MIGRATORY BIRDS AND MARINE MAMMALS OF THE BRISTOL BAY REGION

Wildlife Narratives for the Bristol Bay Cooperative Management Plan

U.S. Fish and Wildlife Service
Refuge Planning
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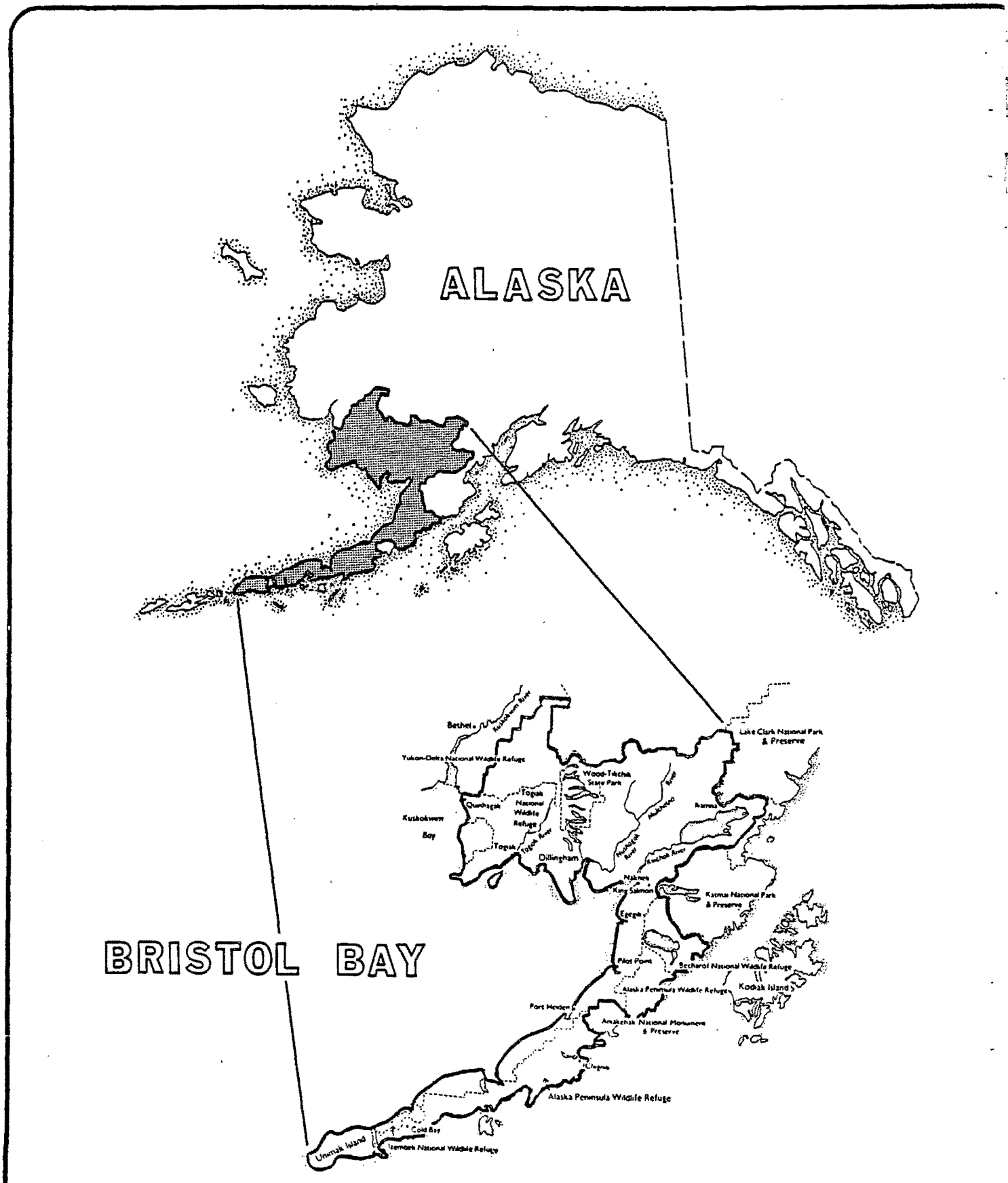
PREFACE

The following narratives on migratory birds and marine mammals of the Bristol Bay region were compiled by U.S. Fish and Wildlife Service biologists for the purpose of facilitating the planning process in Bristol Bay. Similar narratives for game and fish resources have been compiled by Alaska Department of Fish and Game personnel. The information will serve as groundwork for resource management decisions in the Bristol Bay Cooperative Management Plan and in the National Wildlife Refuge Comprehensive Plans.

BRISTOL BAY
COOPERATIVE MANAGEMENT PLAN

COOPERATIVE STUDY REGION



CONTENTS

	Page
PREFACE	iii
INTRODUCTION	1
MIGRATORY BIRDS	
Seabirds	4
Pelagic distribution of seabirds in Bristol Bay - Patrick J. Gould	
Shearwaters	4
Kittiwakes	5
Alcids	7
Murres	9
Total birds	11
Seabird colonies - Calvin J. Lensink and John Trapp	14
Waterfowl - Dirk L. Dirksen and William D. Eldridge	20
Tundra (whistling) swan	20
Snow goose	21
Emperor geese	22
White-fronted goose	24
Cackling Canada goose	24
Other Canada geese	26
Brant	27
Dabbling ducks	28
Diving ducks	30
Eiders	32
Other Waterbirds	35
Loons - Margaret R. Petersen	35
Lesser Sandhill Crane - William D. Eldridge	36
Shorebirds - Robert E. Gill, Jr. and Colleen M. Handel	38
Raptors - Philip Schempf	55
Bald Eagle	55
Other Raptors	56
Migratory Bird References	59
MARINE MAMMALS - James L. Baker, Scott L. Schliebe, William T. Schmidt	
Carnivora	65
Steller's (northern) sea lion	65
Northern fur seal	66
Other seals	67
Pacific walrus	68
Sea otter	71
Cetacea	73
Beluga	73
Gray whale	74
Other whales	75
Marine Mammal References	78
ENDANGERED SPECIES - Michael Amaral and Dennis Money	79
SPECIAL ECOLOGICAL RESOURCES - Calvin J. Lensink	81

INTRODUCTION

Bristol Bay is a large, shallow estuary off the Bering Sea, from Cape Newenham to Unimak Pass. It abuts on the southern border of the subarctic zone, and half of its surface is covered by sea ice for five months of the year. The bay constitutes one of the most productive marine systems in the world. The waters of the Pacific Ocean, heavily laden with nutrients, flow through the Aleutian Passes and enrich the subsurface waters of Bristol Bay. Marine upwellings within Bristol Bay and waters from the major river systems also contribute to the high productivity in the bay. Rich in plankton and forage benthos, Bristol Bay attracts larges numbers of marine and anadromous fish, marine mammals, and seabirds.

Unimak Pass is the first major passage between the Gulf of Alaska and Bristol Bay and as a result is a major focal point for birds, mammals, and fish migrating in and out of the Bering Sea. Millions of birds from the North American Pacific flyway and several Asiatic routes funnel through Unimak Pass and the rich coastal environment of Bristol Bay. The bay contains some of the first and last staging and feeding areas for birds fleeing the early freeze on their arctic nesting grounds or awaiting spring break up. The world's population of black brant and most of the world's emperor geese stage in Bristol Bay's coastal lagoons every fall. Virtually all of Alaska's loons pass through Bristol Bay each spring and fall. The majority of North America's eiders also pass through Bristol Bay. Over one million ducks and nearly one million geese use Bristol Bay's estuaries each fall.

Some waterfowl, particularily tundra (whistling) swans, common eiders, greater scaup, oldsquaws, scoters, northern pintails, mallards, American wigeon, and green-winged teal, remain in the coastal marshes of Bristol Bay to nest, although the majority continue north to the Yukon-Kuskokwim Delta or the North Slope. Many return to Bristol Bay lagoons and estuaries to molt in the late summer. Eiders and diving ducks, especially scoters and oldsquaws, also winter along the coasts of the bay.

Millions of shorebirds stage along Bristol Bay coasts in fall and to a lesser extent in spring. Smaller numbers remain to nest. The most commmon migrants are western sandpipers, dunlins, bar-tailed godwits, red and red-necked (northern) phalaropes, short-billed dowitchers, and rock sandpipers. Three species (rock sandpiper, American black oystercatcher, sanderling) winter in the study area.

Ten to 15 million seabirds summer in Bristol Bay. Two million of these nest on the coastal cliffs of the bay, particularly at Cape Newenham in Togiak NWR; the remainder is composed predominantly of shearwaters, which nest in the southern hemisphere during the Alaskan winter. The most abundant nesting seabirds are common murres, black-legged kittiwakes, tufted and horned puffins, and pelagic, red-faced, and double-crested cormorants.

The rugged shorelines, coastal marshes, and interior mountains of the Bristol Bay study area provide habitat and an abundant food supply for many raptors, especially bald and golden eagles, gyrfalcons, peregrine falcons, merlins, northern harriers (marsh hawks), and rough-legged hawks. The endangered subspecies, P.f. anatum, of the peregrine falcon may migrate across the Alaska Peninsula.

Unimak Pass and Bristol Bay are a migration corridor for most of Alaska's marine mammals. Northern fur seals migrate through the pass, primarily to the Bering Sea, although some travel to Bristol Bay to feed. Walrus haul out on several islands in the bay year-round. Numbers increase in the winter when one third of the Bering Sea walrus population concentrates in Bristol Bay along the sea ice edge. Four species of seal also winter in Bristol Bay along the ice edge. Steller's sea lions may be found year-round on the Alaska Peninsula coast.

The endangered gray whale migrates in the spring through Unimak Pass and hugs the Bristol Bay shoreline on its way north. Other whales that pass through Bristol Bay on their way to the Bering Sea are the minke and the endangered fin and humpback whales. Baird's beaked whale occasionally is found in the western third of the bay. The bowhead whale, another endangered species, remains on the loose edge of the ice pack, which extends south into Bristol Bay in winter. Belugas, killer whales, and harbor and Dall porpoise are common in the bay all year.

Sea otters occur on the north shore of the Alaska Peninsula, although in fluctuating numbers. When ice moves into the area, their numbers are drastically reduced. Populations on the south side of the peninsula are more stable.

In summary, the Bristol Bay planning area supports an abundance of fish and wildlife, and as a result constitutes one of the most important recreational and commercial regions in the state.

MIGRATORY BIRDS

SEABIRDS

PELAGIC DISTRIBUTION OF SEABIRDS IN BRISTOL BAY

SHEARWATERS

Only two species of shearwaters occur in Bristol Bay with any regularity or in any appreciable numbers--the sooty shearwater (Puffinus griseus) and the short-tailed shearwater (P. tenuirostris). It is difficult to distinguish between the two species in the field and data for both species are often combined.

Distribution and Abundance

Both species breed in the southern hemisphere--short-tails mostly in Tasmania and sooties in New Zealand and southern South America. Both make transequatorial migrations to spend the nonbreeding season, the austral winter, in the North Pacific (Palmer 1962). Sooty shearwaters from South America also move into the North Atlantic. Recent population estimates for the short-tailed shearwater on its breeding grounds place the world population at over 16 million (Naarding 1980). An estimate for the sooty shearwater is not available. Fish and Wildlife Service surveys in the eastern Bering Sea (Gould et al. 1982) found both species, but sooty shearwaters composed only 3% of those individuals identified to species. Assemblages of up to 300,000 shearwaters were found and a conservative estimate of the number of both species in the eastern Bering Sea was 12 million. Numbers in Bristol Bay vary greatly through the season, however aerial surveys by the Fish and Wildlife Service indicate that as many as 8 million occur there during the summer--33% of the total number of shearwaters estimated by Gould et al. (1982) to be in Alaska.

Life History

Shuntov (1972) summarized much of what is known about the pelagic biology of shearwaters in the Bering Sea. He found that they enter the area through the Aleutian passes in May and June and leave in September and especially in October. Early arrival and late departure dates based on Fish and Wildlife Service data are 24 April and 22 November. Shearwaters tend to be most abundant in Bristol Bay in early summer. At this time they are undergoing an extensive molt and feathers often coat the waters of the southeastern Coastal Domain for many miles. We have no information on which habitats sheawaters prefer to use during this molt. Shuntov (1961) estimated 5-7 million short-tailed shearwaters gathered to molt in the southeastern Bering Sea in June 1960. After molting, the birds appeared to move into deeper waters to the west.

Shearwaters feed principally on euphausiids, amphipods, squid, and small fish, which they capture by surface seizing and underwater pursuit (Hunt et al. 1981a).

Habitat

Shearwaters in Bristol Bay are common throughout the Coastal Domain, but are most concentrated along the 50-m isobath (Hunt et al. 1981b)--the outer edge of an area of total mixing of the water column. Iverson et al. (1979) suggested that this type of distribution is related to the effects oceanographic conditions, especially frontal systems, have on the food preferred by birds. With the possible exception of concentration areas near the 50-m isobath, there appears to be no area that is unique or of critical importance relative to other areas.

Data Gaps

We have no information on the age or sex structure of the shearwater population using Bristol Bay, nor do we have any winter information. In some Alaskan waters, nonbreeding (immature?) shearwaters are found throughout the winter. Censuses of Bristol Bay have been spotty, and data are particularly limited for winter months and for regions near the northern and eastern coasts.

Impacts

Only two sources of potentially adverse impact to shearwaters in Bristol Bay are significant. The first is pollution of the environment by oil and other byproducts of offshore development. The second is increased pressure on the food source by commercial fisheries. Of particular concern would be the development of a small fish (capelin-sand lance) fishery. Recent studies indicate that these birds are extremely vulnerable to entanglement in commercial fishing nets (DeGange and Newby 1980, Ainley et al. 1981). Currently, the stress from these sources on shearwaters in Bristol Bay appears to be minimal. King and Sanger (1979) rated sooty and short-tailed shearwaters as moderately vulnerable to oil pollution, with scores of 51 and 53 respectively out of a possible 100.

The only stipulations that we currently feel should be applied to minimize impacts on shearwaters in Bristol Bay are the use of good management of the fisheries resources, and the avoidance of environmental pollution.

KITTIWAKES

Black-legged kittiwakes (Rissa tridactyla) regularly occur in large numbers in Bristol Bay. Red-legged kittiwakes (R. brevirostris) are abundant in the Pribilof Islands but usually forage over deep water and are rare over the shallow waters of Bristol Bay (Kessel and Gibson 1981). The two species are often difficult to distinguish from one another in the field, therefore the data are often combined for the two species. Red-legged Kittiwakes, however, make up less than 1% of the kittiwake numbers in Bristol Bay.

Distribution and Abundance

Black-legged kittiwakes have a broad circumpolar breeding distribution (50°N-82°N). Their winter dispersal is to the south, although a few birds remain in ice-free northern areas. Many reach Baja California, Korea, northwest Africa, and the mid-eastern United States. In Alaska, black-legged kittiwakes breed from Cape Lisburne south, throughout the Aleutian Islands to the west, and to Glacier Bay in the east. The center of breeding abundance lies between Middleton Island in the north-central Gulf of Alaska and Cape Peirce and the Pribilof Islands in the Bering Sea.

J.C. Coulson (in Cramp et al. 1974) estimated the number of breeding black-legged kittiwakes in Britain and Ireland to be 939,400. Sowls et al. (1978) gave a rough estimate of 2.5. million birds for Alaska. Nettleship (1977) estimated the number of black-legged kittiwakes in the eastern Canadian arctic and Atlantic Canada to be 437,524. These figures indicate that the world population may be in excess of 5 million birds. Sowls et al. (1978) listed over 388,000 breeding birds in Bristol Bay and located the largest breeding colony (200,000 birds) in that area at Cape Pierce. The total population, breeding and non-breeding birds, dependent on Bristol Bay may exceed 500,000 birds.

Red-legged kittiwakes breed only in the Bering Sea on the Komandorski, Pribilof, Buldir, and Bogoslof islands. In winter, all birds move into open waters but the extent of this dispersal is unknown. Sowls et al. (1978) provided an estimate of 230,000 birds for the Alaskan population. This represents almost the entire population, since the only colony outside Alaska is a small one on the Komandorskie Islands.

Life History

Shuntov (1972) suggested that black-legged kittiwakes oriented toward land in the summer and dispersed to sea in September and October. Most leave the Bering Sea for the North Pacific in winter and do not return until April. Peterson and Sigman (1977) found at Cape Peirce that kittiwakes first occupy the colony in late April and that nesting begins in the first or second week of June. The last young fledged on 2 September.

The events of the breeding cycle of red-legged kittiwakes are about one week later than those of black-legged kittiwakes (Hunt et al. 1981c). Little is known about the postbreeding dispersal of red-legged kittiwakes, but a number of individuals have been seen in the Gulf of Alaska and North Pacific Ocean in the fall and winter (Kessel and Gibson 1978).

Black-legged kittiwakes feed on small fish, euphausiids, and sometimes squid which they catch at the surface by dipping or shallow plunging. Red-legged kittiwakes generally feed on the same type of food as black-legged kittiwakes but their diet also includes large numbers of myctophids found in deep water habitats (Hunt et al. 1981a).

Habitat

Shuntov (1979) dicussed the pelagic biology of black-legged kittiwakes in the Bering Sea and reported them to occur in all ice-free waters. Hunt et al. (1981b) found these birds to be scattered evenly throughout the eastern Bering Sea, and were unable to detect any obvious habitat preferences. Their surveys, however, did not cover nearshore waters to any great extent and kittiwakes may be most abundant there. A staging, loafing or resting area in front of the colony appears to be important for these birds. They will also travel many miles to bathe in fresh water.

Red-legged kittiwakes concentrate over shelfbreak or deeper waters where myctophids are most abundant. Bristol Bay thus does not contain important habitat for this species although the area around Unimak Pass may be important as a migration corridor in spring and fall.

Data Gaps

We have no information on the age, sex, or breeding status of kittiwakes over pelagic habitats in Bristol Bay, nor do we have any winter information. Coverage of Bristol Bay during any season has been spotty in critical areas such as those near the northern and eastern coasts, especially near Cape Peirce.

Impacts

There are two principal sources of potential harm to kittiwake populations in Bristol Bay. The first is pollution of the environment by oil and other activities associated with offshore development, including increased ship traffic. The second is increased pressure on the food source by overexploitation of commercial fisheries. Current impacts on the kittiwake population in Bristol Bay appear to be minimal. King and Sanger (1979) rated black-legged and red-legged kittiwakes as moderately vulnerable to oil pollution, with scores of 49 and 66 respectively out of a possible 100.

The only stipulations that we currently feel should be applied to minimize impacts on kittiwakes in Bristol Bay are to use good management practices for the fishery resources, and to avoid contamination of the environment.

ALCIDS

Eight species of alcids are known to breed in Bristol Bay--common murre (Uria aalge), thick-billed murre (U. lomvia), pigeon guillemot (Cepphus columbia), Kittlitz's murrelet (Brachyramphus brevirostris), parakeet auklet (Cuclorrhynchus psittacula), crested auklet (Aethia cristatella), horned puffin (Fratercula corniculata), and tufted puffin (Lunda cirrhata). A ninth species, the marbled murrelet (Brachyramphus marmoratus), may breed in the area as well. All of the above nine species, except the crested auklet and marbled

murrelet, are common in the area. Several species from the nearby Aleutian and Pribilof islands may occur in pelagic habitats of Bristol Bay--ancient murrelet (Synthlibormaphus antiquus), Cassin's auklet (Stychoramphus aleuticus), least auklet (Aethia puasilla), and rhinoceros auklet (Cerorhinca monocerata)--but only the ancient murrelet occurs regularly in appreciable numbers.

Distribution and Abundance

Alcids are resticted to the Northern Hemisphere and have their center of diversity and abundance in the Bering Sea. Sowls et al. (1978) estimated a breeding population in the Bering Sea of over 14 million, of which only 1.45 million, 93% of which were murres, were in Bristol Bay. Cape Peirce and the Walrus Islands are the most important breeding colonies of alcids in Bristol Bay.

Life History

Most alcids arrive at their Bristol Bay colonies in late April or early May and begin nesting in mid- to late June. Puffins and many murres move out of Bristol Bay into the northern Pacific in September-October and return in April-May. Most alcids will probably leave in heavy ice years.

Alcids tend to partition food resources through prey size, prey type, and prey location. Food items vary from small fish such as sand lance and capelin through large amphipods and euphausiids to various sizes of zooplankton (Hunt et al. 1981a).

