern Bristol Bay, was established in 1972 in order to protect habitat crucial to the continued existence of fish and wildlife, particularly waterfowl.

The Redoubt Bay CHA was established in 1989 to assure the protection and enhancement of fish and wildlife, particularly Tule geese.

The Tugidak CHA located south of Kodiak Island was established in 1988 in order to protect and enhance fish and wildlife, particularly marine mammals, birds, fish and shellfish. This CHA encompasses state lands above mean high tide and the land and water in the lagoon.

There are several other critical habitat locations in Alaska, however, shore-based and floating seafood processing facilities are not expected to occur in the vicinity of these refuges, and thus, they are unlikely to be impacted by seafood waste discharges.

8.3.4.2 Steller Sea Lion Critical Habitat. On 27 August 1993, the National Marine Fisheries Service published the final rule designating critical habitat for the Steller sea lion under the ESA. The critical habitat designations became effective on 27 September 1993. Designated critical habitat includes; all Steller sea lion rookeries and major haulouts (>200 sea lions) located within state and federally managed waters off Alaska, including a zone that extends 0.9 km (3,000 ft) landward and vertical of each rookery and haulout boundary, and that extends 0.9 km (3,000 ft) seaward from rookeries and major haulouts located east of 144^{o} W longitude, or 20 m (65.6 ft) seaward from rookeries and major haulouts west of 144^{o} W longitude, and one aquatic foraging zone located exclusively in the Gulf of Alaska and two aquatic zones located in the Bering Sea/Aleutian Islands area. All of Shelikof Strait has been designated as critical habitat. Air zones extending 0.9 km (0.56) above these terrestrial and aquatic zones have also been designated as critical habitat (NMFS 1993b). Figure 8-1 indicates the locations of Steller sea lion critical habitat.

In addition to the above designated habitat, Steller sea lion rookeries where vessels are not permitted to travel within 5.6 km (3 nm) and trawling is prohibited within 18.52 km (10 nm) are listed in the Federal register (NMFS 1993b).

The critical habitat designation contributes to a species conservation primarily by identifying critically important areas and by describing the features within the area that are essential to the species. There are no mandates or any specific management or recovery actions associated with the designation. Under Section 7 of the ESA, the designation of critical habitat requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to destroy or adversely modify the designated critical habitat.

8.4 AREAS MERITING SPECIAL ATTENTION

The ACMP authorizes a mechanism for focusing attention to areas of a borough deemed critical to borough needs and where conflicts or potential conflicts are likely to occur. This process is initiated by nomination of an Area Meriting Special Attention (AMSA). Section AS46.40.210(1) of the Alaska statutes defines an AMSA as: "a delineated geographic area within the coastal area which is sensitive to change or alteration and which, because of plans or commitments or because a claim on the resources within the area delineated would preclude subsequent use of the resources to a conflicting or incompatible use, warrants special management attention, or which, because of its value to the general public, should be identified for current or future planning, protection, or acquisition".

A district may nominate, in a district program or as a significant amendment to its program, areas which merit special attention. Relevant criteria which may be used by a district as the basis for designating an area as an AMSA include the following:

Under ACMP Section 46.40.210(1)(A-G):

- Areas of unique, scarce, fragile or vulnerable natural habitat, cultural value, historical significance, or scenic importance.

- Areas of high natural productivity or essential habitat for living resources.

- Areas of substantial recreational or opportunity.

- Areas where development of facilities is dependent upon the utilization of, or access to, coastal waters.

- Areas needed to protect, maintain, or replenish coastal land or resources, including coastal flood plains, aquifer recharge areas, beaches, and offshore sand deposits.

Under 6 AAC 80.158 of the ACMP:

- Areas important for subsistence hunting, fishing, food gathering, and foraging.

- Areas with special scientific values or opportunities, including those areas where ongoing research projects could be jeopardized by development or conflicting uses and activities.

- Potential estuarine and marine sanctuaries (Aleutians West CRSA 1991).

Once an area meets any one of the qualifying criteria listed above, a management plan for the area is prepared by the district. The management plan must include; a description of the uses and activities considered proper and improper and the rationale for the designation of proper and improper uses, a statement of the enforceable policies used to manage the area, and identification of the authority used to implement the management plan. An area is established as an AMSA after approval of the AMSA plan by the Coastal Policy Council.

There are several locations either receiving the AMSA designation or which have been nominated for future designation. A detailed description of each AMSA and the rational for designation may be found in the individual district's CMP (see Table 8-1).