Habitat

During the breeding season, murres and puffins may fly 10 km or more to feed, but the small alcids generally forage close to their colonies. Open water in front of the colonies is often crowded with staging, resting, or loafing birds. Most of the species prefer the Coastal Domain landward of the 50-m isobath, although pigeon guillemots, and Kittlitz's and marbled murrelets are most abundant in bays and along rocky shorelines. In winter the ice edge is extremely important for birds remaining in the area. The only species that appears to prefer the outer continental shelf is the ancient murrelet, which Gould et al. (1982) found most abundant between 50- and 100-m depths in outer Bristol Bay.

Data Gaps

Alcids as a group, excluding murres, are the most poorly documented birds over pelagic habitats in the eastern Bering Sea. The major problems are their detection and identification. Surveys frequently miss important habitats as well as the birds themselves. Winter surveys are almost nonexistent.

Impacts

The most serious threats to alcid populations in Bristol Bay are oil pollution and increased ship traffic resulting from offshore development of petroleum resources, and increased pressure on food resources through pollution and commercial fishing. Current impacts on the alcid population in Bristol Bay appear to be minimal. King and Sanger (1979) considered alcids the most vulnerable to oil pollution of all the marine-oriented birds.

The only stipulations that we currently feel should be applied to minimize impacts on alcids in Bristol Bay are to use good management practices for the fishery resources, and to avoid contamination of the environment.

MURRES

Two species of murres occur in Bristol Bay--the common murre (Uria aalge) and the thick-billed murre (U. lomvia). It is very difficult to distinguish one from the other in the field and therefore data for both species are often combined.

Distribution and Abundance

Common murres breed on islands and coasts of the North Atlantic and North Pacific (38°N-75°N) and winter in open water throughout that range. Sowls et al. (1978) gave an estimate of 5 million birds in Alaska. Estimates based on censuses in Britain and Ireland indicated nearly 577,000 pairs (Cramp et al. 1974). Nettleship (1977) estimated nearly 1.3 million birds for the eastern Canadian arctic and the Canadian North Atlantic. The world population may thus be around 10 million birds.

Thick-billed murres breed in arctic and subarctic areas of North America and Eurasia (50°N-75°N) and generally winter throughout that range. Sowls et al. (1978) gave a rough estimate of 5 million birds in Alaska and Nettleship (1977) estimated more than 5.1 million in the eastern Canadian arctic and the Canadian Atlantic. Thus, the world population may be over 12 million birds.

Over 6.5 million murres breed in the eastern Bering Sea and Aleutian Islands area; about 1.7 million of these breed in Bristol Bay (Sowls et al. 1978). The number of nonbreeding birds is uncertain but the total population of Bristol Bay probably exceeds 2 million. Although thick-billed murres outnumber common murres in the eastern Bering Sea by 1.2:1, common murres far outnumber thick-billed murres in Bristol Bay. The only thick-billed murres found breeding in Bristol Bay are a few pairs around Amak Island and associated Sea Lion Rocks (Sowls et al. 1978).

Life History

Sowls et al. (1978) listed the major Bristol Bay breeding colonies as Cape Pierce (500,000 common murres) and North Twin Island in the Walrus Islands (228,000 common murres). Peterson and Sigman (1977) reported that murres arrive at the colony on Cape Peirce sometime in April and nesting begins in early June. Chicks leave the colony in August or September before they can fly and swim out to sea accompanied by at least one adult. Large numbers of migrating murres have been seen in the spring and fall rounding Unimak Island through Unimak Pass (Gould et al. 1982).

Murres feed on a variety of small fish, euphausiids, and squid which they capture by underwater pursuit. Hunt et al. (1981a) found that thick-billed murres eat more invertebrates than do common murres.

Habitat

Shuntov (1972) summarized most of the available data on murre biology in the Bering Sea, and reported murres to be abundant throughout the year, especially over the continental shelf. Gould et al. (1982) found densities highest over the continental shelf--near colonies in summer and along the ice edge in spring and winter. In summer, Bartonek and Gibson (1972) found large numbers throughout Bristol Bay, mostly between the 50-m isobath and the shore. There is a widespread dispersal of postbreeding adults and flightless young away from colonies but most of the population remains over the shelf. As ice forms in the Bering Sea in winter, it appears likely that many of the murres from large colonies in the northern Bering Sea and Chukchi Sea move into Bristol Bay.

Thick-billed murres are probably associated more closely with deep water than are common murres and this may be the reason for the scarcity of breeding thick-billed murres in Bristol Bay. Of all habitats available to these birds in Bristol Bay, the ice edge in winter and staging or loafing areas in front of colonies may be the most critical.

Data Gaps

Very little information is available on the age, sex, and breeding status of at-sea populations, and differences in distribution between the two species. Coverage of Bristol Bay during any season has been spotty, especially in winter, and in critical areas near large colonies on the northern and eastern coasts. At present, we know that large numbers of murres move out of the Bering Sea in winter and that large numbers also remain along the ice edge; we do not know which colony each group comes from or whether each group is of mixed origin.

Impacts

As with other seabirds in Bristol Bay, the most serious potential threats to murre populations are oil pollution and increased ship traffic resulting from offshore development of petroleum resources, and increased exploitation of murre food resources by commerical fisheries. Flightless young are especially vulnerable to floating oil as they leave the colony and move out to sea. King and Sanger (1979) considered common and thick-billed murres to be among the most vulnerable of marine birds to pollution by oil. Murres have also been found entangled in commercial salmon nets (Ainely et al. 1981), but the extent to which this occurs is not well documented.

The only stipulations that we currently feel should be applied to minimize impacts on murres in Bristol Bay are to use good management practices for the fishery resources, and to avoid contamination of the environment.

TOTAL BIRDS

Twenty-eight species of seabirds are of regular occurrence in moderate to large numbers in Bristol Bay: northern fulmar (Fulmarus glacialis), short-tailed shearwater (Puffinus tenuirostris), sooty shearwater (P. griseus), fork-tailed storm petrel (Oceanodroma furcata), double-crested cormorant (Phalacrocorax uritus), pelagic cormorant (P. pelagicus), red-faced cormorant (P. urile), pomarine jaeger (Stercorarius pomarinus), parasitic jaeger (S. parasiticus), long-tailed jaeger (S. longicaudus), glaucous gull (Larus hyperboreus), glaucous-winged gull (L. glaucescens), mew gull (L. canus), Bonaparte's gull (L. philadelphia), black-legged kittiwake (Rissa tridactyla), Sabine's gull (Xema sabini), arctic tern (Sterna paradisaea), Aleutian tern (Sterna aleutica), common murre (Uria aalge), thick-billed murre (U. lomvia), pigeon guillemot (Cepphus columba), marbled murrelet (Brachyramphus marmoratus), Kittlitz's murrelet (B. brevirostris), ancient murrelet (Synthliboramphus antiquus), parakeet auklet (Cyclorrhynchus psittacula), crested auklet (Aethia cristatella), horned puffin (Fratercula corniculata), and tufted puffin (Lunda cirrhata). Short-tailed shearwaters, common murres, and sooty shearwaters, in that order, numerically dominate the at-sea avifauna to such an extent that the contributions of the other species are obscured.

Distribution and Abundance

Seabirds are common in all marine habitats of Bristol Bay where their occurrence and numbers vary daily, monthly, seasonally, and yearly in response to shifting food supplies, climatic patterns, breeding status, or special activities such as the molt. Seabird densities are moderately high in Bristol Bay with respect to other areas of Alaska, but they tend to be lower than densities along the Bering Sea shelfbreak between the eastern Aleutian and Pribilof islands.

Sowls et al. (1978) listed a little over 3 million breeding seabirds for Bristol Bay. Gould et al. (1982) estimated 27-44 million seabirds for the eastern Bering Sea, and probably 10-15 million of these were from Bristol Bay.

Life History

Most nesting usually begins in mid- to late June and fledging occurs about two months later. Although a large number of murres and other seabirds may winter in Bristol Bay, most migrate south in September-November and do not return until April-May.

The most important food items in the diets of seabirds of Bristol Bay include euphausiids, pollock (Theragra chalcogramma), squid, amphipods (especially Parathemisto libellula), calanoid copepods, and myctophids (Hunt et al. 1981a). The density of seabirds in any given area is usually directly related to the abundance of these food items.

Habitat

The highest densities of seabirds are generally found in the Coastal Domain, especially near the inner front (usually located near the 50-m isobath), and within 5 km of the larger colonies such as the one at Cape Peirce. The ice edge forms a major feeding habitat for all species remaining within the area in winter. Ice also short-stops birds returning to their breeding grounds in the spring, and large numbers of seabirds often build up along the ice edge at that time. As the ice retreats birds follow leads and polygons northward. Large bays provide several species (e.g., mew gulls, pigeon guillemots, arctic terns) with preferred breeding habitat and may also be used by birds to escape severe storms.

Data Gaps

Surveys are almost nonexistent for winter months and along nearshore areas of Bristol Bay. We also do not know the sex, age, and breeding status of birds using various pelagic habitats. We have, at present, only a broad overview of habitat partitioning among seabird distribution and the physical, chemical, and biological characteristics of surface and deep waters.

Impacts

The two serious threats to marine bird populations in Bristol Bay are pollution and increased traffic resulting from development of gas and oil reserves, and the deterioration of the food supply from increasing pressure by commercial fisheries. Stress on marine bird populations in Bristol Bay is currently minimal from the above sources, but the discovery of a major oil or gas field, or the establishment of a capelin or sand lance fishery, could create severe problems.

Procedures to minimize current impacts involve primarily common-sense protection of the environment, controlling the discharge of nonbiodegradeable waste into the ocean, and insisting on good management practices by the fishing industry.

SEABIRD COLONIES

Distribution and Abundance

Twenty-three species of seabirds nest commonly within the Bristol Bay study area. Of these, 15 species nest primarily or exclusively in colonies that may number from a few pairs to several hundred thousand (Table 1). Other species of seabirds common in coastal waters nest solitarily or in small colonies that may or may not be located in coastal regions.

A total of 98 colonies or colony complexes occur within the Bristol Bay study area (Sowls et al. 1978). Of these, 34 colonies with a total of about 110,000 birds are located on the Gulf of Alaska. The largest colony on the Gulf of Alaska is located in Puale Bay and contains 80,000 murres. Remaining colonies on the south side of the Alaska Peninsula are small, with only 9 exceeding 1000 birds and only one exceeding 10,000.

A total of 64 colonies are found in Bristol Bay (Bering Sea). Colonies are relatively sparse and small on Unimak Island, along the Alaska Peninsula, and in Kuichak and Nushagak bays. Numerous large colonies occur from the Walrus Islands west to Cape Newenham, this area supporting 1,850,000 birds or 90% of the population in colonies within the study area.

Species Composition

Of the 15 colonial species occurring within the study region, the common murre is clearly of dominant importance, exceeding half of the total population (Table 1). Common and thick-billed murres together comprise 71.4% of the seabirds in colonies in the study region, and 20.4% of all murres in Alaska. Nearly all murres (97%) within the region are found in a few large colonies in Puale Bay (80,000), the Walrus Islands (470,000), Cape Peirce (550,000) and Cape Newenham (309,000).

Black-legged kittiwakes with a population of 391,000 are second in abundance to murres, and like the latter species are found primarily on the Walrus Islands (77,000), Cape Peirce (220,000) and Cape Newenham (71,000). The largest colony on the south side of the Alaska Peninsula supports only 1000 birds. In Bristol Bay between Unimak Pass and Cape Constantine the largest colonies are at Amak Island and Sea Lion Rocks with a total of 8,800 birds. Although substantially less abundant than murres, kittiwakes in the study area comprise 22.3% of the Alaskan population.

Tufted puffins with a total of 103,000 birds in 33 colonies are the third most abundant species, far outnumbering horned puffins which have a population of about 7,000 birds at 34 breeding sites. Both species are most abundant in the region between the Walrus Islands and Cape Newenham, an area supporting approximately 84% and 59% respectively of the tufted and horned puffins within the study area.

Table 1. Species and populations of birds present in colonies in the Bristol Bay study area.[a]

Species[b]	Number of colonies	Number of birds	Percent frequency occurence[c]	Percent of Alaska population
Fork-tailed storm petrel	2	?	t	t
Cormorants (total all species)	69	34,300	1.7	16.1
Double-crested	11	1,700	0.1+	
Pelagic	27	16,100	0.7+	
Red-faced	25	5,200	0.1+	
Glaucous-winged gull	50	36,100	1.8	15.8
Black-legged kittiwake	32	391,000	19.3	22.3
Arctic tern	4	1,400	0.1	
Aleutian tern	4	1,700	0.1	50.8
Murres (total all species)	22	1,447,600	71.4	20.4
Common	19	1,036,800	51.1+	?
Thick-billed	4	?	?+	?
Pigeon guillemot	20	1,700	0.1	4.3
Parakeet auklet	9	2,500	0.1	0.6
Crested auklet	1	100	t	+
Horned puffin	34	6,900	0.3	0.9
Tufted puffin	33	103,500	5.1	4.9
Total (15) species	98	2,027,100	100.0	5.0

a. Data are from Sowls et al. (1978).
b. Other species that nest solitarily or in small colonies within the Bristol Bay study area include parasitic and long-tailed jaeger, glaucous, herring, mew, Bonaparte's, and Sabine's gulls and marbled and Kittlitz's murrelets.
c. Percent frequency occurrence for individual species of cormorants and murres are biased (low) because of large numbers not identified to species - sea total for each group.

Although populations are small, cormorants are known to breed at 69 locations within the study area and, except for the double-crested cormorant, are the most widely distributed of all species. The pelagic is most abundant, being about three times more numerous than the red-faced, although the latter is as widely distributed. The population of double-crested cormorants numbers only 1,700, but represents 36% the state's population.

Of the remaining species, the widely distributed glaucous-winged gull is the only one present in substantial numbers. The Bristol Bay population of 36,100 comprises nearly 16% of the state's population.

The Aleutian tern may be of most significant interest among seabirds of Bristol Bay. The breeding range of this species is exclusively Alaskan, and the 1,730 terns breeding at four sites (Izembek Bay, Port Moller Spit, Port Heiden and Goodnews Bay) within the study area represent more than half of the entire population of the species.

Habitat Requirements

The single most important factor controlling the distribution of colonial seabirds is security from mammalian predators. Thus, most seabirds are confined to islands on which predators do not occur or to marine cliffs and boulder or talus slopes where nesting sites are inaccessible to predators. Gulls and terns are most successful in island habitats but may also use spits or marsh areas where predators are less abundant than in other mainland habitats. The aggressive behavior of gulls and terns provides additional protection from predators and permits these species to use areas not available to other seabirds.

Within the Bristol Bay study area, 56 colonies are located on marine cliffs, 26 on islands, 4 on islands on inland lakes, 4 in marshy areas, 3 on spits and 2 on talus slopes. Depending on individual species, secondary elements of habitat may include soils suitable for burrowing, presence of nesting ledges, or topographic relief. Availability of reliable foraging areas offshore may be important to many species, but this relationship is difficult to demonstrate for individual colonies.

Critical and Important Habitats

Critical and important habitats (Table 2) were determined on the basis of the distribution and abundance of birds within the study area and the populations of individual species in relation to that of the entire state. On this basis, the Walrus Islands, cliffs at Cape Peirce and Cape Newenham, Shaiak Island off Cape Peirce, Bird Island off Cape Newenham and the cliffs west of Puale Bay are considered of critical importance. These areas support nearly all of the populations of murres, kittiwakes, and puffins as well as

Table 2. Critical and important habitats

Critical and important habitat (colony number)[a]	Key species	Number of birds
	Critical Habitat	
028-046	Aleutian tern	1,400
035-008	Common murre	80,000
039-004	Black-legged kittiwake, murre, tufted puffin	215,500
-005	Black-legged kittiwake, murre	48,000
-006	Black-legged kittiwake, murre	66,200
-007	Black-legged kittiwake, murre	21,800
-008	Black-legged kittiwake, murre	15,100
-009	Black-legged kittiwake, murre	20,500
-010	Black-legged kittiwake, murre Horned puffin	702,200
-011	Glaucous-winged gull, black-legged kittiwake, murre, tufted puffin	155,800
-024	Pelagic cormorant, black-legged kittiwake, common murre	70,000
-025	Common murre	55,000
-026	Black-legged kittiwake, common murre	239,600
-027	Black-legged kittiwake, common murre	57,100
040-001	Pelagic cormorant, black-legged kittiwake, common murre Parakeet auklet, horned puffin	142,300
053-001	Aleutian tern	600
	Subtotal	1,891,100
	Important Habitat	
028-042	Glaucous-winged gull, arctic tern	14,500
029-005	Aleutian tern	?
030-008	Aleutian tern, arctic tern	200
035-013	Common murre, tufted puffin	10,700
039-013	Common murre, black-legged kittiwake	24,800
	Subtotal	50,200
	Total	1,941,300

a. Colony number as given in Sowls et al. 1978

significant numbers of other species. All of these areas are protected as state or federal refuges. Such protection should be continued with additional protection as necessary, particularly for foraging and staging areas immediately offshore major colonies which at present have no special status. Other areas that are considered of critical importance include the spit at the entrance to Goodnews Bay and Entrance Point on Port Moller Spit which support the largest known colonies of the rare Aleutian Tern.

Important habitats include other smaller colonies of Aleutian terns, Amak Island, and areas of sea cliffs on Hagemeister Island. Collectively these few "critical" and "important" areas support 95% of all nesting seabirds in the study area and 8.5% of the seabirds in Alaska.

Movement from Colonies

During the breeding season, April to September, birds are largely confined to the general area of the colonies. Foraging distances from the colony are probably less than 80 km for most species occurring in Bristol Bay and for many species, considerably less.

During fall and winter, birds disperse from colonies. Information is lacking on migration patterns of individual species, but distrubution patterns of birds in winter indicate that most birds from Bristol Bay move through Unimak Pass and other Aleutian passes to the Gulf of Alaska and the North Pacific during winter. A substantial number of birds, particularly murres, the dominant nesting species, remain in the Bering Sea in the winter and are particularly abundant near Unimak Pass, the edge of continental shelf, and the edge of the pack ice (Divoky 1979, Gould et al. 1982).

Potential Impacts from Development Activities

A number of activities may adversely affect the welfare of seabird colonies including most importantly: pollution by oil, certain types of commercial fisheries, introduction of mammalian predators on islands, and excessive disturbance of nesting birds, particularly by low-flying aircraft. None of these potential impacts has significantly affected any colony within the study area but all pose a continuing threat.

The effects of oil contamination on marine birds have been the subject of numerous reviews. Vermeer and Vermeer (1974) provided a comprehensive bibliography of literature published between 1922 and 1973 on the effects of oil on birds. A report by the National Academy of Science (1975) found that of all marine creatures, birds indisputably were most affected by oil pollution. With only low shipping traffic in Bristol Bay, major impacts from this source are unlikely unless substantial offshore development of petroleum were to occur in the vicinity of large colonies or in winter foraging areas.

Introduction of foxes to islands has caused the devastation of numerous colonies of seabirds in Alaska, particularly in the Aleutian Islands. No colonies in the study area have been affected, and the cliff habitats which dominate are relatively invulnerable.

Commercial fisheries cause significant direct and indirect losses to marine birds. Japanese driftnet fisheries currently cause losses exceeding 200,000 birds annually, including many from Alaskan colonies (DeGange 1978). The Atlantic fisheries on capelin, herring, and sand lance are believed to cause mortality and lowered reproduction by reducing food supplies. However, it is unlikely that Japanese fisheries, all conducted west of 175°, have affected or will affect colonies in Bristol Bay. Only the proposed development of capelin fisheries poses a threat.

Human disturbance of colonies is a potential threat unlikely to significantly affect most colonies in Bristol Bay, which are remote and rarely visited. For most colonies, low-flying aircraft are the most significant threat, causing panic flights of adults and loss of eggs or young. Such disturbance primarily affects murres, the dominant species in the region. Control of such disturbance would require restrictions on flights near major colonies. The most vulnerable colonies to human disturbance within the region appear to be small colonies of Aleutian terns nesting on low spits near villages. These vulnerable colonies could be afforded additional protection by providing them state or federal protection as refuges or by local educational programs.

WATERFOWL

TUNDRA (WHISTLING) SWAN

Population Size and Distribution

Winter surveys of tundra (whistling) swans (Cygnus columbianus) in the United States indicate a slow increase in the population over the last 25 years, with a high of 157,000 recorded in 1971 (Bellrose 1976). The breeding distribution of the tundra swan extends over most of the subarctic and arctic tundra from Bristol Bay north along the coast of the Bering Sea and the Arctic Ocean, east to Baffin Island and south to the northwest corner of Quebec (Bellrose 1976). Approximately 69,000 adults occur on Alaskan breeding areas (US Fish and Wildl. Serv. 1980) but this population has shown no upward trend from 1956 to 1971. The Bristol Bay region, with 11,000 breeders, is the second most important breeding area in Alaska after the Yukon-Kuskokwim Delta, which supports 40,000 breeders (Bellrose 1976). Densities of breeding swans in the Izembek Lagoon area range from 0.25 to 0.56 pairs per square mile (Sarvis 1980).

Migration

Two populations, one migratory and the other non-migratory, use the Bristol Bay region. The non-migratory population consists of 400-500 birds that winter on Urelia Bay, primarily in Peterson Lagoon, on Unimak Island. The birds move into the bay in late October (Sarvis 1980). The migratory population moves south along the coast to Vancouver Island and small bays along the Washington and Oregon coast. The birds leave Bristol Bay in mid- to late September. Birds returning in the spring first arrive on Izembek Refuge in mid-March, although most fresh water is frozen at this time. Swans congregate on rivers, which are the first water to open. The Naknek River near King Salmon supports flocks of swans numbering 1000 or more in early spring (Jim King, pers. comm.).

Nesting, Molting, and Brood Rearing

Nesting in Bristol Bay begins in the last week of April, and hatching occurs from the end of May until mid-June (Sarvis 1980). Swans use traditional ponds and lakes, often returning to the same nest site year after year. Generally, islands or peninsulas are preferred for nesting. Production is usually low (less than 30% of the broods reached flight stage in 1980) due to the severe climate and high predator population (Sarvis 1980).

Critical Habitat

Tundra swans occur throughout the Bristol Bay region as nesters, nonbreeders, and migrants. Because nesting occurs at traditional sites on lakes, it is possible to mark these lakes for protection. Lakes of sufficient size with habitat requirements of swans (islands, peninsulas, food source) should be protected for future

expansion of the population. River outlets and deltas, such as the Naknek River, should be protected for spring and fall migrants, as should the important lagoons and estuaries in the bay. The Cathedral River valley and flats have been identified as an important nesting, molting, and stopover area (John Sarvis, pers. comm.). The Urelia Bay area should be considered critical habitat for the non-migratory population in Bristol Bay.

Development Conflicts

Experience from other areas in Alaska (Ed Bailey, Jim King, pers. comm.) indicate an inverse relationship between swan production and human activity. A disturbance within the vicinity of a swan nest, regardless of the amount of habitat destruction, can diminish production and cause abandonment of the lake as a nesting site. Oil development can cause such disturbance in a variety of ways, from aircraft traffic to actual destruction of nesting habitat. To protect the large but sparsely-distributed Bristol Bay swan population and to maintain the current population level it may be necessary to restrict onshore development activities over large areas during the breeding season.

Data Gaps

Although swan populations have been surveyed for several years during the spring, there is a lack of comprehensive information on the population dynamics on the western end of Bristol Bay. Additional data on sizes of wintering and breeding populations, productivity, harvest, and distribution are needed for the Bristol Bay region. More data is needed on habitat needs swan in Bristol Bay during all stages of the swan's life cycle.

SNOW GOOSE

Population Size and Distribution

The snow geese using the Bristol Bay region belong primarily to the Wrangell Island, Siberia, breeding population. This population has declined dramatically since 1960 estimates of 400,000 birds (Uspenski in Bellrose 1976) to a low of 44,000 birds in 1976. Data from 1975 to 1979 indicate a significant recovery of the population to 84,000 birds. The decline is attributed to severe weather conditions prohibiting successful production (Bellrose 1976). Very few lesser snow geese breed in Alaska. King (1970) reported 19 broods of snow geese and 343 non-breeders on the Arctic Slope.

Migration

Snow geese use the Bristol Bay area in significant numbers on fall but not on spring migration (Bellrose 1976). From late September to early October, the Egegik and Cinder river deltas and Pilot Point support up to 15,000 snow geese at one time (Dan Timm, pers. comm.), although recent data indicate that use may be diminishing (Chris

Dau, pers. comm.). It is likely that 100,000 snow geese, or 62% of the Wrangell Island fall flight, use Bristol Bay during a 3-week period before freeze-up, which usually occurs between October 18 and 22 (Dan Timm, pers. comm.). The majority of the fall migrants follow coastal or sea routes. Those destined for California fly over water from the Alaska Peninsula before heading inland from the Columbia River. The Skagit-Fraiser segment returns north along a similar route, but most of the Wrangell Island snow geese from California swing northeastward from Tule Lake, and follow an overland route across Montana and Alberta before turning northwest toward Alaska and Siberia (Bellrose 1976). Migrating geese eat a variety of salt marsh vegetation, including leaves, seeds and tubers.

Critical Habitat

Fall-migrating snow geese probably use most of the deltas and lagoons in Bristol Bay, but survey data is lacking. Areas known to be important to snow geese include the Egegik and Cinder river deltas and the Pilot Point region. Snow geese also feed heavily on berry crops in upland areas, and use will vary depending on annual variations in the berry crop (Dan Timm, pers. comm.). Oil development activities threaten this population. Any habitat destruction in major fall staging areas could inhibit the development of important fat reserves needed for the long trip south. Disturbance by increased human activity can cause major disruption in feeding patterns of geese. The use of aircraft and other activities that cause disturbance to geese should be prohibited near staging areas.

Data Gaps

Important data gaps exist concerning the snow geese that use Bristol Bay. These include: 1) current information on all aspects of mortality throughout the flyway, 2) the distribution of Wrangell Island snow geese, 3) accurate information on the spring subsistence harvest, and 4) the ranking of important habitats used by geese during migration.

EMPEROR GOOSE

Population Size and Distrubution

Emperor geese (Anser canagicus) nest along the Bering and Chukchi coasts as far north as the Seward Peninsula in western Alaska and the Chukotsk Peninsula in the USSR, and south to the Yukon-Kuskokwim Delta. About 2000 pairs nest on St. Lawrence Island in the northern Bering Sea, a few occur on Nunivak Island west of the Yukon-Kuskokwim Delta, and a few occur from Kokechik Bay south to the south shore of Kuskokwim Bay at Carter Spit.

Emperor geese winter in bays and estuaries from Port Moller west along the Aleutian Islands to the Kamchatka Peninsula in the USSR. Up to 3000 birds may winter along the coast of Kodiak Island. Up to

20,000 subadults and failed breeders from the Yukon-Kuskokwim Delta and Soviet nesting areas migrate to St. Lawrence Island in June to molt. The number of emperor geese has been estimated from spring and fall aerial surveys conducted along the Alaska Peninsula. Counts made in the fall of 1981 revealed 63,156 emperors; however, it should be recognized that some birds probably had migrated west to the Aleutians before the surveys of the Yukon-Kuskokwim Delta and the Alaska Peninsula. The total Soviet summering population is estimated to contain 12,000-15,000 geese.

Very few emperor geese nest within the boundaries of the Bristol Bay study area. The coastal strip from Quinhagak south to Carter Bay has a few breeding birds. However, Bristol Bay lagoons and estuaries are used extensively by emperors during the post-breeding period.

Migration

Emperors leave the western Aleutian Islands in mid-March and appear at Unimak Island and Izembek Lagoon in April, where up to 40,000 may gather to feed on eelgrass. Other key spring staging areas on the north side of the peninsula include: Nelson Lagoon (used from March through early June), Seal Islands Lagoon (used in April and May), Port Heiden (used in April and May), and Cinder River Delta (used in April and May). Ugashik and Egegik bays are used by a few emperors in spring. By mid-May all emperors have migrated north, across Bristol Bay or along the coast to breeding areas on the Yukon-Kuskokwim Delta and Seward Peninsula.

In fall, adult geese arrive at Nelson Lagoon in mid-August, with hatching-year birds following one to two weeks later. Nelson Lagoon, Seal Island Lagoon, and Cinder River Delta are the most important fall staging areas on the north side of the Alaska Peninsula. Key fall staging areas on the south side of the Alaska Peninsula include Stepovak Bay, Chignik Bay and Wide Bay.

Critical Habitat

The most critical habitat for emperor geese in Bristol Bay includes Izembek Lagoon, Nelson Lagoon, Seal Islands, Port Heiden and the Cinder River Delta on the north side of the Alaska Peninsula. Some of these lagoons have eelgrass, and all have benthic invertebrates and bivalves, which are important in the diet of emperors during spring and fall migration. Threats to the status of these lagoons and the emperor geese that use them include oil spills from outer continental shelf exploration and development, increased petroleum-related air traffic, disturbances from fish processing ships, and gravel and sand removal from intertidal feeding areas.

WHITE-FRONTED GOOSE

Population Size and Distrubtion

White-fronted geese (Anser albifrons) breed circumpolarly. In Alaska birds that nest in the Yukon-Kuskokwim Delta, Bristol Bay and Cook Inlet are considered Pacific Flyway geese while those that occur to the east and on the North Slope migrate through the Central Flyway. It has been estimated that there are 250,000 white-fronted geese in Alaska after the breeding season. Band recoveries suggest that 95% of the white-fronts composing the early fall populations in the Pacific Flyway nest on the Yukon-Kuskokwim Delta in western Alaska. By comparison, only 10% of the white-fronts banded in the Innoko-Iditrod breeding ground have been recovered in the Pacific Flyway. The population objective for white-fronts of the Pacific Flyway is to build and then maintain a population, based on a 3-year moving average, of 300,000-350,000 geese.

Based on spring aerial surveys, it is estimated that about 4000 white-fronted geese breed in the Bristol Bay lowlands. Key areas in the study area include: 1) the Nushagak River Delta where white-fronts stage prior to breeding and during fall migration; and 2) the Naknek River Delta, Egegik Bay, Cinder River Delta and Ugashik tidelands, where up to 25,000 white-fronts gather during spring migration.

Critical Habitat

The most critical habitat for white-fronted geese in the Bristol Bay study area are the estuaries, lagoons and river deltas on the north side of the Alaska Peninsula, and eastern Bristol Bay from the Cinder River Delta to the Nushagak River Delta. The most significant potential threat to these areas is offshore oil and gas development and associated activities such as increased air, vehicular and vessel traffic, and pipeline and terminal construction.

CACKLING CANADA GOOSE

Population Size and Distribution

The cackling Canada goose (Branta canadensis minima) is the smallest of the currently recognized races of Canada geese. Nearly the entire population nests in a large loose colony on the coast of the Yukon Delta, although there are a few isolated nest records from as far north as Wainwright in northwestern Alaska.

Cacklers spend the early winter in Oregon and move later to northern and central California. They are an important species to hunters in these states.

Population estimates from winter inventories in 1972-1978 indicate some 71,000 birds. This figure represents a 50% decline from the 1965-1971 mean. Both figures are far below the Pacific Flyway

Council population target of 400,000-450,000 cacklers. Hunting throughout the range is thought to be the critical limiting factor.

Migration

Use of the Bristol Bay region by cacklers is limited to migration periods. A few thousand may use the uplands during spring migration, especially in years when the snow cover of the Yukon Delta lingers into the migration period, as the spring thaw is always earlier in Bristol Bay. Spring observations are clouded by the presence of larger Canada geese in the area. Fall distribution throughout Bristol Bay is better understood, through bag checks of sport hunters. Major portions, perhaps all, of the cacklers use the estuaries at Nanvak and Osviak on the north side of Bristol Bay, and Ugashik Bay, Cinder River, Port Heiden, Izembek and other estuaries on the Alaska Peninsula side for fall staging. The most important staging area is Ugashik Bay. Geese move into the region in August or September and leave in October. The Bristol Bay habitat is ice-free approximately one month earlier and stays open one month later than the nesting habitat immediately north on the Yukon Delta. This phenomenon may be particularly important in the one or two years of each decade when the summer on the nesting grounds is compressed by a late thaw and an early freeze, by providing the birds with an alternative food source.

The Cook Inlet marshes appear to be a more important staging area for cacklers than Bristol Bay. However, the population is at a low level. If the target level of a six-fold increase is approached or achieved, Bristol Bay could assume a far greater value for cacklers.

Data Gaps

The subject of pre- and post-nesting staging areas for geese is poorly understood. The phenomenon is frequently observed, but the basic biological parameters it fulfills are unknown. Staging by cackling geese in Alaska is further complicated by the fact that they often mix with other races of Canada geese and are not easily separated by ground or aerial observers. Much additional study of cackler movements is needed.

Upland areas as well as estuarine marshes in Bristol Bay are used by cacklers, but information is too scanty to determine if land acquistion is needed to protect specific habitat.

Development Conflicts

Two conservation measures in Bristol Bay that would benefit cackling geese are protection of estuarine habitat and reduction of hunting pressure. It follows then that development within this habitat and improved access for people would adversely affect the present cackler population.

OTHER CANADA GEESE

Population Size and Distrubtion

The lesser Canada goose (Branta canadensis parvipes) and Taverner's Canada goose (B. c. taverneri) are subspecies collectively called lesser Canada geese. It is believed that the breeding ranges of the two subspecies encompass tundra areas of Alaska and western Canada for taverneri and interior forested areas for parvipes, with an unknown degree of intergradation between ranges. They apparently follow the major fall migration routes (coastal, interior and trans-oceanic) and two spring routes (coastal and interior) to wintering areas in British Columbia, Washington, Oregon, and California.

The number of wintering lesser Canada geese, based on mid-winter surveys in Washington and Oregon, is probably between 28,700 and 41,600. During winter surveys they intermingle with other Canada geese and the population is difficult to estimate. Breeding population estimates are determined annually for parts of the breeding range in Alaska. The 1982 estimate of 3766 for the Bristol Bay strata is undoubtedly low.

Bristol Bay provides limited breeding habitat for taverneri. Lesser Canadas use Bristol Bay coastal lagoons prior to a trans-oceanic fall migration to the mouth of the Columbia River. Key fall staging areas include Nanvak Bay, Ugashik Bay, Pilot Point, Cinder River Lagoon, Port Heiden, and Izembek Lagoon (including Morzhovoi Bay and lagoons; Kenzaroff, Nurse and Mortenson lagoons). Over 22,000 Canada geese used the Izembek Lagoon complex in late September and early October 1980. The geese feed primarily on crowberries and vegetation in the uplands, as well as on eelgrass in the marine systems.

Migration

Canada geese begin arriving on their fall staging area near Cold Bay, Alaska in late August to early September (7-year average arrival date is August 29). Typically, their numbers build slowly during September and new arrivals increase considerably in early October. During mid- to late October numbers peak. Their departure to the southeast usually occurs from late October to early November (3-year average departure date is 2 November) during daylight hours. Weather conditions for the Canada goose departure are similar to those for the black brant departure: strong northwesternly winds on the backside of an extensive low-pressure system. Unlike brant, Canada geese leave daily over several days to a two-week period, whenever favorable tailwinds occur. Occasionally the majority leaves in one day. Canada geese have been recorded only sporadically in the Cold Bay area in spring and summer (4 records: 1 in May, 1 in June, 2 in July). Nesting has not been documented anywhere on the Alaska Peninsula.

Critical Habitat

The most critical habitat for lesser Canada geese in the Bristol Bay study area is probably the Izembek Lagoon complex and adjacent uplands. This lagoon system is within Izembek and Alaska Peninsula National Wildlife Refuges. The most significant threat to the geese is outer continental shelf oil and gas development that could result in spills, blowouts and disturbance from increased air and vessel traffic.

BRANT

Population Size and Distribution

Pacific black brant (Branta bernicla nigricans) breed from the delta of the Lena River in Siberia, east along the coast of the Beaufort Sea in Alaska to the Queen Maud Gulf in the Canadian Arctic, and south along the Chukchi Sea and Bering Sea coasts in western Alaska. The largest breeding ground of the black brant is on the outer Yukon-Kuskokwim Delta, where up to 50% of all brant in the Pacific Flyway are produced.

Black brant numbers are determined by mid-winter aerial counts made in Washington, Oregon, California, Baja and mainland Mexico. Three-year average counts have ranged from 109,055 (1957-1959) to 171,325 (1964-1966). Population estimates of black brant in late summer in the Canadian Arctic are: Mackenzie Delta, 200; Liverpool Bay, 3000; Banks Island, over 9000; southeast Victoria Island and Prince Albert Peninsula, 3000; and the Queen Maud Gulf Coast, 3000. About 1000-2000 pairs nest on Wrangel Island off the coast of Siberia. It is estimated that up to 75,000 brant breed on the Yukon-Kuskokwim Delta, and about 17,000 nest on the North Slope of Alaska.

Migration

The Bristol Bay region does not include breeding habitat, but is especially important to brant during spring and fall migration. Virtually the entire world population stages at Izembek and adjacent lagoons near the tip of the Alaska Peninsula from September through early November. A smaller number uses Izembek and adjacent bays and lagoons in spring.

Black brant migrate north along the Pacific coast from wintering areas in Mexico, California, Oregon, Washington, and British Columbia and arrive at Izembek Lagoon and adjacent estuaries in late April and early May. Up to 25,000 stage in Izembek Lagoon for 3-6 weeks before migrating to breeding areas to the north. In fall, the first migrants arrive at Izembek Lagoon around 25 August, until nearly the entire population is in the area by mid-September. Departure from Izembek lagoon usually occurs in late October or early November. Although most brant winter in coastal estuaries in mainland and Baja Mexico, up to 5,000 winter at Izembek Lagoon and Cold Bay in some years.

Distribution of black brant in the Bristol Bay region before and after the breeding season is related to the distribution of eelgrass, the most important marine food for the species. Eelgrass is high in organic nutrients which are important in building energy reserves for the 1800- to 3000-mile flight from Izembek across the Gulf of Alaska to wintering areas from Puget Sound to Mexico. Izembek Lagoon has the most extensive eelgrass bed in the Bristol Bay region. Other Bristol Bay estuaries used by brant include Ugashik Bay, Port Heiden, Seal Islands, Nelson Lagoon, Nanvak Bay and Hagemeister Strait. Brant have been recorded in many bays and estuaries in the spring on the south side of the Alaska Peninsula, including Wide Bay, Aniakchak Bay, Chignik Bay, Ivanof Bay, Mitrofania Bay and Kinzarof Lagoon.

Critical Habitat

The most critical habitat for Pacific brant within their entire range is the 93,500-acre Izembek Lagoon and the adjacent Moffet Lagoon and Applegate Cove. The major potential threats to the Izembek complex include outer continental shelf petroleum exploration and development that could result in spills, blow-outs, and increased air traffic over the lagoon. The boundary of the proposed St. George Basin lease site is within 35 miles of Izembek Lagoon.

DABBLING DUCKS

Population Size and Distribution

In the Bristol Bay region, dabbling ducks are composed primarily of northern pintails (Anas acuta acuta) 44%; mallards (A. platyrhynchos platyrhynchos) 15%; American wigeon (A. americana) 20%; American green-winged teal (A. crecca carolinensis) 10%; and northern shovelers (A. clypeata) 2% (Conant and King 1982). Other dabbling duck species use the area in smaller numbers. The species composition for the Alaskan population can change dramatically depending on annual harvest and production and drought conditions in the prairie provinces (Bellrose 1976). For example, mallard, American wigeon, green-winged teal, pintail and northern shoveler populations all decreased by 45-74% in Alaska between 1981 and 1982 (Conant and King 1982).

The breeding population index for dabbling ducks in Bristol Bay is 108,100 (less than half that of diving ducks) and represents nearly 5% of the Alaskan dabbling duck breeding population and 2.2% of the total Alaskan breeding duck population (Conant and King 1982). The dabbling duck species found in Bristol Bay average 10.9 ducks/square mile over 9,900 square miles of habitat (Conant and King 1982).

Migration

Although dabbling ducks from Alaska use all of the major flyways on their journey south, the majority use the Pacific Flyway. For example, about 85% of Alaska's pintail and green-winged teal populations migrate to the north Pacific coast and California (Bellrose 1976).

Timing of migration varies with species and annual variations in weather conditions. Pintails are generally the earliest species to arrive (late April in Bristol Bay) and the first to leave (mid-August to mid-September), although individuals remain as late as November (Bellrose 1976). Most of the dabbling ducks arrive in Bristol Bay by mid-May, and most depart by late September or early October.