The Kenai Peninsula Borough CMP identified the Port Graham/Nanwalek area as an AMSA and implemented the Port Graham/Nanwalek Area AMSA Plan which became effective in March of 1992 (Kenai Peninsula Borough 1992). In addition, the following areas within the Kenai Peninsula Borough have been identified as potential candidates for future AMSA planning: Anchor River mouth, Bridge Creek watershed, Cape Starichkof, Chuitna Area, Kasilof River, Kenai River, Nikiski industrial area, Ninilchik/Deep Creek waterfront, Paint River/Chenik Lake drainages, the Seldovia watershed, and upper Resurrection Bay (Kenai Peninsula Borough 1990).

The Kodiak Island Borough CMP recommends the following areas as candidates for future AMSAs: Shuyak Island, Raspberry Island, and the Karluk Lake and River and the City of Thorne Bay has identified the Thorne River Estuary as a potential candidate for AMSA designation. The city of Hydaburg has nominated Meares Passage, McFarland Islands/Dunbar Inlet, Jackson Island, Hydaburg River and tideflats, Saltery Point/Crab Trap Cove, and Hetta Cove/Eek Inlet as future AMSAs.

The Cenaliulriit Coastal Management District has nominated 15 areas as potential AMSAs. A detailed description of each area and the rationale for nomination may be found in the Cenaliulriit CMP.

The Matanuska-Susitna Borough has recommended the following six areas be considered for AMSA designation: Susitna Flats State Game Refuge (SGR), Goose Bay SGR, Palmer Hay Flats SGR, Knik/Matanuska River Floodplain, Nancy Lake State Recreation Area, and Point MacKenzie Industrial Port/Park Site. State laws currently provide protection to the areas listed above, with the exception of Knik/Matanuska River Floodplain.

The City of Angoon has nominated the following locations as AMSAs and has developed an AMSA Plan for each location: Mitchell Bay, Hood Bay, and Chaik-Whitewater Bay. A detailed description of each of the three areas may be found in the City of Angoon CMP.

- **Mitchell Bay** - The Mitchell Bay AMSA borders the City of Angoon and includes all the waters of Kootznahoo Inlet, Mitchell Bay, Favorite Bay, Kanalku Bay, Kanalku Lake, Salt Lake, and the surrounding lands for a distance inland of 201 m (660 ft) from mean high tide (City of Angoon 1990).

- **Hood Bay** - The Hood Bay AMSA is located along the west Admiralty Island shoreline of Chatham Strait south of Angoon. The AMSA contains all waters of Hood Bay, including the North and South Arms as well as all lands within 201 m (660 ft) of mean high tide (City of Angoon 1990).

- **Chaik-Whitewater Bay** - The Chaik-Whitewater Bay AMSA is located south of Hood Bay approximately 32.2 km (20 mi) south of Angoon. This AMSA includes all the waters of Whitewater Bay and all the waters running north in a line from Woody Point to Village Point, just north of Chaik Bay (City of Angoon 1990).

Two locations within the Aleutians West Coastal Resource Service Area (CRSA) district have been identified as potential candidates for AMSA designation: Unalaska Bay and Chernofski Harbor. The Unalaska Bay location includes the waters of Unalaska Bay, Amaknak Island, and the coastal waters and adjacent shorelands of Unalaska Bay and Dutch Harbor. The Chernofski Harbor area extends from Chernofski Point to West Point to the head of Chernofski Harbor. This area includes all the waters and adjacent shorelands within the area delineated above (Aleutians West CRSA 1991).

An area of intensive subsistence usage identified in the vicinity of Bethel has been proposed for identification as an AMSA. This area contains land and waters in both the City of Bethel and the Ceñaliulriit Coastal Management districts, therefore, both of these districts will jointly develop the management plan for the AMSA (City of Bethel 1984).

The City of Valdez has recommended four areas be designated as an AMSA: Duck Flats/Mineral Creek Islands, Mineral Creek Canyon, Robe Lake, and Keystone Canyon. A detailed description of each of the areas may be found in the Valdez CMP (Valdez 1986). The City of Sitka has identified Swan Lake as a future AMSA.

The Bristol Bay Coastal Resource Service district has identified two areas as potential candidates for AMSA designation: Togiak fishing grounds and the Nushagak/Mulchatna drainage. There are several sensitive areas within the boundaries of the Bristol Bay CRSA (i.e., Togiak NWR and the Alaska Maritime NWR), however, these areas are currently protected by state and federal laws.

- **Togiak Fishing Grounds** - The Togiak fishing grounds contain the largest herring fishery in the state and are located in northern Bristol Bay. The proposed AMSA includes the waters of Kulukak Bay, Nunavachak Bay, Metervik Bay, Togiak Bay, and Hagemeister Strait.