Nesting, Molting and Brood Rearing

Dabbling ducks generally require lowland ponded areas for nesting. Such habitat is scattered throughout the Bristol Bay region. Bristol Bay accounted for 12.5% of the total breeding habitat and pond numbers surveyed in the 1982 Alaska spring waterfowl breeding pair survey (Conant and King 1982).

The timing of nest initiation depends on local temperatures, water conditions and variations among species. Incomplete clutches have been found on 25 May and new nests as late as 10 July on the Yukon Delta (Bellrose 1976). Yukon Delta chronology is approximately one week behind that of Bristol Bay (Cal Lensink, pers. comm.). Hatching generally coincides with the longest days of the year and peak production of aquatic invertebrates in late June. Aquatic invertebrates are the major staple in the diet of young ducks and an adequate supply is critical for their successful development.

Male dabbling ducks begin flocking by mid-June and are flightless by late June or early July. Flight feathers are generally regained by 1 August (Bellrose 1976). The wing molt of females is delayed to coincide with the development of the young. Concentrations of molting ducks are found in freshwater habitat, such as upriver portions of the Kvichak River, and estuarine areas such as Ugashik, Nushagak and Chagvan bays.

Critical Habitat

The lowland ponded areas scattered throughout the Bristol Bay region are requisite nesting habitat for dabbling ducks. Those associated with river deltas and estuaries, such as Ugashik Bay, are critically important because the birds are highly vulnerable in concentrated areas. Molting sites are usually traditional areas, returned to annually. Destruction of such areas could have severe impacts.

Fall and spring migration staging areas are scattered throughout Bristol Bay. Generally they are associated with productive

estuaries, river deltas, lagoons and tidal flats where a variety of vegetation is present. Izembek Lagoon has supported 75,000 pintails in September (Bellrose 1976). Other important fall and spring stopover areas include the Kvichak River and Naknek, Chagvan, Nushagak and Kvichak bays.

Development Conflicts

Increased activities related to oil development will affect dabbling ducks through disturbances on nesting, staging and molting areas, as well as through the destruction of habitat. Dabbling species are most vulnerable during periods of concentration, such as the molt and spring and fall migration. Habitat used during these activities is particularly vulnerable to damage from oil development. The negative effects of oil spills on invertebrate populations in ponds has also been well documented (Mozley and Butler 1978).

Data Gaps

Data is insufficient on a variety of issues concerning dabbling ducks in Bristol Bay. We lack an understanding of the importance of various habitats for migration and molting by dabbling ducks. These areas should be identified and ranked. Food habits and requirements of dabbling ducks have not been adequately studied in the Bristol Bay region. The effects of disturbances related to oil production on the various life stages of dabbling ducks are not fully known.

DIVING DUCKS

Population Size and Distribution

Several species, including some of the sea ducks, comprise the diving duck group that uses Bristol Bay. The greater scaup (Aythya marila) has been the most numerous species on spring breeding pair surveys conducted by the USFWS. The 1982 Bristol Bay diving duck population index was 267,000, of which greater scaup comprised 35%; oldsquaws (Clangula hyemalis) 22%; combined surf scoter (Melanitta perspicillata), white-winged scoter (M. fusca deglandi), and black scoter (M. nigra americana) 41%; combined Barrow's goldeneye (Bucephala islandica) and common goldeneye (B. clangula americana) 2%; and combined red-breasted merganser (Mergus serrator) and common merganser (M. merganser americanus) 1% (Conant and King 1982). The adjusted breeding diving duck population estimate for Alaska is 1,483,700, of which the Bristol Bay diving ducks comprise about 18% (Conant and King 1982).

The diving duck group is distributed throughout the Bristol Bay lowlands. Approximately 9,200 square miles of breeding habitat produce a fall flight of 572,000 ducks (King and Lensink 1971). Fall duck numbers on Bristol Bay estuaries exceed one million birds, the majority of which are divers (King and Lensink 1971).

intertidal areas which provide the bulk of food organisms could be destroyed with an extensive spill. The disturbance caused by oil production activities would also negatively impact ducks.

More information is needed on habitat and food requirements for diving ducks during all stages of their life cycle. Sufficient data is not available to properly rank habitats needed by these species.

EIDERS

Population Size And Distribution

The Steller's eider (Polysticta stelleri), Pacific common eider (Somateria mollissima vinigra), and king eider (S. spectablis) nest in northern latitudes in the Siberian arctic and in the North American arctic and subarctic. The majority of the population of Steller's eiders nests in the eastern Palearctic from the Chukchi Peninsula to the Lena Delta and Anaber tundra; some nest on the arctic coast of Alaska. The majority of the world's population of Steller's eiders winters along the north and south sides of the Alaska Peninsula. Pacific common eiders nest on both sides of the north Pacific: in the Aleutians, in Siberia, and in coastal Alaska to Coronation Gulf in northern Canada. The king eider is a circumpolar nester, from high arctic regions to the subarctic. Birds nest most abundantly in the Canadian arctic from Boothia Peninsula to Banks Island, Victoria Island, and other islands nearby. Vast numbers of king eiders winter in open water from Adak Island eastward, primarily in deep bays along the south side of the Alaska Peninsula.

Because of the difficulities in censusing eiders in the remote, inhospitable habitats they generally frequent, population estimates for all species are few. Recent estimates suggest that there are about 200,000 Steller's eiders, 105,000 Pacific common eiders, and 1-1.5 million king eiders in North America (Bellrose 1976). During some portions of the year, most of these eiders are in Bristol Bay or along the south side of the Alaska Peninsula. The Bristol Bay region has a resident breeding population of Pacific common eiders, and provides important spring and fall staging, molting, and wintering areas for all species.

Nesting, Molting, and Brood Rearing

Subadult Steller's eiders begin arriving at Nelson Lagoon, Port Heiden, Seal Islands Lagoon, and Izembek Lagoon in June, and adults begin arriving in August for the wing molt. Over 60,000 birds have been reported in Nelson Lagoon, and tens of thousands of birds in the other lagoons during the molting period from mid-July to early November. After completing the molt and if ice conditions are favorable, birds move to their wintering areas on the south side of the peninsula. Steller's eiders again congregate in large numbers in lagoons on the north side of the peninsula from April to early May before migrating to nesting areas.

Pacific common eiders frequent Bristol Bay year-round. Birds nest on fox- and bear-free barrier islands near the major lagoons on the north side of the peninsula, and on islands throughout the south side of the peninsula. Observations of eiders marked on their nests at Nelson Lagoon suggest that local populations also winter in nearby lagoons. The timing of arrival, length of stay, and timing of departure of Pacific common eiders that do not nest in Bristol Bay is less understood, but probably is related to ice conditions and other weather factors influencing the distribution and availability of their food.

Similarly, the distribution, timing of movement, and habitat preferences of king eiders in the Bristol Bay region is unknown. Apparently the timing of their migration to the wintering area in fall and early winter is influenced by ice conditions, with many birds moving ahead of the ice pack as it advances in winter. King eiders remain in the Bristol Bay region until April and early May, when they migrate to more northerly nesting areas.

Critical Habitat

The distribution of all species of eiders in the Bristol Bay region is related to the distribution of food, primarily mollusks, crustaceans and echinoderms. Key lagoons for Steller's eiders molting or preparing to migrate to the nesting areas include Izembek Lagoon, Nelson Lagoon, Seal Islands Lagoon, and Port Heiden. Although more sporadic in their occurrence in lagoons, hundreds of thousands of king and common eiders can be found in lagoons before spring migration. Bristol Bay has a shallow shelf, and is used extensively for feeding by king and common eiders throughout the fall, winter, and spring. Bays and estuaries along the south side of the Alaska Peninsula are also used extensively by Steller's, king, and common eiders.

Data Gaps

Few eider studies have been done in the Bristol Bay region, and all have been restricted to Steller's eiders at Nelson and Izembek lagoons. Seasonal distribution and abundance, characteristics of preferred habitat, molt, and breeding biology of all species of eiders in the Bristol Bay region, as well as throughout Alaska, is poorly studied. This information is needed to accurately describe the importance of areas within the region to the majority (over 90%) of the world's population of Steller's and Pacific common eiders, and to the western North American and eastern Siberian population of king eiders.

Development Conflicts

Perhaps the most critical and vulnerable habitats necessary to Steller's eiders are the intertidal areas of Port Heiden, Seal Islands Lagoon, Nelson Lagoon, and Izembek Lagoon. These lagoons provide the only known molting areas for the majority of Steller's

eiders. In the flightless stage, eiders are extremely vulnerable to petroleum spills, as are the intertidal invertebrates they depend upon for food. In addition, congregations of eiders in areas away from the coast (not yet adequately documented), within Bristol Bay and along the Alaska Peninsula coast may be vulnerable to spills, blow-outs, and increased air traffic associated with petroleum exploration and development.

located for any species of loons. Their distribution seems to be relatively even throughout the coastal areas.

Critical Habitat

The most critical habitat for these species is essentially the entire coastal portion of Bristol Bay, and lakes and ponds found within the region. The most obvious potential threats are the losses of large blocks of nearshore food resources for staging and molting loons, and their extreme susceptibility during the breeding season to human disturbance (aircraft traffic over breeding areas, presence of humans on the ground).

LESSER SANDHILL CRANE

Population Size and Distribution

The lesser sandhill crane (Grus canadensis canadensis) is the smallest race of the species. It nests throughout north-central and northwestern Canada, Alaska, and into the extreme northeastern portion of the USSR (Bellrose 1976). From 1957 to 1980 the Alaskan breeding population ranged from 64,000 to 232,000 with an average of 121,700. The race winters in both the Pacific and Central Flyways. A major portion of the sandhill cranes from Alaska winter in the Central Flyway; however, those breeding in Bristol Bay and the upper Cook Inlet winter in the Pacific Flyway (Conant et al. 1981). The Bristol Bay and Cook Inlet cranes comprise 8.3% and 0.3% respectively of the crane population surveyed in Alaska (Kramer et al. 1981). The 1982 breeding population index for Bristol Bay was 4,200, down from a high of 5,200 in 1979, but 50% above the 15-year average of 2,800 (Conant and King 1982). The current size of the wintering population of Pacific Flyway lesser sandhill cranes is estimated at 20,000-25,000 (Kramer et al. 1981). Since 1957, the sandhill crane has been routinely recorded along with waterfowl on spring breeding pair surveys conducted by the USFWS.

Migration

In March, cranes leave the Central Valley of California and begin their migration north. Cranes have been reported stopping near the Stikine River delta and Gustavus on their way to a major spring staging area at the Copper River delta. From there, they spread out across the Kenai Peninsula and upper Cook Inlet before moving to Bristol Bay and other breeding areas. Cranes generally arrive early in the breeding areas, often before the snow melts. Arrivals in the Bristol Bay region probably peak in late April to mid-May, depending on spring weather conditions (Cal Lensink, pers. comm.). Cranes begin staging in Bristol Bay in late August and move south by mid-September, but migration routes are not clearly understood. Important staging areas in Bristol Bay are found in north Ugashik Bay. Cook Inlet tidal flats are also important stopover points.

Nesting and Brood Rearing

Boise (1977) reported that nest initiation for cranes on the Yukon-Kuskokwim delta began in mid-May but the majority of nests were initiated later in May. Nesting in the Bristol Bay region is probably one week ahead of the Yukon-Kuskokwim Delta (Cal Lensink, pers. comm.). Clutches contain either one or two eggs. Nests are generally located on wet marsh sites in mosaic habitat or in sedge/grass meadows. Hatching occurs from mid-June through the first of July in the Yukon-Kuskokwim Delta (Boise 1977) and could be slightly advanced in Bristol Bay, with annual variations depending on weather. Cranes remain in the vicinity of their nesting territory until the chicks fledge in August. Production of cranes, even in good years, is low; the proportion of juveniles in the fall population ranges from 9 to 14% (Boise 1977). Food habits of cranes have not been thoroughly studied but incidental observations indicate they use a variety of food sources from green vegetation and berries to mice and fish (Boise 1977). There may be some movement from lower, wet areas in June and July to drier areas with berry crops in August (Boise 1977).

Critical Habitat

The dispersed nature of the nesting population of cranes in Bristol Bay makes it difficult to identify critical nesting areas. The birds use a varity of habitats in coastal lowlands and uplands. Widespread disturbance during the breeding season in the Bristol Bay region could have severe impacts on the Pacific Flyway population. Although cranes are determined defenders of their nests and territories, continuous activity in the nest vicinity often causes abandonment (Boise 1977). River deltas and associated tidal flats, such as those identified near Ugashik Bay, are important staging areas for cranes during migration, but complete data are lacking on crane use of the Bristol Bay region.

Data Gaps

Most northern migration routes and stopover points to and from California are unknown or have only been cursorily identified. Estimates of population size and production are not sufficiently accurate for management needs. The magnitude and consequences of subsistence harvest are unknown. A major need is to identify, classify and rank habitats used by the Pacific Flyway cranes to facilitate protection of these areas.

SHOREBIRDS

Introduction

Worldwide there are 165 extant species of shorebirds (Johnsgard 1981). Sixty-eight of these are known for Alaska (Kessel and Gibson 1978); approximately half occur regularly in the Bristol Bay region (Table 1). Twenty species are known to nest regularly in the region, but for only eight species (Greater Yellowlegs, Northern Phalarope, Common Snipe, Short-billed Dowitcher, Western, Least, and Rock Sandpipers, and Dunlin) does the region host a significant portion of the Alaska breeding population. The importance of the region to shorebirds is primarily that of a fall staging area for both local breeding populations and significantly greater numbers of shorebirds that breed north of Bristol Bay.

Chronology of movement

In spring, migrant shorebirds move rapidly into and through the Bristol Bay region to surrounding nesting areas and those further north. Migration is usually quite direct and only moderate numbers of birds stop along intertidal areas to augment body reserves before breeding. Although spring migration spans from early April through late June, most migrants move through the area between late April and mid-May (Table 2). Shorebirds remain on nesting areas within the region from early May until late July, when young fledge and become independent. Movements of post-breeding shorebirds begin in early June and continue through mid-October. Failed breeders are the first to leave nesting areas, followed by successful adults and finally by juveniles. Members of most species move to coastal areas before migrating to wintering areas, but the duration of stay along the coast varies with each species. Those that molt before migrating (Dunlin, Rock Sandpipers) remain the longest (Table 2).

Because of the harshness of Alaska winters, very few species of shorebirds remain year-round. In the Bristol Bay region, only three species winter regularly, the most numerous of which is the Rock Sandpiper (Table 2).

Seasonal and geographic abundance and habitat use

The coast of the Bristol Bay study area can be subdivided into four distinctly different segments: east Kuskokwim Bay, from Quinhagak to Cape Newenham; north Bristol Bay, from Cape Newenham to Naknek; the north side of the Alaska Peninsula; and the south side of the Alaska Peninsula. Different habitats predominate along each segment, and shorebird use varies accordingly. Similarly, the inland areas adjacent to these coastal segments also host different assemblages of shorebirds because of differences in habitats and geophysical barriers to nesting distribution. A fifth geographic subunit used by a few shorebird species is the marine waters of Bristol Bay itself. The importance to shorebirds of these geographic subunits and their habitats is directly related to seasonal aspects of the birds' annual cycle.

Spring. - In spring, comparatively little use is made of the extensive intertidal of Bristol Bay, except by a few species that mainly nest north of the region (principally American Golden Plover, Black-bellied Plover, Bar-tailed Godwit; Table 3). These species replenish energy reserves expended on the often extensive migrations from their wintering grounds. Lagoons and estuaries are also used briefly in spring by large numbers of Rock Sandpipers and lesser numbers of Greater Yellowlegs, Dunlin, and a few other species (Table 2). Marine waters of the Bristol Bay region are used by both Northern and Red Phalaropes in spring.

Nesting. - Most shorebirds move directly to habitats available for nesting: sand beaches and dunes; rocky shorelines; wet meadows in lowland and upland areas; wet bogs in forests; streamsides and lakeshores; and dwarf shrub tundra in the uplands (Table 3). All of these habitats are used but densities and the diversity of species are generally highest in the lowland meadows and decrease as elevation increases. Densities of nesting shorebirds are moderate compared with high densities found in other regions of the state, such as the Yukon-Kuskokwim Delta and the Arctic Coastal Plain, but the Bristol Bay region does provide major nesting grounds for several species, including the Short-billed Dowitcher and Greater Yellowlegs (Table 1).

Shorelines provide nesting habitat for small numbers of shorebirds: Semipalmated Plovers nest on exposed sand beaches and dunes and Black Oystercatchers inhabit rocky shorelines, predominantly along the south side of the Alaska Peninsula (Table 3). Our knowledge of use of inland areas of the Bristol Bay region for nesting is extremely limited. It is based on few records and a lot of inferences drawn from knowledge of Bristol Bay habitats and shorebird use of similar habitats in other areas of the state. The low inland areas of north Bristol Bay are distinct from those on the Alaska Peninsula, in that many of the northern wetlands consist of wet, upland bogs interspersed with patches of spruce or mixed forests; these are important nesting areas for Common Snipe, Least Sandpipers, and both yellowlegs. Along the Alaska Peninsula such habitat is largely absent, and the large expanses of wet meadows and dwarf shrub meadows along the gentle northern slope of the Aleutian Range provide the most southern breeding area for Dunlin and Western Sandpipers. Species such as Northern Phalaropes nest ubiquitously throughout wet meadows of the

region. What species may nest in the steep coves and valleys of the south side of the Peninsula is unknown. Similarly, little is known about the importance of the more mountainous areas of the region to nesting shorebirds. Rock Sandpipers and possibly Surfbirds nest in low densities in such areas throughout the region, but other upland-nesting species, such as Bar-tailed Godwits, Wandering Tattlers, and American Golden and Black-bellied Plovers, probably reach the southern limit of their breeding range in the Kilbuck Mountains in the northern sector of the study area.

Post-breeding. - Bristol Bay hosts spectacular concentrations of shorebirds in fall, particularly within the extensive lagoon systems along the north Alaska Peninsula (Gill and Jorgensen 1979, Gill and Handel 1981). The extensive mud, sand, and mixed-sediment intertidal flats of the numerous lagoons and estuaries support larger numbers and a greater diversity of species of shorebirds than do all other habitats. Among the estuaries most heavily used are Carter, Goodnews, and Chagvan bays along east Kuskokwim Bay; Nanvak Bay and the intertidal flats of the Nushagak and Kvichak rivers in north Bristol Bay; and Egegik and Ugashik bays, Cinder River, Nelson, and Izembek lagoons, and Port Heiden and the Seal Islands along the north Alaska Peninsula. The estuaries in east Kuskokwim Bay interrupt large stretches of sand beaches and provide important stopovers for shorebirds moving from more northern nesting grounds. Although northern Bristol Bay is almost entirely characterized by expansive intertidal mud and sand flats, these appear to be comparatively poor in food resources, and shorebird densities appear to be much lower than those occurring in lagoons and estuaries of the north Alaska Peninsula. Shorebird densities peak in Nelson Lagoon (Gill and Jorgensen 1979).

Between July and October these habitats support a majority of the shorebirds that breed in the region (Table 4). It is then that both adults and juveniles of several species move to the estuaries to undergo molt and build lipid reserves to carry them through fall migration. Indeed, the benthic fauna of the estuaries of the region is sufficiently rich that major populations of species nesting north of the region move to Bristol Bay, where they too molt and put on fat for migration (Gill et al. 1981, Gill and Handel 1981). Fat reserves accumulated on these staging areas are critical for some species, particularly Dunlin and Bar-tailed Godwits, which immediately embark on non-stop, transoceanic migrations to wintering areas.

The south side of the Alaska Peninsula is quite different in character from the other coastal segments, but its use by shorebirds is still relatively unexplored. Because of the large amount of rocky intertidal, densities of shorebirds are lower and different species predominate (Table 4). In fall this geographic area is probably important for Black Oystercatchers, Rock Sandpipers, Surfbirds, and Black Turnstones, species that characteristically inhabit rocky intertidal outside the breeding season. The numerous small areas of intertidal flats scattered along the south Alaska Peninsula also support shorebirds, but the relative importance of these areas to overall shorebird populations in the region needs further evaluation.

Wet meadows and upland dwarf shrub tundra immediately adjacent to the coast are also important to shorebirds staging in the region before fall migration. These habitats are used both by species that feed on lagoon intertidal but fly inland to roost at high tide (e. g., Bar-tailed Godwits and Whimbrels), and by others that rarely frequent mudflats but

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instead remain on coastal wet meadows until they depart (e. g., Least Sandpipers and Greater Yellowlegs). Sand spits and barrier islands also provide important roosting sites (Table 4).

Marine waters of Bristol Bay are used by both species of phalarope during fall migration, but Northern Phalaropes outnumber Red Phalaropes by about 2:1 (Gould et al., in press). Although greater concentrations of phalaropes can be found in such areas as Unimak Pass and the eastern Aleutians, Bristol Bay is extremely important to both species, hosting at least several tens of thousands of birds (Table 2). What environmental elements are important to the phalaropes during these periods is not yet known. We also know very little about how much variation occurs in the numbers and timing of birds using offshore waters of the bay.

Winter. - Habitat use by shorebirds during winter is confined to those sandy and rocky beaches along the north and south sides of the Alaska Peninsula that remain free of ice. During this time shorebirds reach their low in numbers and diversity (Tables 2, 5), although the habitat may be critical for those populations that do remain, particularly Rock Sandpipers (Table 1).

Data gaps

To better understand the importance of the Bristol Bay area to its seasonally resident and migrant shorebirds, basic information on the numbers of shorebirds that occur and the periods during which they are present should be obtained for two major geographic areas: (1) upper Bristol Bay, particularly the intertidal flats from the Nushagak Peninsula east to Naknek, and (2) all intertidal habitats along the south Alaska Peninsula. However, probably the most conspicuous data gap that exists throughout the Bristol Bay region is the lack of information on nesting

shorebirds and their habitat requirements. As a beginning, the importance to nesting shorebirds of Bristol Bay habitats should be sampled from (1) wet meadows and bogs of north Bristol Bay and east Kuskokwim Bay south and east to the vicinity of King Salmon, (2) wet and dwarf shrub meadows of all major drainages along the north Alaska Peninsula, and (3) montane areas throughout the region.

Once the basics of distribution and abundance of shorebirds throughout the region are understood, we can then begin to address the more complex questions that must be answered before we can really predict what impacts might occur with various types of development. Do individual shorebirds rely on only specific lagoons during fall migration or do they hop from one to another along the Alaska Peninsula? What do the shorebirds eat during various stages of their annual cycle and can they readily switch to another food resource if their major prey is decimated? How site-specific are nesting shorebirds; can they readily move to other areas if habitats are altered? How does human disturbance affect molting shorebirds?

Threats to shorebirds in the Bristol Bay region

Shorebird habitats in the Bristol Bay region are at risk from two principal sources: accidental oil spills and physical disturbance. The latter, if it does not entail long-term disruption or elimination of major segments of habitat, can generally be planned to keep environmental risk to a minimum. However, the former risk, oil spills, poses by far the greatest potential threat to shorebirds and their habitats. Chronic, long-term contamination of littoral zone benthic fauna from both at-sea and onshore spills has been documented in several instances (in Hood

and Calder 1981). The benthic bivalves Mytilis and Macoma, major foods of several species of shorebirds and waterfowl in the Bristol Bay region, have been shown to concentrate hydrocarbons in unusually high levels. Ingestion of these contaminated foods by shorebirds could, as has been shown for other bird species, affect rates of egg laying and reduce the rate of fertilization of eggs (Grau et al. 1977, Holmes et al. 1978, Stickel and Dietz 1979). To date, shorebirds in general have not demonstrated as high a susceptibility to direct oil contamination as have other water birds (i. e., seabirds and certain pelagic waterfowl). However, even small amounts of oil which might be transferred from feathers to eggs during incubation could result in mortality of the embryos (cf. Albers 1976, Szaro and Albers 1976, Patten and Patten 1977, Stickel and Dieter 1979).

Critical shorebird lands

Most species of shorebirds are resident in Alaska for three to four months. Roughly half of this time is devoted to duties on the breeding grounds and half to such activities as molt and the replenishment of energy reserves following nesting. For most species these latter events are dependent upon the rich benthos of the intertidal habitats of Alaska, particularly in Bristol Bay, and there, particularly in the lagoons and estuaries along the north Alaska Peninsula. Often entire populations depend upon a particular lagoon and in some cases restrict their use to specific areas within a lagoon. If shorebird populations within the region are to prove vulnerable to human-caused and -regulated activities, it will most certainly be when they congregate on estuaries and adjacent areas. For these reasons (plus those that would apply to any other

resource group dependent on estuaries, e. g. waterfowl and anadromous fisheries) it must be assumed that all estuarine habitat and associated spits and barrier islands within the Bristol Bay area are important and should be given protection, preferably through designation as State Critical Habitat or State or Federal Wildlife Refuges.

Table 1. Relative seasonal importance of the Bristol Bay Region to Alaska populations of shorebirds. L = low, M = medium, H = high, and dash = no importance compared with other regions of the state.

Species	Spring	Fall	Nesting	Wintering
Black Oystercatcher	L	L	L	L
Semipalmated Plover	L	L	L	-
American Golden Plover	L	L	L	-
Black-bellied Plover	L	L	L	-
Hudsonian Godwit	-	L	-	-
Bar-tailed Godwit	L	H	L	-
Marbled Godwit	-	-	?	-
Whimbrel	-	M	-	-
Bristle-thighed Curlew	-	L	-	-
Greater Yellowlegs	L	M	M	-
Lesser Yellowlegs	L	L	L	-
Solitary Sandpiper	L	L	L	-
Spotted Sandpiper	L	L	L	-
Wandering Tattler	L	L	L	-
Ruddy Turnstone	L	M	-	-
Black Turnstone	L	L	L	-
Northern Phalarope	L	M	M	-
Red Phalarope	L	M	L	-
Common Snipe	L	M	M	-
Short-billed Dowitcher	L	H	H	-
Long-billed Dowitcher	L	L	-	-
Surfbird	-	L	L	?
Red Knot	-	L	-	-
Sanderling	L	M	-	L
Semipalmated Sandpiper	-	L	-	-
Western Sandpiper	L	M	M	-
Least Sandpiper	L	L	M	-
Pectoral Sandpiper	L	L	L	-
Sharp-tailed Sandpiper	-	L	-	-
Rock Sandpiper	H	H	H	H
Dunlin	L	H	M	-

Table 2. Migration periods[1] and seasonal abundance[2] of shorebirds occurring regularly in the Bristol Bay region (data from Gill and Handel 1981 with modifications).

Species	Spring Migration		Fall Migration		Nesting	Winter
	Dates	Abundance	Dates	Abundance		
Black Oystercatcher	Resident		Resident		L	L
Semipalmated Plover	1Apr-eMay	f100's	eJul-mSep	s100's	L	-
American Golden Plover	mApr-mMay	s100's	mAug-1Oct	f1000's	L	-
Black-bellied Plover	eMay-eJun	s100's	1Jul-mOct	f1000's	L	-
Hudsonian Godwit	-		RM		-	-
Bar-tailed Godwit	m-1May	f1000's	eAug-mOct	f10,000's	L	-
Marbled Godwit	-		-		?	-
Whimbrel	-		1Jun-eSep	s1000's	-	-
Bristle-thighed Curlew	-		1Jul-eSep	f100's	-	-
Greater Yellowlegs	1Apr-1May	f1000's	eJul-mOct	f1000's	M	-
Lesser Yellowlegs	1Apr-1May	s100's	1Jul-eOct	s100's	L	-
Solitary Sandpiper	RM		1Jul-1Aug	f100's	L	-
Spotted Sandpiper	1May-mJun	f100's	1Jul-1Aug	s100's	L	-
Wandering Tattler	mMay-mJun	f100's	mJul-eSep	f1000's	L	-
Ruddy Turnstone	e-1May	f1000's	mJul-1Oct	s1000's	-	-
Black Turnstone	e-1May	s100's	mJul-1Aug	f1000's	L	-
Northern Phalarope	mMay-1Jun	f1000's	mJul-1Sep	s10,000's	M	-
Red Phalarope	mMay-eJun	s1000's	mJul-eOct	f10,000's	-	-
Common Snipe	mApr-1May	f1000's	eAug-1Sep	s1000's	M	-
Short-billed Dowitcher	e-1May	f1000's	mJun-eSep	f10,000's	M	-
Long-billed Dowitcher	RM		1Jul-eOct	f1000's	-	-
Surfbird	-		RM		L	?
Red Knot	-		RM		-	-
Sanderling	e-1May	s100's	mAug-1Oct	f1000's	-	L
Semipalmated Sandpiper	-		eJul-1Aug	f100's	-	-
Western Sandpiper	e-1May	f1000's	1Jun-eSep	f100,000's	M	-
Least Sandpiper	e-mMay	f1000's	1Jun-1Aug	s1000's	M	-
Pectoral Sandpiper	RM		RM		L	-
Sharp-tailed Sandpiper	-		1Sep-eOct	s100's	-	-
Rock Sandpiper	eApr-1May	f10,000's	eJul-1Oct	f10,000's	M	M
Dunlin	e-1May	f10,000's	1Jun-mOct	f100,000's	M	-

[1] Usual period of first arrival to last departure; e = early, m = mid, l = late.

[2] Numbers: f = few, s = several. Relative abundance: L = low, M = medium, H = high. Dash = absent, ? = suspected. RM = rare migrant.

Table 3. Use of habitats within subunits of the Bristol Bay Region during the breeding season (May - July). BB = Bristol Bay waters, EKB = East Kuskokwim Bay (Quinhagak to C. Newenham), NBB = North Bristol Bay (C. Newenham to Naknek), NAP = North Alaska Peninsula, and SAP = South Alaska Peninsula.

Subunit	Habitat	Use	Species
BB	Marine waters	Feeding in spring	Northern Phalarope, Red Phalarope
EKB	Lagoons and estuaries	Feeding in spring	Greater Yellowlegs
NBB	Lagoons and estuaries	Feeding in spring	Black-bellied Plover, Bar-tailed Godwit, Black Turnstone, Northern Phalarope, Sanderling, Rock Sandpiper, Dunlin
EKB & NBB	Exposed sand beaches and dunes	Nesting, feeding	Semipalmated Plover
	Wet meadows, wet bogs and streamsides	Nesting, feeding	Semipalmated Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Wandering Tattler, Black Turnstone, Northern Phalarope, Red Phalarope?, Common Snipe, Short-billed Dowitcher, Western Sandpiper, Least Sandpiper, Pectoral Sandpiper, Dunlin
	Dwarf shrub tundra	Nesting, feeding	American Golden Plover, Black-bellied Plover, Bar-tailed Godwit, Ruddy Turnstone, Surfbird, Western Sandpiper, Rock Sandpiper
NAP	Lagoons and estuaries	Feeding in spring	American Golden Plover, Bar-tailed Godwit, Rock Sandpiper, Dunlin
	Exposed sand beaches and dunes	Nesting, feeding	Semipalmated Plover

Table 3 (continued). Use of habitats during the breeding season.

Subunit	Habitat	Use	Species
NAP	Wet meadows	Nesting, feeding	Greater Yellowlegs, Lesser Yellowlegs?, Black Turnstone, Northern Phalarope, Common Snipe, Short-billed Dowitcher, Least Sandpiper, Pectoral Sandpiper, Dunlin
	Dwarf shrub tundra	Nesting, feeding	Western Sandpiper, Least Sandpiper, Rock Sandpiper
SAP	Lagoons and estuaries	Feeding in spring	Black-bellied Plover
	Exposed sand beaches	Nesting, feeding	Semipalmated Plover?
	Exposed rocky shorelines	Nesting, feeding	Black Oystercatcher
	Wet meadows and bogs	Nesting, feeding	Greater Yellowlegs, Northern Phalarope, Common Snipe, Short-billed Dowitcher?, Least Sandpiper
	Dwarf shrub tundra	Nesting, feeding	Rock Sandpiper

Table 4. Use of habitats within subunits of the Bristol Bay Region by post-breeding shorebirds (July - October). BB = Bristol Bay waters, EKB = East Kuskokwim Bay (Quinhagak to C. Newenham), NBB = North Bristol Bay (C. Newenham to Naknek), NAP = North Alaska Peninsula, and SAP = South Alaska Peninsula.

Subunit	Habitat	Use	Species
BB	Marine waters	Feeding	Northern Phalarope, Red Phalarope
EKB	Lagoons and estuaries	Feeding and roosting	Semipalmated Plover, American Golden Plover, Black-bellied Plover, Bar-tailed Godwit, Whimbrel, Greater Yellowlegs, Lesser Yellowlegs?, Wandering Tattler, Ruddy Turnstone, Black Turnstone, Northern Phalarope, Red Phalarope, Short-billed Dowitcher?, Long-billed Dowitcher?, Semipalmated Sandpiper?, Western Sandpiper, Least Sandpiper?, Pectoral Sandpiper?, Sharp-tailed Sandpiper?, Rock Sandpiper, Dunlin
	Exposed sand beaches and dunes	Feeding	Semipalmated Plover, American Golden Plover, Black-bellied Plover, Sanderling
	Lowland wet meadows	Feeding and roosting	American Golden Plover, Bristle-thighed Curlew?, Solitary Sandpiper, Common Snipe, Short-billed Dowitcher, Least Sandpiper
	Dwarf shrub tundra	Feeding and roosting	Bristle-thighed Curlew?
NBB	Lagoons and estuaries	Feeding and roosting	Semipalmated Plover, American Golden Plover?, Black-bellied Plover, Hudsonian Godwit, Bar-tailed Godwit, Whimbrel, Greater Yellowlegs, Lesser Yellowlegs, Spotted Sandpiper, Wandering Tattler, Ruddy Turnstone, Black Turnstone, Northern Phalarope, Red Phalarope, Short-billed Dowitcher, Long-billed Dowitcher, Sanderling, Semipalmated Sandpiper, Western Sandpiper, Pectoral Sandpiper, Sharp-tailed Sandpiper, Rock Sandpiper, Dunlin

Table 4 (continued). Use of habitats by post-breeding shorebirds.

Subunit	Habitat	Use	Species
NBB	Rocky shoreline	Feeding and roosting	Surfbird
	Lowland wet meadows and streamsides	Feeding and roosting	American Golden Plover, Greater Yellowlegs, Spotted Sandpiper, Northern Phalarope, Common Snipe, Short-billed Dowitcher, Least Sandpiper
NAP	Lagoons and estuaries	Feeding and roosting	American Golden Plover, Black-bellied Plover, Bar-tailed Godwit, Marbled Godwit, Greater Yellowlegs, Ruddy Turnstone, Black Turnstone, Northern Phalarope, Red Phalarope, Short-billed Dowitcher, Long-billed Dowitcher, Sanderling, Western Sandpiper, Least Sandpiper, Pectoral Sandpiper, Sharp-tailed Sandpiper, Rock Sandpiper, Dunlin
	Exposed sand beaches and dunes	Feeding	Semipalmated Plover, Black-bellied Plover, Ruddy Turnstone, Black Turnstone, Sanderling
		Roosting	Short-billed Dowitcher, Western Sandpiper, Rock Sandpiper, Dunlin
	Lowland wet meadows	Feeding and roosting	American Golden Plover, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Northern Phalarope, Common Snipe, Long-billed Dowitcher, Least Sandpiper, Pectoral Sandpiper, Dunlin
	Dwarf shrub tundra	Feeding	Whimbrel
		Roosting	Bar-tailed Godwit, Whimbrel

Table 4 (continued). Use of habitats by post-breeding shorebirds.

Subunit	Habitat	Use	Species
SAP	Lagoons and estuaries	Feeding and roosting	American Golden Plover, Black-bellied Plover?, Bar-tailed Godwit?, Whimbrel, Greater Yellowlegs?, Lesser Yellowlegs?, Ruddy Turnstone?, Black Turnstone, Northern Phalarope, Red Phalarope, Short-billed Dowitcher?, Long-billed Dowitcher?, Sanderling?, Western Sandpiper, Least Sandpiper, Pectoral Sandpiper?, Rock Sandpiper, Dunlin
	Rocky shorelines	Feeding and roosting	Black Oystercatcher, Wandering Tattler, Ruddy Turnstone, Black Turnstone?, Surfbird?, Rock Sandpiper
	Lowland wet meadows	Feeding and roosting	Greater Yellowlegs?, Common Snipe, Northern Northern Phalarope
	Dwarf shrub tundra	Feeding and roosting	?

Table 5. Use of habitats within subunits of the Bristol Bay Region during winter (November - April). NAP = North Alaska Peninsula, and SAP = South Alaska Peninsula.

Subunit	Habitat	Use	Species
NAP	Lagoons and estuaries	Feeding, roosting	Sanderling, Rock Sandpiper
	Exposed sand beaches	" "	Sanderling
SAP	Lagoons and estuaries	" "	Rock Sandpiper
	Exposed rocky shorelines	" "	Black Oystercatcher, Surfbird?, Rock Sandpiper

RAPTORS

BALD EAGLE

Population Size and Distribution

Bald eagles (Haliaeetus leucocephalus) occur throughout North America north of Mexico. Two subspecies are recognized, the southern bald eagle (H. l. leucocephalus) found in the contiguous United States and southern Canada, and the northern bald eagle (H. l. alascanus) in northern Canada and Alaska. The Alaskan population is estimated at 30,000-35,000 birds at fledging time, with most of these occurring along the Pacific coast from southeast Alaska through the Aleutians.

In the Bristol Bay study area, bald eagles are most numerous along the south side of the Alaska Peninsula, with fewer occurring in the bay itself. Nesting eagles can also be found along the rivers and lakeshores of the region. The number of adult eagles in the study area is roughly 1000, in contrast to an estimated 7200 adults in southeastern Alaska.

Migration

Little is known about the migratory patterns of Bristol Bay eagles. Adult birds along the coast probably remain near their nesting areas throughout the year, but possibly range several hundred miles to seasonally abundant food sources such as salmon spawning runs. Birds nesting inland probably move to saltwater habitat after freeze-up. Immature eagles are much more mobile and may travel long distances to find optimal habitat with abundant food or a milder climate.

Nesting

Bald eagles are closely tied to the land/water interface. Nearly all nests occur within several hundred meters of coastlines or in riparian zones along rivers. Likewise, eagles feed primarily in these areas, either on fish or water birds. This dependence on the water/land interface concentrates the population and makes it vulnerable to a number of impacts. Many human activities occur in this zone and increase the likelihood of adverse consequences for eagles. Efforts should be made to retain the basic integrity of these habitats.

Data Gaps

The available information on bald eagles in Bristol Bay is very limited and only covers a few areas of limited extent. A single survey of the region during the breeding season would vastly improve our knowledge of eagle numbers and distribution. Data on migration and concentration areas would be more difficult to collect and probably could only be obtained through an extensive telemetry study.

Development Conflicts

Activities that eliminate nesting habitat obviously will adversely affect eagles. Land clearing for whatever reason will eliminate these areas as nesting habitat. Locating roads, utility corridors and other land-altering projects away from the immediate proximity of coastlines and rivers will minimize most adverse impacts. The impact of environmental contaminants on raptor populations has been documented many times. Oil spills or run-off from mining activities are two potential sources of environmental contaminants. The loss of prey species by overuse, habitat loss, environmental contamination, or other impacts will ultimately impact eagle numbers. Human activities may be a source of disturbance in some areas and may impact some individuals, but probably will not influence the population as a whole.

OTHER RAPTORS

Besides the bald eagle and peregrine falcon, there are 17 species of raptors recorded in the Bristol Bay study area. Their habits and ecological requirements are diverse and cannot reasonably be discussed together. Table 3 briefly outlines the pertinent facts for each species. This information was prepared specifically for the Bristol Bay Region and may not be applicable to other parts of Alaska.

Data Gaps

Most of this information has been gleaned from more general literature sources and tailored to the Bristol Bay Region. I am aware of few studies in the area done specifically on raptors. What little data there are come from general ornithological surveys or casual observation by workers involved in other duties. A major effort will be required to gain even a rudimentary understanding of the distribution and abundance of the raptors in the Bristol Bay region and to identify important habitat.

Development Conflicts

Activities that affect a small land area will not be detrimental to most raptor populations, but may impact individuals or species using limited or unique habitat such as riparian areas (bald eagles and ospreys) or cliffs (peregrine falcons and others). Coordination and project planning can prevent most of these impacts.

Activities that influence a broader area may have a more serious impact on the raptors of the Bristol Bay area. Environmental contaminants are of particular concern. Many birds of prey are at the top of their food chains and are especially susceptible to the impacts of contaminants as evidenced by the drastic declines recorded for peregrine falcons, bald eagles, ospreys and other species. Oil development and mineral extraction are two sources of pollutants. Such activities should be monitored carefully so steps can be taken to minimize any adverse consequences.