- **Nushagak/Mulchatna Drainage** - This area is 321.9 km (200 mi) in length from the headwaters of the Mulchatna River to Bristol Bay and includes the land drained by the

Nushagak and Mulchatna Rivers upstream of the Wood River. A management plan for this area was prepared jointly by the Alaska Department of Natural Resources, Alaska Department of Fish and Game, and the Bristol Bay CRSA.

8.5 PRIBILOF ISLANDS

The Pribilof Islands are considered to be special aquatic sites as these islands are essential for the continued existence of the northern fur seal. Approximately 72 percent of the entire fur seal population are found on the Pribilof Islands during the breeding season. These islands, particularly St. Paul and St. George Islands, contain mating, pupping, pup rearing, and important feeding grounds extending to a minimum of 200 to 300 km (124 to 186 mi) from these islands (NMFS 1993c).

The Pribilof Islands have been designated as a "special reservation" due to the important habitat contained on these islands. Landing on any of the Pribilof Islands, with the exception of unavoidable causes such as inclement weather, is prohibited unless authorized by the NMFS.

8.6 CONSISTENCY ASSESSMENT

The waste discharges associated with seafood processing activities covered under the proposed NPDES general permit are expected to comply with, and will be conducted in a manner consistent with, relevant Alaska Coastal Management Program policies and district policies under the limitations and conditions set forth in the general permit with the following provisions: discharges are avoided or minimized in areas containing significant concentrations of shellfish, waterfowl, shorebird, or marine mammal habitat or harvest areas, and floating processors shall not be located within 152.4 m (500 ft) of the mouth of any anadromous fish stream within the Borough of Angoon. This consistency assessment is based upon the following:

- Based upon the evaluation in Section 7.0, opportunities for subsistence usage of coastal resources are not likely to be threatened or adversely affected by seafood waste discharges.

- Coastal habitats will be managed to maintain the biological, physical, and chemical characteristics of the habitats which contribute to their capacity to support living resources. This finding is based upon the evaluations in Sections 3.0 and 5.0 indicating that coastal habitats are unlikely to experience significant adverse impacts from seafood waste discharges under the limitations and conditions set forth in the proposed NPDES general permit.

- Offshore areas will be managed to maintain sport, commercial, and subsistence fisheries. This conclusion is based upon the evaluation in Section 7.0 indicating that sport, commercial, and subsistence harvests are unlikely to experience degradation from seafood waste discharges under the limitations and conditions of the proposed NPDES general permit.

- Estuaries, wetlands, and tideflats will be managed to assure adequate water flow, nutrients, and oxygen levels, and will not be adversely affected by the discharge of toxic wastes. This finding is based upon the evaluations in Sections 3.0 and 9.0 indicating that toxic substances in seafood waste discharges are not likely to be present and discharges are not expected to substantially affect nutrient or oxygen levels in the vicinity of these coastal habitat under the limitations and conditions of the proposed general permit.

- Rocky islands and seacliffs will be managed to avoid the harassment of wildlife, destruction of important habitat, and the introduction of competing or destructive species and predators. This finding is based upon the evaluation in Section 5.0 indicating that seafood waste discharges are unlikely to adversely affect wildlife or habitat in the vicinity of these areas.

- Barrier islands and lagoons will be managed to maintain adequate water flow of sediments, detritus, and water, and will be managed to avoid the alteration of wave energy and the avoidance of activities which would decrease the use of barrier islands by coastal species, including polar bears and nesting birds. This finding is based is based upon the evaluation in Section 5.0 indicating that seafood process waste discharges are not expected to adversely impact habitat or wildlife in these areas under the limitations and conditions set forth in the proposed general permit

- Mixing and transport processes of high energy coasts will not be affected by seafood waste discharges.

CRSA

8.7 SUMMARY

Discharges associated with seafood processing wastes are expected to be consistent with relevant ACMP and district policies with the following provisions: discharges are avoided or minimized in areas containing significant concentrations of shellfish, waterfowl, shorebird, or marine mammal habitat or harvest areas, and floating facilities shall not be located within 152.4 m (500 ft) of the mouth of any anadromous fish stream within the Borough of Angoon. The consistency assessment is based upon ACMP policies and individual district policies approved by local, state, and federal governments. Discharges are expected to be consistent with the objectives of subsistence uses of the coastal zone, management of all coastal habitats, and management of specific habitat types (offshore areas, estuaries, wetlands and tideflats, rocky islands and seacliffs, barrier islands and lagoons, and high energy coasts).