The impact of disturbance on raptors is not well understood and the topic usually generates more emotional than rational debate. Disturbance probably will not greatly affect raptor populations in the Bristol Bay region except in local areas where the disturbance is frequent, prolonged and recurrent. Individual pairs may be impacted, however, and the significance of these impacts should be evaluated on a case-by-case basis.

Impacts to prey species will eventually impact their predators. A decrease in prey populations through over-harvesting, habitat loss or other causes will result in decreases in raptor numbers. Contamination of prey species with pollutants may also impact raptor populations by decreasing productivity or increasing mortality. Impacts to bird, fish, mammal and insect populations should be evaluated for their ultimate impact to the predators using these species.

Table 3. Raptors of the Bristol Bay region.

	Distribution				Importance of Bristol Bay Region			Habitats	
	World	Alaska	Status	Abundance	World Population	Alaska Population	Migratory Nature (Winter)	Used	Sensitivity
Goshawk	Holarctic	Forested part of state	Resident	Uncommon	Low	Moderate	Local	Open forests	Moderate
Sharp-shinned Hawk	North America	Forested part of state	Breeding	Uncommon	Low	Low	Central America	Forests	Low
Red-tailed hawk (includes Harlan's)	North America	Forested part of state	Breeding	Rare	Low	Low	"Lower 48"	Mixed forest	Low
Rough-legged hawk	Holarctic	Western and northern Alaska	Breeding	Common	Low	Moderate	"Lower 48"	Tundra/alpine cliffs	Moderate
Golden eagle	Holarctic	Statewide	Resident	Uncommon	Low	Moderate	Local	Tundra/alpine cliffs	Moderate
(Bald eagle)	See section on Bald eagles								
Steller's sea eagle	East Asia	Southwest	Accidental	Very rare	Very low	High	Korea	Coast	High
Northern harrier	Holarctic	Statewide except North Slope	Breeding	Uncommon	Low	Moderate	"Lower 48" to Central America	Open country marshes	Low
Osprey	Cosmopolitan	Statewide except North Slope and Aleutians	Breeding	Rare	Moderate	Very high	Southern US to Brazil and Peru	Coast and riparian zones	High
Gyrfalcon	Holarctic	Statewide except Southeast	Resident	Uncommon	Low	Moderate	Local	Tundra/alpine cliffs	Moderate
(Peregrine falcon)	See section on Peregrine falcons								
Merlin	Holarctic	Statewide except Aleutians	Breeding	Uncommon	Low	Moderate	Southwestern US to Peru	Open forests	Low
Great horned owl	Western Hemisphere	Forested part of state	Resident	Uncommon	Low	Low	Local	Forests	Low
Snowy owl	Holarctic	Northern and western Alaska	Resident Resident	Rare	Low	Moderate	Nomadic	Tundra	Low
Hawk owl	Holarctic	Forested areas except Southeast	Resident	Rare	Low	Low	Local	Open forests	Low
Great gray owl	Holarctic	Forested part of state	Resident	Very rare	Low	Low	Local	Dense conifer forests	Moderate
Short-eared owl	Northern Hemisphere	Statewide	Breeding	Common	Low	Moderate	Southern Alaska through "Lower 48"	Open habitats	Low
Boreal owl	Holarctic	Forested areas except Southeast	Resident	Uncommon	Low	Moderate	Local	Dense forest	Low

MIGRATORY BIRD REFERENCES

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MARINE MAMMALS

STELLER'S (NORTHERN) SEA LION

POPULATION SIZE AND DISTRIBUTION

The Steller's sea lion (Eumetopias jubatus) breeds along the west coast of North America and across the Pacific Rim to the Kuril Islands, Kamchatka Peninsula, and islands in the Okhotsk Sea. Presently Steller's sea lions extend southward to the vicinity of California's Channel Islands. In Alaska, their distribution follows the Aleutian Islands, Alaska Peninsula, and the Gulf of Alaska coastline. A few animals range as far north as St. Lawrence Island. The greatest concentrations in Alaska are found along the Alaska Peninsula, in Bristol Bay and in the western end of the Gulf of Alaska.

In the Bristol Bay region, sea lions are abundant along the entire Pacific coastline and on the Bering Sea side from Unimak Pass to Port Moller. The world population is approximately 250,000 animals. There is no current population estimate for the Bristol Bay study area, but general observations indicate that sea lions are abundant on the Pacific side.

Migration and Breeding

Little is known about the length, duration, and path of migration of individual sea lions. The breeding season extends from June through early August. This terrestrial phase of the yearly cycle is best known because animals gather predictably at certain haulout and rookery sites. Although the phase lasts less than three months, it is critical, as the entire reproductive cycle occurs on these land sites. Males defend discrete territories while females form loose assemblages. Females may wander freely from one male's territory to another.

Feeding

In Alaskan waters sea lions feed primarily upon capelin, sand lance, rockfish, sculpins, and flatfish. Most feeding occurs in less than 100 fathoms of water and usually not more than 15 miles from shore.

Data Gaps

For management purposes the primary data needed is up-to-date information on use of haulouts and rookeries and their relative importance. There is also a need to determine the seasonality, distribution and numbers of free-floating fish eggs and larvae.

Development Conflicts

Oil spills and subsequent fouling of animals and haulout rocks would likely cause high mortality by upsetting body thermoregulation and causing animals to ingest oil during grooming efforts.

The free-floating eggs and larvae of food source fishes could be severely reduced by repeated large hydrocarbon spills.

To reduce harassment during the critical reproductive season (June through early August), Steller's sea lion haulouts and rookeries should be avoided by excessive aircraft and boat traffic.

NORTHERN FUR SEAL

Population Size and Distribution

The northern fur seal (Callorhinus ursinus) is the most abundant fur seal in the Bering Sea. The North Pacific population is estimated to be roughly 1.7 million, about 75% of which are centered around the Pribilof Islands in the eastern Bering Sea. Other colonies are located around the North Pacific rim, including: Commander, Robben and Kurile islands (USSR) and San Miguel Island off the coast of California.

Migration and Feeding

Fur seals are pelagic and highly migratory and rarely come ashore except during the breeding and pupping season from May to November. Most adult males winter south of the Aleutian Islands and east into the Gulf of Alaska. Females predominate in the southern parts of the range, from southern California north to southeast Alaska, in the winter.

In early August, males leave the islands. Adult females and juveniles migrate south from the Pribilof Islands in October. Pups of the year leave the breeding area last and reach the Aleutian passes (e.g., Unimak Pass) by November and early December. Little is known of the movements of juveniles until they return to the Pribilof Islands as nonbreeding 3-year-olds.

Unimak Pass and several other passes in the Aleutians are major migration routes in spring and fall. Fur seals also forage in the summer from the Pribilof Islands southeast as far as Unimak Pass. Most of the important feeding areas are located in upwellings and are rarely found close to shore. In the Bering Sea, important summer and fall foods include walleye pollock (Theragra chalcogramma), capelin (Mallotus villosus), and squid.

Sightings of fur seals in Bristol Bay have been concentrated mostly in the western portions of the bay and in the Unimak Pass area.

Data Gaps

More definitive information needs to be gathered on distribution, abundance, and chronology of movements of animals throughout Bristol Bay in order to better evaluate the degree of man's impact on fur seals.

Development Conflicts

Oil spills can be disastrous to fur seals. Even small amounts of oil on the pelage result in increased heat loss and a subsequent increase in metabolic rate to maintain body temperature.

Judging from the seal's close association with man on the Pribilof Islands, they seem to have a relatively high tolerance for disturbance.

OTHER SEALS

"Other seals" include the following ice-associated species: ringed seal (Phoca hispida), bearded seal (Erignathus barbatus), spotted or harbor seal (Phoca vitulina largha), and ribbon seal (Phoca fasciata). These species occur from the northern Chukchi Sea to the Bering Sea. In the winter, all of these species occur along the ice edge in the northern portion of Bristol Bay.

Ringed seals are the most abundant ice seal and the population in the Bering and Chukchi Seas is between 1 and 1.5 million seals. No estimates are available for animals occuring in the Bristol Bay study area. They are only present in the winter ice season, which varies from year to year. Ringed seals occur in the shallow waters of the Bering and Chukchi continental shelf. Depth of the shelf averages 200 feet. However, ringed seals are not restricted to these depths and may dive as deep as 600 feet. In very deep water ringed seals feed on organisms in the upper parts of the water column. Organisms eaten include schooling fish such as saffron, polar cod, capelin, and sand lance. Other major prey items are crab, shrimp, mysids, euphausiids, amphipods, and zooplankton.

Bearded seals in contrast to ringed seals are restricted to shallow water and to regions where the sea ice is in motion. The northern segment of Bristol Bay along the ice edge of the central and southern Bering Sea is the center of the bearded seal's winter abundance. In winter and spring, bearded seals are randomly distributed throughout the drifting ice of this area. They do not show the marked selectivity of the other three species for specific ice habitats. The population in the Bering and Chukchi Sea is estimated to contain about 300,000 animals. No specific estimates are available for the Bristol Bay study area; however, most of the population probably winters in the study area. The bearded seal is a benthic feeder; and major prey items include crab, shrimp, clams, benthic fish, and schooling near-bottom dwelling fish. These seals are restricted by their feeding habits to depths less than 500 feet. The peak pupping period occurs in the last three weeks of April. In most years the ice edge has retreated north of the Bristol Bay study area by this time.

The spotted (harbor) seal occurs only in the North Pacific, primarily in the Bering, Chukchi, and Okhotsk seas. The Bering and

Chukchi seas' population is estimated to contain approximately 300,000 animals. Breeding occurs in late April and early May. Birth occurs in late March and April on ice floes. In April, spotted seals are found in all areas of the ice front; however, highest densities occur in Bristol Bay near the Alaska coast and in Kavaginski Bay on the Siberian coast. The spotted seal is not a deep diver and stays within the confines of the continental shelf. Food items include capelin, pollock, smelt, cod, sand lance, sculpin, herring, shrimp, octopus, and small crabs.

The ribbon seal occurs only in the North Pacific region primarily in the Bering and Okhotsk seas. In late winter and spring, it is most abundant on the ice front. The population estimate for this seal is approximately 100,000 animals, the least abundant of the four ice-associated seals of the North Pacific. Bristol Bay constitutes important winter habitat: most of the population is in the study area from December through April in an average year. Prey items include pollock, capelin, ellpouts, pricklebacks, snailfish, sculpin, and saffron cod. Births occur primarily during the first half of April. The breeding season is from late April to mid-May.

The winter and spring ice edge in the Bristol Bay study area is of vital importance to the ribbon and spotted seals, as both species depend on the area for pupping and winter feeding. Negative impacts from development in this area during the critical winter-spring season would include disturbance from increased ship and aircraft use. Hydrocarbon contamination could adversely affect important prey species.

PACIFIC WALRUS

Population Size and Distribution

The Pacific walrus (Odobenus rosmarus divergens) is a common inhabitant of the Bering Sea. Other subspecies of walrus inhabit the Atlantic and possibly the Laptev Sea. The Pacific population is by far the largest. The smaller, Atlantic population contains approximately 25,000 animals and the Laptev Sea population numbers 4,000-5,000 animals. Current population estimates of the Pacific subspecies places the number at approximately 300,000 animals, possibly a historic high. The population is believed to be nearing its carrying capacity, as preliminarily indicated by hunter-provided reproductive tracts and stomachs. The samples collected in 1980, compared with a series of biological specimens periodically collected since the early 1950's, indicated a decrease in the size and number of clams eaten, an increase in the number of secondary prey items, and a lower reproductive rate with a noticeably higher abortion rate. It has been hypothesized by various researchers that a general leveling off of the population or a decline followed by a leveling off will take place in the near future.

Biology

The Pacific walrus spends nearly its entire life at sea, although much of this time is spent on ice floes. Walruses regularly take advantage of ice floes as haulout or resting sites. Floes also serve as a means of transportation. Land is used as a haulout site in some instances, especially during migration when exhaustion from swimming long distances forces the animals to rest. Groups of males have established permanent haulout areas which are used seasonally or year-round by some animals.

Haulout areas are located primarily in the Soviet Union, although a notable haulout site occurs in Bristol Bay on Round Island and on the surrounding Walrus Islands. The Round Island haulout is occupied year round. With the recent population increase walruses are now revisiting haulouts unused for some time. Most notable in Bristol Bay are haulouts around Cape Seniavin, Amak Island and Port Moller. Up to 3,000 animals used Cape Seniavin in 1981.

Walruses inhabit the moving pack ice over continental shelf water, where they are allowed access to benthic organisms at depths to 80 meters. Spring migration generally follows the retreat of the ice edge, while fall migration generally precedes the ice edge advancement.

Two general stocks of wintering walruses are believed to exist. One stock winters in the "shadow" of St. Lawrence Island and to the south and west; the other inhabits the southern Bering Sea and the Bristol Bay study area. The winter advancement of the southern ice edge into Bristol Bay determines the extent of walrus use there; however, the ice edge usually reaches at least the northern part of Bristol Bay. The occurrence of a large concentration (13,000-19,000) of potential breeding bulls in the Round Island vicinity suggests that they intermingle with overwintering females in Bristol Bay. The breeding season is now believed to occur in late January, February and possibly March, which coincides with the southernmost extension of the ice edge into the Bristol Bay area. It is therefore probable that breeding takes place to some extent in this area.

Winter use of Bristol Bay is moderate or high depending on the annual extent of ice edge advancement. Year-round use of Round Island is significant and may provide a nucleus of breeding age bulls for stock wintering in or adjacent to the study area.

February and March signal the start of the northern migration, as small herds begin the journey out of Bristol Bay. Bristol Bay wintering walruses either move along the Alaskan coast or northwestward toward the Gulf of Anadyr.

Clams comprise 85-95% of the walrus diet. Food requirements of walruses are great and the size and abundance of clam beds determines the welfare of walrus populations using a general area. Benthic research in Bristol Bay has revealed that extensive clam beds are available to walruses.

Data Gaps

A more comprehensive knowledge of the winter distribution of walruses in Bristol Bay is necessary. This would entail a study of the amount of intermingling of the Round Island males with females in estrus, and the long-term monthly distribution of walruses in the area. Recent findings of 3 of the 9 Round Island radio-tagged bulls on the Punuk Islands indicates a high probability of interchange and some emigration. Additional information on the status of clam beds in the area is needed. Impacts of oil contamination of the marine environment is poorly understood, as are the effects of the extent and timing of disturbance.

Development Conflicts

Researchers have identified areas (west to northwest and northcentral portions of the study area) that are considered to be important to the welfare of wintering populations of walruses in Bristol Bay. These areas traditionally support large densities of overwintering walruses. The maintenance of adequate feeding areas and the absence of disturbance during the breeding periods are thought to be important to the maintenance of southern Bering Sea stocks of walruses. Management prescriptions should strive to prohibit or reduce confliciting activities.

Activities which could conflict with the welfare of the walrus populations using the study area include: commercial clamming, oil and gas exploration or development, and increased human activity and associated disturbances.

Commercial Clamming Commercial clamming activities present direct competition for the walruses' primary food source. Clamming in areas of higher walrus concentrations would probably have the greatest effect on the species and should be avoided.

Human Disturbances The walrus' vision is poor, but the senses of smell and hearing are keen. This implies that most man-made disturbances create responses based on odor and sound. It has been observed that a person on foot can walk upright within 20 m of walruses on the downwind side before they become alarmed and head for the water. If the person crawls toward them, he/she can approach to within 6 m without causing alarm. On the other hand, when approached from the upwind side, the animals detect human odor and rush into the water, even without visual contact. Walruses hauled out on shore may be alarmed by the sound of aircraft passing by at an altitude of about 300 m. They appear not to be disturbed by the sound of gunfire or outboard engines on small boats at distances of 400 m or more.

Three levels of response to disturbance have been classified for walruses: 1) head-raising (animal raises head, usually looks toward the disturbance); 2) orientation (animal shifts position and

orients toward the sea in preparation for escape); and 3) escape (animal goes into the water). On this basis the responses of a small herd of walruses on shore were classified when approached by aircraft. The study showed that aircraft at distances of 1 km or less and at altitudes of less than 150 m caused some animals to orient and escape, but others remained on the haulout apparently undisturbed. Even when frightened into the water, the animals usually remained near the beach and eventually hauled-out again. Females with calves or yearlings were most responsive to the disturbance; adult males were least responsive. Soviet investigators observed that a low overflight (150 m) by a twin-engine aircraft (IL-14) caused a large herd of females and young to stampede into the water. The result of the stampede was that 21 young were trampled to death, and 2 adult females aborted their fetuses.

The reaction of walruses to man and machines can therefore be described generally as an escape response, attributed to visual, auditory, and olfactory cues. All walruses do not respond in the same way however, and many other factors appear to play a part in the severity of the response, including sex and age of the animal(s), group size and location (on ice, in water, on land), distance from the disturbance, type and level of activity, weather, and sea conditions. There is no real understanding of potential effects of repeated disturbance, for example, on such major biological events as mating, calving, or feeding. A study devoted to the qualitative and quantitative documentation of responses to disturbance is clearly needed.

Oil and Gas Development Human activity associated with oil and gas exploration and development could adversely affect walruses as detailed above. More specifically, oil spillage could have an impact on walruses by contaminating their food source. Because deposit-feeding mollusks (clams) generally accumulate hydrocarbons more than suspension-feeders, walruses may be more exposed than other marine mammals to long-term hydrocarbon accumulation.

SEA OTTER

Population Size and Distribution

Sea otters (Enhydra lutris) occur along the Northern Pacific Rim from the South Kurile Islands north to the Kamchatka Peninsula, east and south along the Aleutian Islands, Alaska Peninsula, Gulf of Alaska, and discontinuously from Southeast Alaska to Santa Cruz, California. From Southeast Alaska to Santa Cruz sea otters occur off Vancover Island and off the Washington coast south of the Straits of Juan de Fuca. The present Alaska population contains 150,000-200,000 animals. Specific population estimates are not available for Bristol Bay.

Low to moderate densities of sea otters occur on the Bering Sea coast from Unimak Pass to the vicinity of Port Heiden. Sea otter numbers fluctuate in this area depending on how many ice-free years

the coast enjoys. When ice moves into the area sea otter numbers are severely reduced. On the Pacific coast low to high densities occur and the population is probably at carrying capacity. However, no systematic survey has been done in these areas. General population densities are based on two overflights of the areas and random observations from observers working on other projects in the area.

Biology

Sea otters are not migratory; their home range includes about 5-10 miles of coastline. They usually remain within their home ranges, although studies of expanding populations have documented large numbers of animals moving from areas of high to low density.

Outside of the breeding season, sea otter populations tend to segregate. Breeding peaks in June but may occur anytime. Male pods may contain several hundred animals. Females are rarely found in these pods. Additional studies in Bristol Bay would probably indicate that certain areas are traditionally exploited by pods and are predictable, although they may change seasonally. Storms cause movement to sheltered bays.

Because sea otters are usually confined to their home ranges and because breeding and pupping can occur anytime, no specific time is more important than another to species survival.

Clams, crabs, sea urchins, mussels and in some areas slow-moving fish are the primary foods of sea otters. Shoal areas and the shallow areas (less than 30 fathoms) near shore provide the habitat necessary for foraging.

Data Gaps

The primary management need in the Bristol Bay region is up-to-date distribution and abundance data and information on the impacts of sea otters on shellfish resources.

Development Conflicts

Oil contamination causes fur to lose its insulative value, and may result in death from exposure or from ingestion of oil during grooming.

Sea otters are cogenial and tolerate a moderate amount of stress from boat and aircraft traffic. However, continual harassment will displace them from the area.

Due to their trusting nature sea otters are vulnerable to poaching. Increased surveillance would probably be necessary if large numbers of people come in contact with sea otters in the Bristol Bay region.

CETACEA

BELUGA

Population Size and Distribution

The beluga (Delphinapterus leucas) is one of the most abundant cetaceans in the North Pacific. While circumpolar in distribution, it does not normally occur south of Alaska. Estimates of the world population run from 100,000 to 200,000. The whales are highly mobile, making accurate population estimates difficult. Herds of up to 100 animals are common.

The Bristol Bay/Bering Sea stock is estimated to contain 9,000-16,000 whales, approximately 1,500 of which are concentrated in Bristol Bay. The Bristol bay herd appears to remain in the area year-round and usually remains in shallow waters, feeding in depths of 20-40 feet. In spring and summer belugas frequent estuarine areas to feed on young salmon migrating to sea. Warm estuaries (50° - 68°F) are important as calving areas. Concentrations of belugas have been observed in Nushagak Bay near the mouth of the Snake, Igushik, Wood, and Nushagak rivers. They enter fresh water while feeding and in the Bristol Bay area have been sighted in those rivers as well as in the Kvichak River near Lake Iliamna. In winter in Bristol Bay the species is generally associated with the ice-edge.

Biology

Food, which is swallowed whole, consists of invertebrates and fish such as capelin, cod, herring, salmon, char, smelt, and flounder in spring, summer, and fall. They also feed heavily on young salmon in the estuaries. To discourage salmon depredation, belugas have been kept from some river mouths by broadcasting underwater the calls of the killer whale, the primary predator of the beluga. Fish larger than about 9 lbs are rarely eaten. In winter their mainstay appears to be the polar cod (Boreogadus saida).

Data Gaps and Development Conflicts

The various habitat components important to belugas have not been sufficiently studied to determine precisely how they relate to maintaining population levels. The Nushagak and Kvichak rivers and bays are important for feeding and presumably calving. Impacts on these areas that reduce the food supply could adversely affect the beluga. Intensive commercial fishing or energy exploration and development have serious disruptive potential. Environmental contamination stemming from energy development could also affect beluga populations. The problem with tying down specific impacts to belugas or other cetaceans is that very little is known about the direct effects of man's activities on the animals. Any action affecting the food supply, in this case primarily fish, should be looked at carefully. Oil spills could affect belugas directly by prolonged oil contact with the skin; it is doubtful that they would inhale oil into their blowhole.

GRAY WHALE

Population Size and Distribution

The migration route of the endangered gray whale (Eschrichtius robustus) is one of the longest of any known mammal, spanning about 14,000 miles from the Chukchi and Bering seas south to California, Baja, and Mexico. The North American stock is estimated at 15,000-17,000 individuals, most of which pass through Bristol Bay in their migration path to and from the Bering Sea. The Korean stock is nearly extinct.

Biology

Gray whales migrate in February and March from Baja California north along the Pacific Coast. They go through Unimak Pass and hug the shoreline of Bristol Bay, frequently crossing the Bay between Egegik Bay and Cape Constantine, then continue their northward migration toward Nunivak Island, St. Lawrence Island and points north. They remain extremely close to shore during this northward migration and are usually seen within one mile of land. Feeding has been observed in such areas as Nelson Lagoon and around the Walrus Islands.

During the southward migration in October, their route across Bristol Bay to Unimak Pass is more direct and does not closely follow the shoreline. Gray whales arrive on their wintering grounds in late December and remain there until spring. When they head north again they have lost about 20-30% of their weight. Southern waters are warm but do not offer the productive feeding grounds for whales that feed on bottom-dwelling amphipods in shallow water. Most of the feeding is done in Alaskan waters.

They breed in late November and early December during their southward migration. The gestation period lasts about 13 months. Calves are born in shallow, protected lagoons in Baja California and are weaned on the northern feeding grounds by August.

Data Gaps

In the Bristol Bay study area emphasis needs to be placed on more precisely delineating migration routes and chronology and important feeding areas. At present we do not have sufficient information to explain what habitat is critical to the maintenance of current Bristol Bay population levels, nor do we know how important sites such as feeding areas are to the well being of the whales. Feeding sites are probably extremely important during the spring migration, after the whales have been fasting for 5 or 6 months.

OTHER WHALES

"Other Whales" include the following species: fin whale (Balaenoptera physalus), minke whale (B. acutorostrata), humpback whale (Megaptera novaeangliae), bowhead whale (Balaena mysticetus), giant bottlenose whale (Berardius bairdii), and killer whale (Orcinus orca).

The endangered fin whale is a migratory open-ocean animal in the North Pacific. It feeds on both the Pacific and Bering Sea side of the Bristol Bay study area from February through September. The fin whale have a worldwide distribution and is the most abundant large baleen whale. No estimates for the Bristol Bay study area are available. Fin whales are fairly broad in their food preferences. Copepods, euphausiids, capelin, and herring are important prey items. Fin whales will travel to the ice edge to feed. The most critical area for whales moving between the Bering Sea and Pacific Ocean is Unimak Pass, where the animals must concentrate in a relatively small area.

The minke whale inhabits all oceans of the world except equatorial seas. It occurs broadly over the North Pacific and in the southeastern Chukchi Sea in summer and migrates to latitude below 25°N in winter. It is considered to be low in abundance, but not endangered. No population estimate is available for the Bering Sea or North Pacific Ocean. Minke whales inhabit both coastal and offshore continental shelf areas. They are sighted throughout Bristol Bay but most commonly in the western two-thirds of the bay. Minke whales feed on capelin, sand lance, euphausiids, copepods, and other invertebrates.

The endangered humpback whale is broadly distributed in cool temperate waters in summer, ranging from Point Conception north to the Chukchi Sea. The Hawaiian Island stock contains approximately 500 animals, the Gulf of California stock approximately 100 animals. An undetermined number occurs around the Marina Islands, the Bonin Islands, the Ryuku Islands and Taiwan. The total population on the Pacific summer feeding grounds consists of approximately 850 animals. There are many gaps in our knowledge of humpback movements. The Mexican humpbacks migrate from Mexican and California waters to the Bering Strait and Chukchi Sea, reaching Vancouver Island in May or June, and the Bering Sea in late June or early July. The critical habitat in the Bristol Bay study area is Unimak Pass. Most humpbacks calves are born in winter. Lactation continues for approximately 11 months. The diet of humpbacks consists mainly of krill (euphausiids) and schooling fish, mostly herring, capelin, and sand lance. Much of their feeding occurs at the surface.

The bowhead whale, because of its strictly arctic distribution and the intense, protracted nature of its exploitation, is probably the most critically endangered of the baleen whales. The Spitsbergen stock is near extinction and the Davis Strait/Baffin Bay and Hudson Bay population numbers less than 200 animals. The population in the

Bering, Chukchi and Beaufort seas contains about 800 animals. The bowhead spends most or all of its life on or near the loose edge of the ice pack, migrating north as the ice recedes in the spring and south as it extends in the winter. During spring migration, bowheads are usually seen singly or in pairs, often in the company of belugas. During the fall migration they are frequently seen in groups of up to 50 animals. Bowheads occur in the Bristol Bay study area in the winter along the ice edge of the Bering Sea. The bowheads of the western Arctic mate and calve mainly in April and May, during spring migration. Gestation may last about 12 months, and weaning probably occurs in the first year of an individual's life. Bowheads feed on euphausiids, copepods, pteropods, and amphipods, and occasionally on benthic organisms.

The giant bottlenose whale or Baird's beaked whale is the largest of the beaked whales, reaching lengths of almost 13 meters. The species occurs only in the North Pacific, mainly between southern California and the Pribilof Islands on the east side, and between the Sea of Okhotsk or Kamchatka and southeastern Japan on the west. The giant bottlenose whale ranges as far north as St. Matthew Island, and occasionally occurs in the western third of Bristol Bay. There are no estimates of population size for this species. Beaked whales generally occur along the seaward edge of the continental shelf and are believed to feed primarily on cephalopods and deep-sea fish.

Killer whales are unique among the Cetacea in that they regularly prey on warm-blooded vertebrates. They are found throughout North Pacific waters in all months of the year and throughout all seas of the world to the limits of polar-fast ice. There are no estimates of numbers. Killer whales eat almost any palatable form of animal life in the oceans, from seabirds and herring to the great whales. They are common along the Pacific side of the Bristol Bay study area and are occasionally sighted on the Bering Sea side.

Data Gaps and Development Conflicts

There is no evidence that whales are able to detect hydrocarbon pollution. Although oiled whales have not been observed, the nature of their skin suggests that they may be vulnerable to effects of surface-contact with hydrocarbons. The epidermis is not keratinized, but composed of live cells. Whale epidermis is virtually unshielded from the environment, and may react to substances such as crude oil or gas condensates in a manner similar to that of sensitive mucous membranes.

Inhalation of toxic substances in the vicinity of a spill could adversely affect whales. Hydrocarbon ingestion would vary with species, type of hydrocarbon, and nature of the spill. Whales, especially benthic feeders, have a poorly developed sense of taste (the presence of foreign bodies in whale stomachs attests to this) and thus may not be able to differentiate between hydrocarbon-contaminated and uncontaminated food. Another potential direct effect of spilled oil on certain whales is the fouling of baleen, with a subsequent decrease in feeding efficiency.

The destruction of benthic amphipods or altered productivity of benthic communities may adversely affect all whales, with the possible exception of the killer whale, in the Bristol Bay study area. Local or temporary contamination or chronic pollution resulting in reduced productivity of plankton or other important food items may be an additional stress to endangered whale populations.

Whales may be disturbed by activities associated with energy exploration such as drilling, seismic operations, and air and boat traffic. We know little about the effects of these disturbances. For example, the gray whale population has dramatically recovered since commercial whaling was stopped, even though a tremendous amount of noise and disturbance from ships occurs throughout the migration route along the west coast of the U.S. Other impacts may derive from disposal of drilling muds, facility siting, and shoreline alterations.

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ENDANGERED SPECIES

The only endangered species (other than endangered marine mammals discussed earlier) believed to occur in the Bristol Bay region are the peregrine falcon (Falco peregrinus) and the short-tailed albatross (Diomedea albatrus).

PEREGRINE FALCON

Three subspecies of the peregrine falcon occur in Alaska: F. p. anatum, F. p. tundrius and F. p. pealei. F. p. anatum and F. p. tundrius are Federally listed endangered species, whereas F. p. pealei is not listed as threatened or endangered. Of the two endangered subspecies only F. p. anatum may occur in the Bristol Bay region.

F. p. anatum occurs throughout interior Alaska where suitable habitat is available. Densities are highest along portions of the Yukon, Tanana and Porcupine rivers. There is no evidence to indicate that the Bristol Bay region ever supported a substantial number of peregrine falcons, and in fact, there is little evidence to indicate that F. p. anatum even occurs in the region. This may be due in part to the lack of intensive surveys directed specifically toward peregrine falcons in that part of Alaska.

F. p. anatum is highly migratory, nesting in Alaska and elsewhere in North America in the summer and wintering as far south as Argentina and Chile. The birds arrive in Alaska in April or early May and depart in late August or early September. Typically, they nest on cliffs, bluffs, or steep cutbanks near a body of water and with adequate prey nearby. Peregrines feed primarily on other birds.

Because of the dearth of information on peregrine falcons in the Bristol Bay region, intensive surveys are needed. Using topographic maps and information supplied by individuals familiar with the region, areas of potentially suitable habitat could be delineated and intensively surveyed for falcons.

The sensitivity of peregrines to human presence and activity varies widely among individual birds. In some cases human activity near nests can result in nestling mortality and even nest desertion by the parents. Therefore, if nests are found in the Bristol Bay region, it will be necessary to limit activity around those sites. The severity of restrictions needed depends on the type of activity proposed.

SHORT-TAILED ALBATROSS

Short-tailed albatrosses were once abundant in the North Pacific (DeGange 1981) and probably were present in the off-shore areas of Bristol Bay. In the late 19th and early 20th century the species was nearly extirpated by feather hunters on breeding grounds. The total population is believed now to number around 250 individuals.

Short-tailed albatrosses are presently known to breed on Minami Kojima and Torishima islands, in the Pacific Ocean near Japan. Breeding occurs in the fall and winter. In summer the birds scatter widely over the North Pacific. During this period, the birds generally remain far off shore feeding on squid, small fish and crustaceans (DeGange 1981).

There is no evidence to indicate that short-tailed albatrosses are currently present in the Bristol Bay region. However, should the species recover to historic population levels, it is reasonable to assume that the short-tailed albatross would at least occasionally be present in Bristol Bay.

Since 1975 numerous aerial and shipboard marine-bird surveys in Alaskan waters have resulted in only one documented sighting of a short-tailed albatross, and that occurred in the Bering Sea (DeGange 1981). Additional surveys designed specifically to document the presence of this species are currently not justifiable nor economically feasible.

DeGange (1981) identified two potential human/albatross conflicts: oil spills and commercial fishing. Short-tailed albatrosses could be affected by spills through direct contact with oil or by oil detrimentally impacting their food source. The species could be affected by commercial fisheries through entrapment of individuals in nets. Given both the scarcity of the short-tailed albatross and its free-roaming nature, either source of potential conflict is unlikely to pose a substantial threat to the species in Bristol Bay.

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SPECIAL ECOLOGICAL RESOURCES

In Bristol Bay a variety of physical and biotic features, individually or in combination, create conditions of unique importance to a broad array of fish and wildlife resources. Physical features of primary importance include: Unimak Pass at the western end of Unimak Island; lagoon systems; estuaries; and various oceanographic features, of which the "inner front", roughly following the 50-fathom contour and the moving edge of the pack ice, is the most important. Biotic features of unique importance include beds of eelgrass that usually are associated with lagoon systems, and kelp that most frequently occurs along rocky coasts. These features are described below primarily in their relationship to birds, but they are of similar importance to numerous species of marine mammals and fish.

UNIMAK PASS

Unimak Pass, at the western end of Unimak Island, is the first major passage between the Gulf of Alaska and the Bering Sea--the terminous of the 600-mile barrier created by the Alaska Peninsula. Because of its location, the pass is a major focal point for marine birds, mammals, and fish between the Bering Sea and the Gulf of Alaska (Figure 1). It is uncertain whether or not the area has a particularly high primary production, but the area is characterized by upwellings from the North Pacific and strong tidal currents which, by advective processes, continually replenish food organisms critical to marine birds and mammals. Thus the area surrounding Unimak Pass is able to support unique year-round populations. (Figures 2-5).

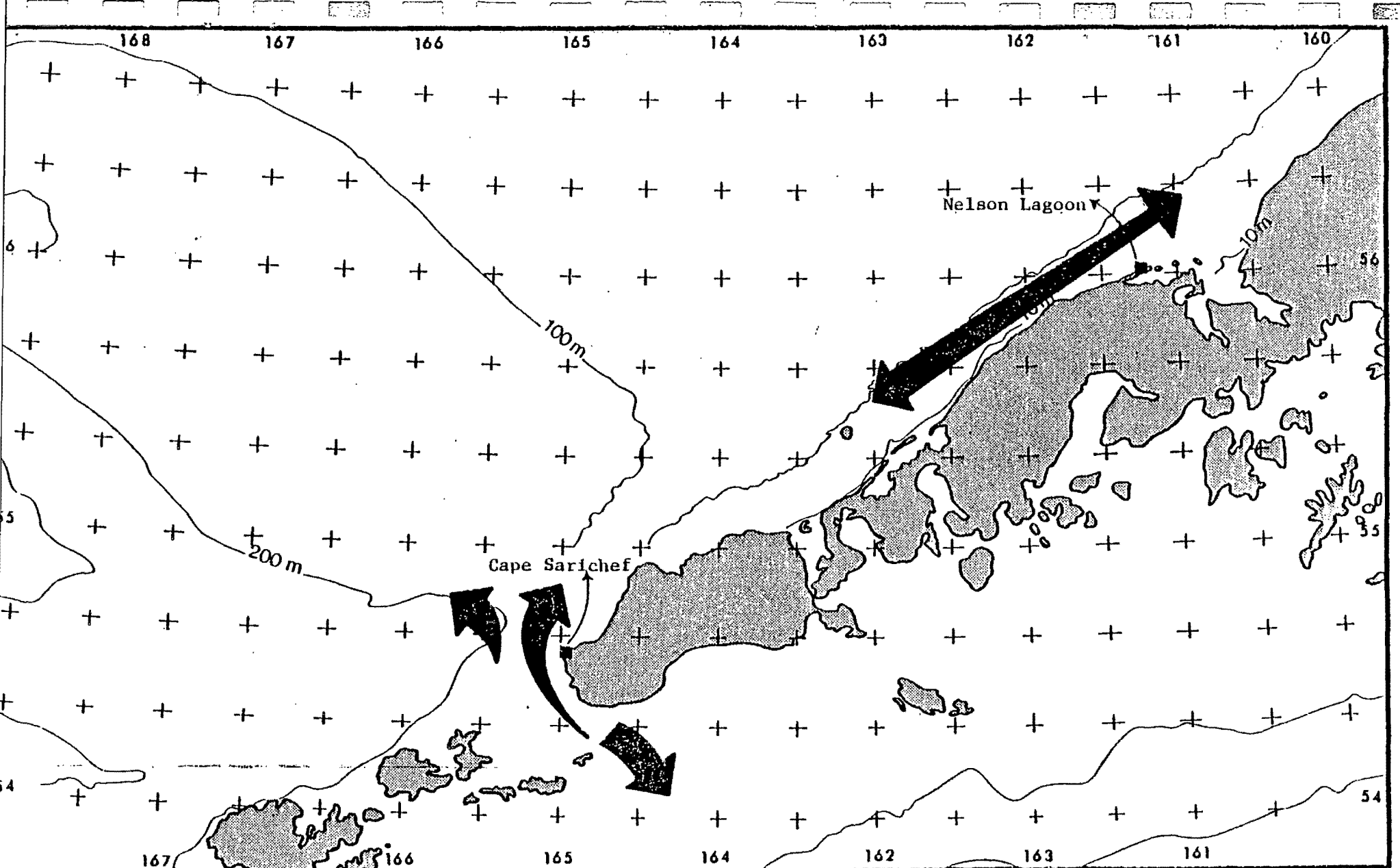
ESTUARIES AND LAGOON SYSTEMS

Estuaries and lagoon systems are a principal feature of Bristol Bay (Table 4). They have numerous features in common, including protected waters and extensive intertidal habitat. For the purpose of this discussion, we classify lagoons as areas of shallow water substantially closed from the sea by barrier reefs, spits, and islands (e.g. Chagvan, Nanvak, Bechevin, and Izembek bays, and Nelson Lagoon). Estuarine systems are more open and may be very large, as are Nushagak and Kuichak bays, but all considered here have subtantial freshwater inflow. Smaller estuaries such as Ugashik, Egegik, and Cinder rivers may be intermediate in character with lagoons.

In Bristol Bay all estuarine systems are obvious focal points for migrating salmon and are also the principal habitat of the beluga. Kvichak and Nushagak bays are of particular importance for the latter species, with a total population exceeding 1,500 animals. Intertidal areas are used extensively by migrant shorebirds and waterfowl.

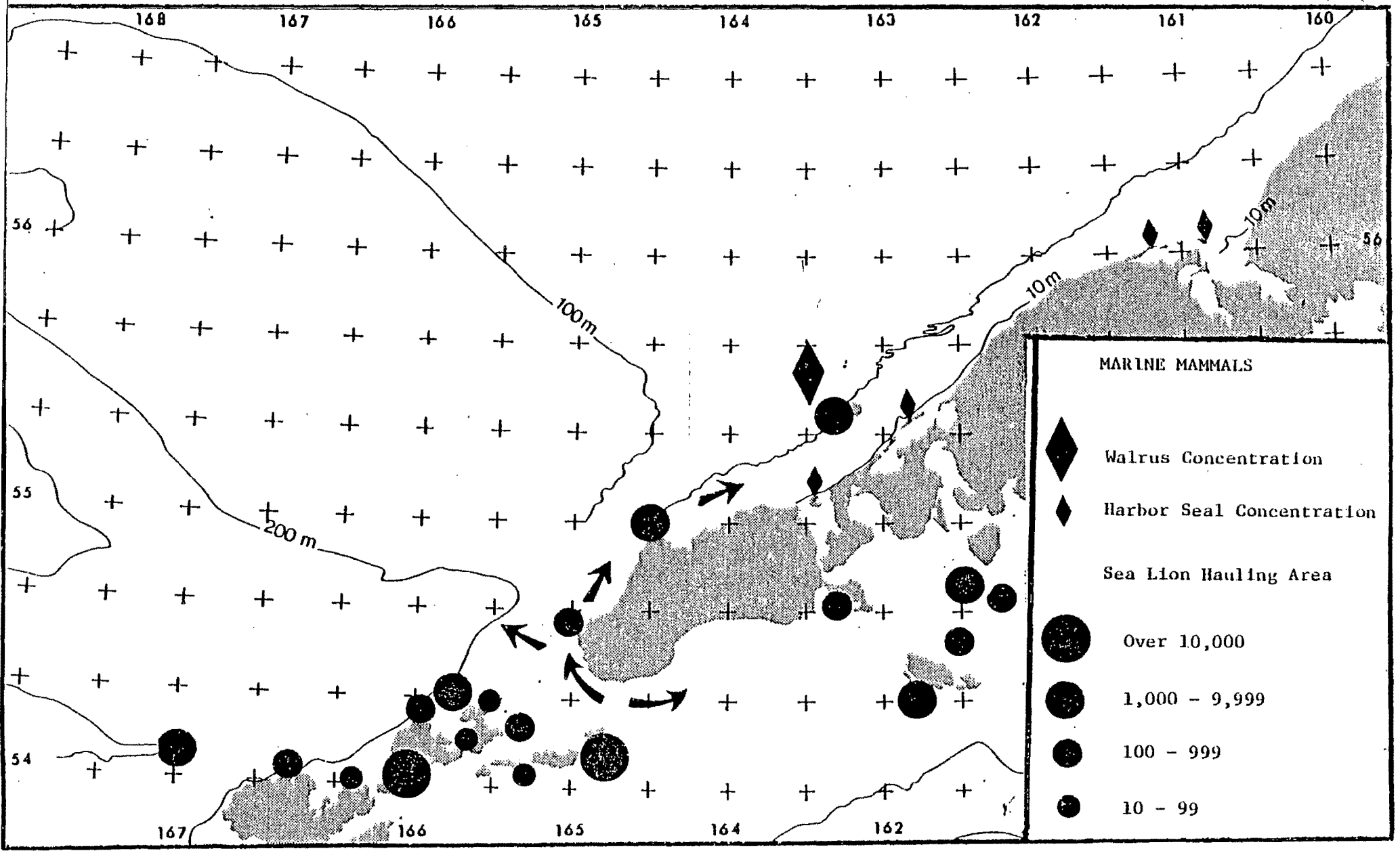
Table 4. Major estuaries and lagoon systems of Bristol Bay.

Name	Location	Map Module
Estuarine Systems		
Kuskokwim Bay	Yukon Delta	1
Nushagak Bay	Inner Bristol Bay	4
Kvichak Bay	Inner Bristol Bay	4
Egegik Bay	Alaska Peninsula	4
Ugashik Bay	North Shore Alaska Peninsula	4
Cinder River	Alaska Peninsula	4
Herendeen Bay	Alaska Peninsula	5
Morzhovi Bay	South Shore	5
Lagoon Systems		
Jacksmith Bay	Kuskokwim Bay	1
Carter Bay	Kuskokwim Bay	1
Goodnews Bay	Kuskokwim Bay	1
Chagvan Bay	Kuskokwim Bay	3
Nanvak Bay	Northern Bristol Bay	3
Osviak Lagoon	Hagemeister Strait	3
Nelson Lagoon	North Shore Alaska Peninsula	5
Izembek Bay	Alaska Peninsula	5
Bechevin Bay	Alaska Peninsula	5
Other		
Hagemeister Strait	Northern Bristol Bay	3



Migration Route for Birds and Marine Mammals. Unimak Pass is a major route of travel for birds moving between the Bering Sea and the Gulf of Alaska during all seasons, and the coast of the Alaska Peninsula is a major migration route during spring and fall for many waterfowl including Black Brant, and Canada and Emperor Geese. During April and May up to 25,000 shearwaters passed Cape Sarichef each hour on several occasions and at Nelson Lagoon up to 1,000 shearwaters passed each minute during a period of several hours. In addition, Unimak Pass is a major passage for marine mammals and each spring and fall approximately 10,000 endangered grey whales pass Cape Sarichef on their migration between Baja California and the Bering Sea.

Figure 1



Marine Mammals. Unimak Pass and the Aleutian Shelf are important habitat for many species of marine mammals. Large concentrations of sea lions and harbor seals and many small groups are scattered throughout the region. Major concentrations of sea otters are present. A unique population of 17,000 otters forage up to 30 miles from land in the Bering Sea. Unimak Pass is a primary route for the endangered Grey Whale on its migration between the Bering Sea and Baja California with more than 10,000 (most of the world's population) making the passage each spring and fall. Unimak Pass is also a major route for Northern fur seals traveling to and from their rookeries in the Pribilof Islands.

Figure 3

In winter, an even more indefinite boundary is established by the broken edge of the ice pack. In mild winters, the edge of the ice may consist of no more than a band running roughly southeast from St. Matthew Island to Nurcivis and Ugashik Bay. In severe winters it may extend south from the Pribilof Islands, thus covering essentially all of the study area. Such conditions are rare.

The edge of the pack ice is of particular importance, as this moving zone supports most of the bearded seal population throughout the year. It is also used extensively by other pinnipeds, primarily spotted and ribbon seals, which may occur along the ice front for the entire breadth of the Bering Sea (Burns 1981). In winter, marine birds are also particularly abundant at the ice edge (Divoky 1981), but do not depend on it to the extent marine mammals do.

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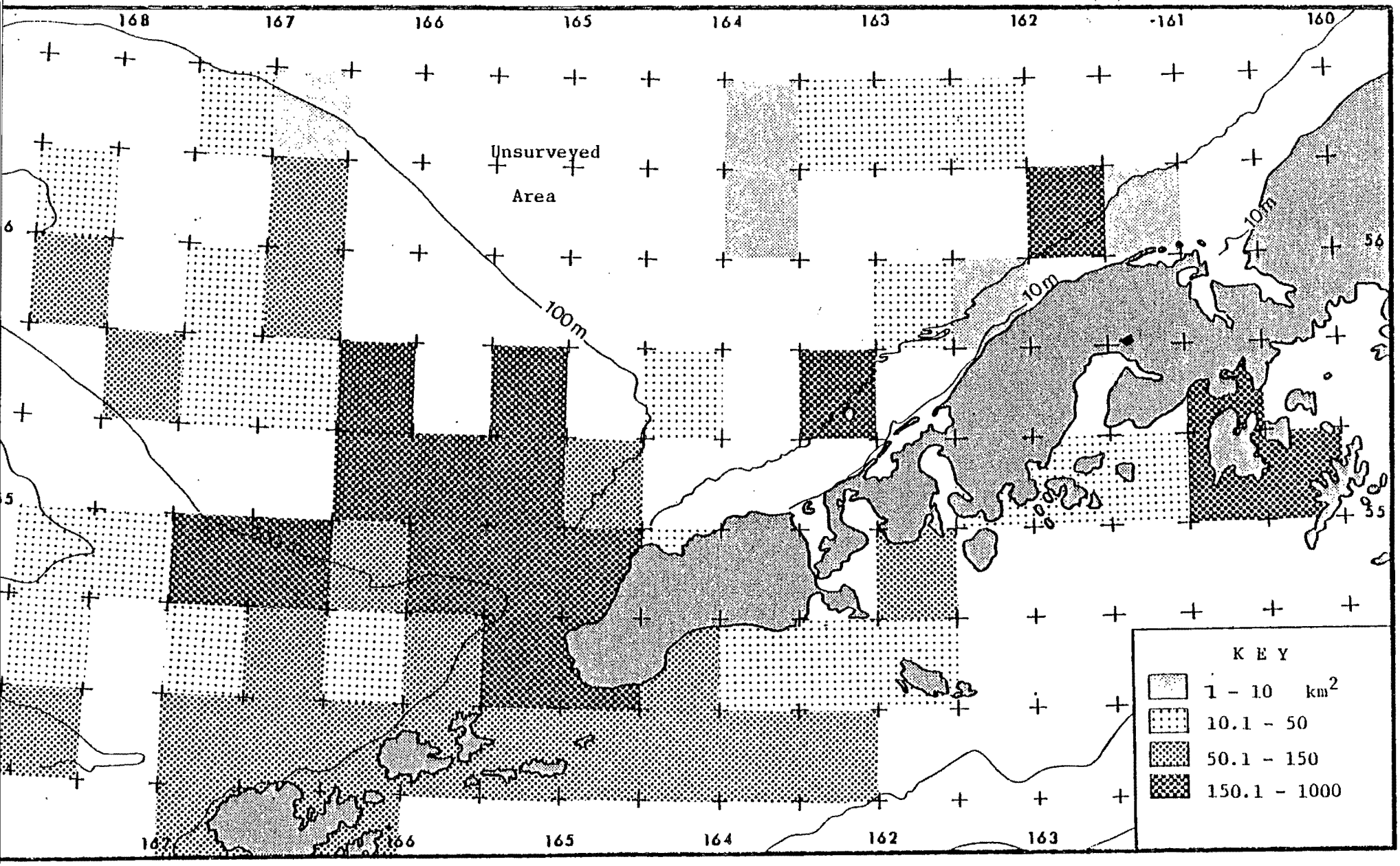
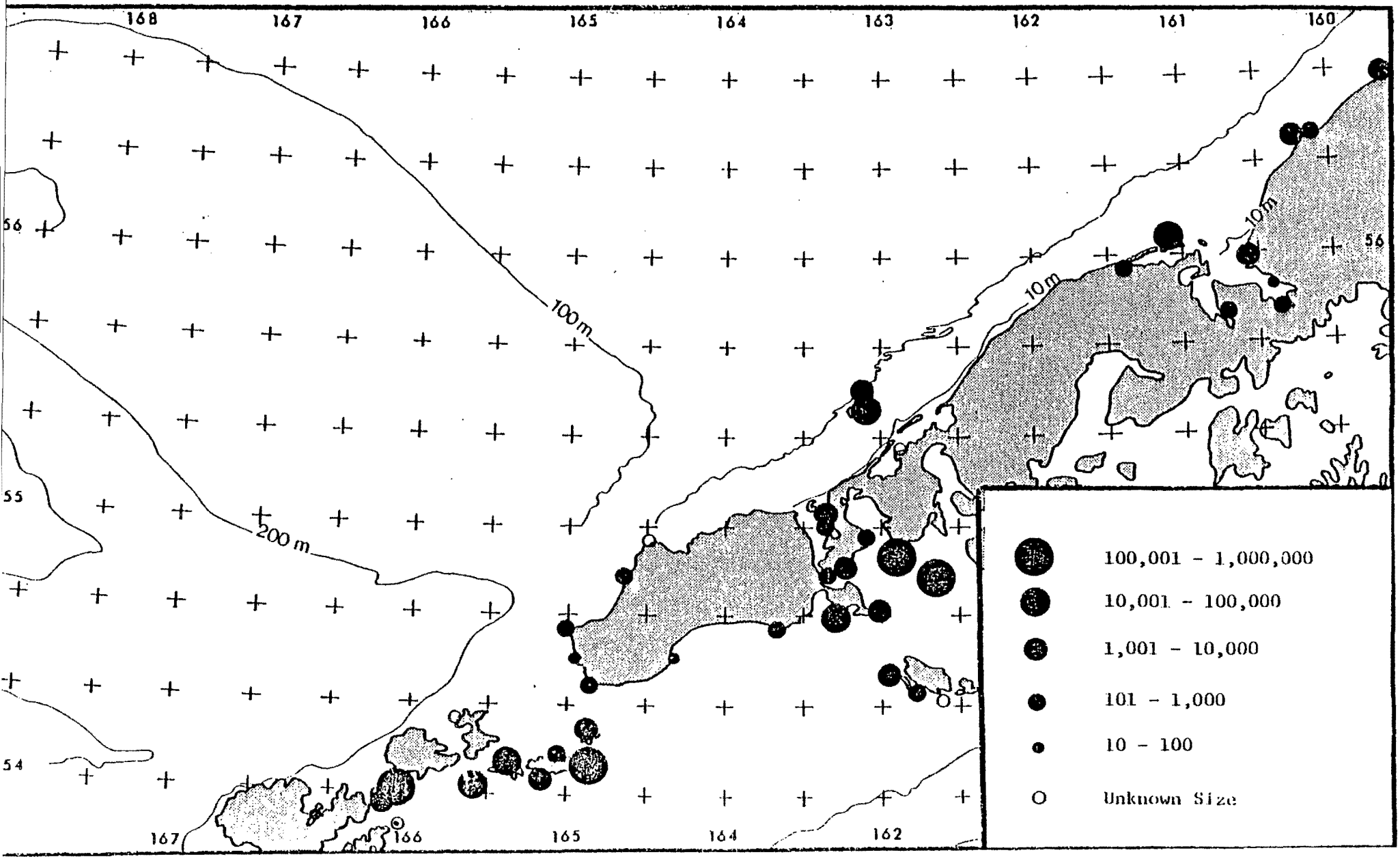


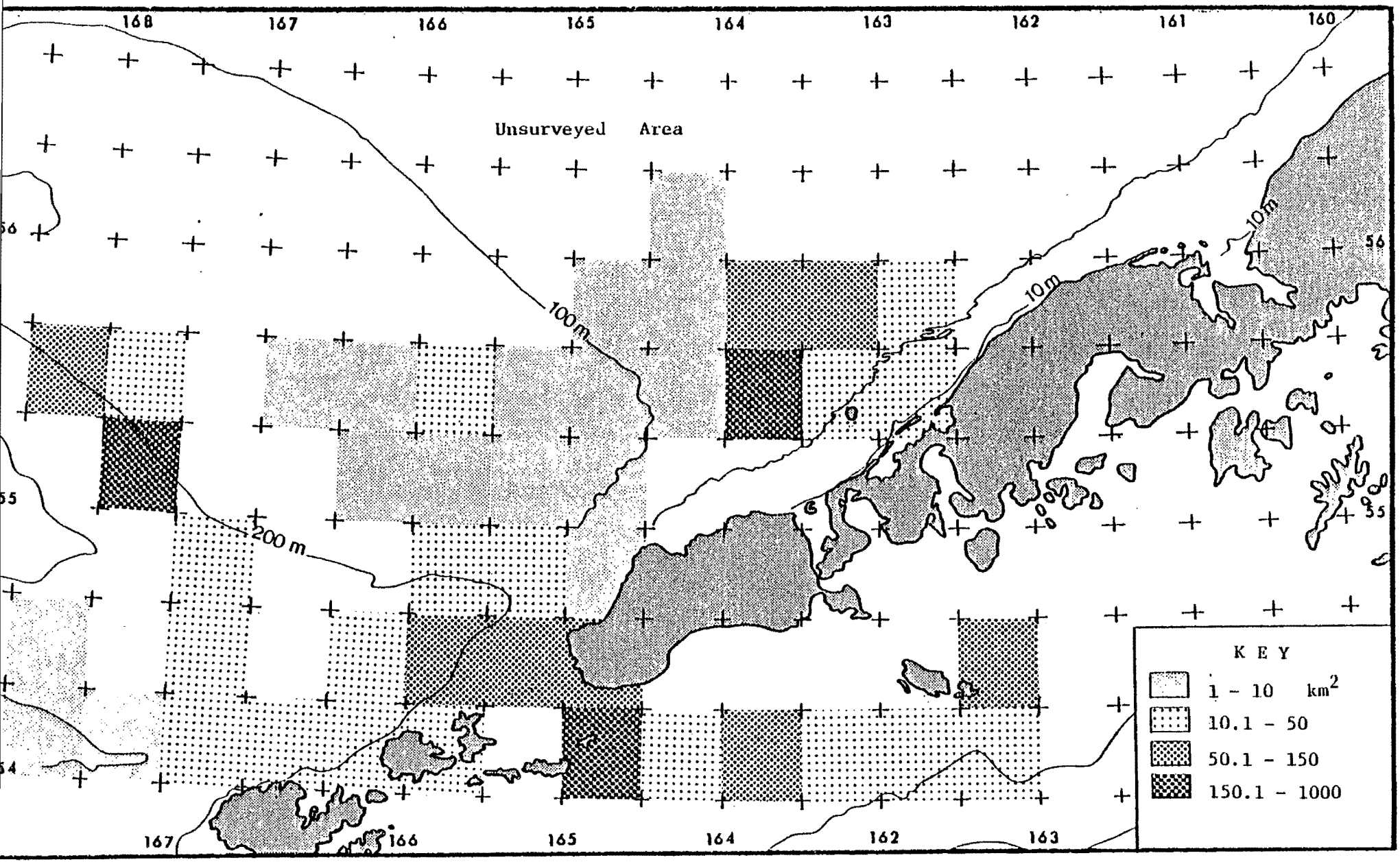
Distribution and Abundance of Seabirds in the Region of Unimak Pass During Summer. An estimated 10-15 million birds were present on surveyed areas and perhaps 20 to 30 million birds were present on the entire area covered by the map. During summer a large part of the population is composed of Sooty and Short-tailed Shearwaters which nest in the southern hemisphere. Other major species, all of which nest in Alaska, include murres, puffins, kittiwakes (including the rare Red-legged Kittiwake), storm petrels, several species of auklets and the Northern Fulmars. Data are based on censuses conducted by the FWS from oceanographic vessels during June, July, and August 1975.

Figure 5

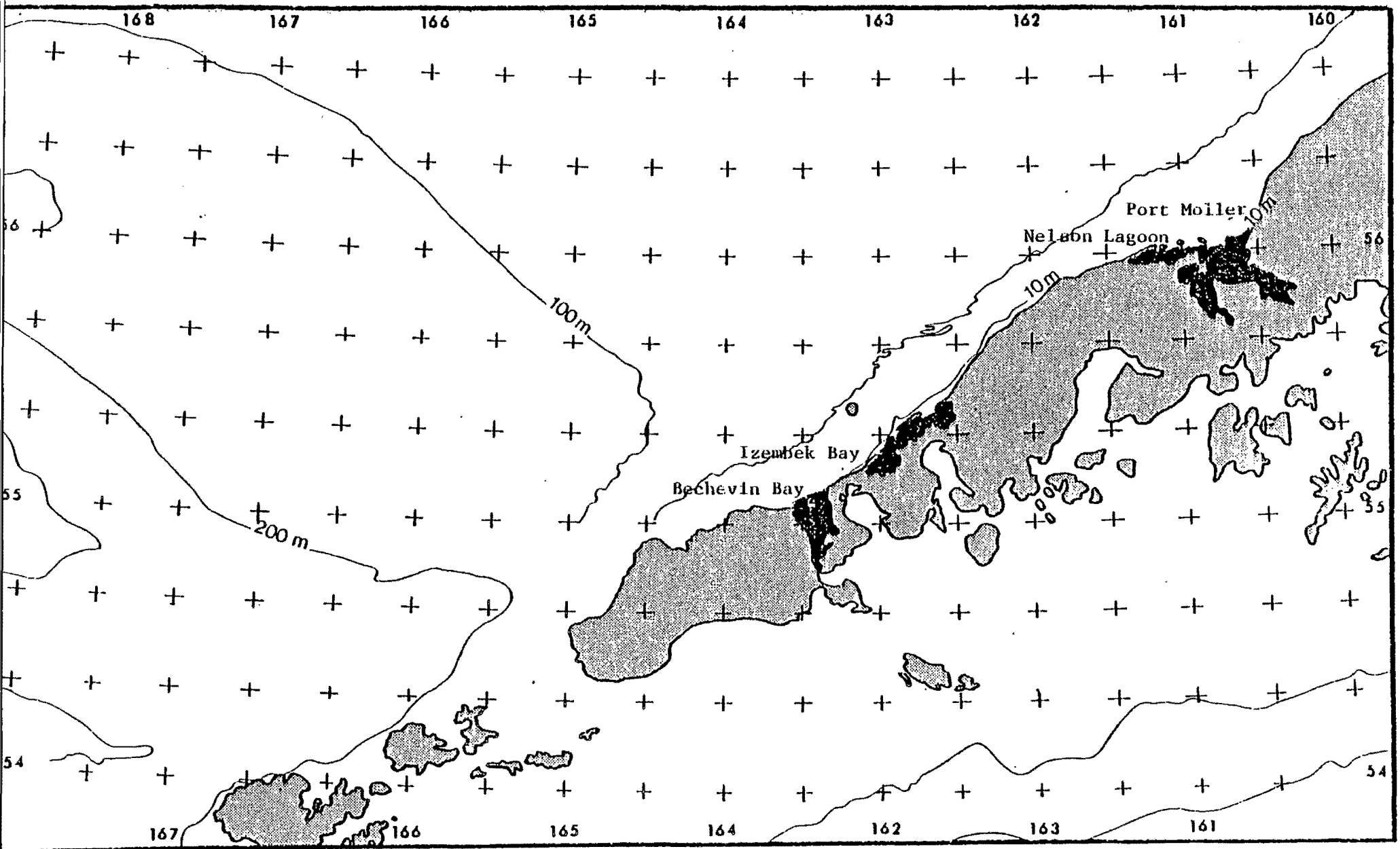


Nesting Colonies of Seabirds. The Alaska Peninsula and the eastern Aleutian Islands provide nesting areas for large numbers of seabirds. The area has not been adequately surveyed, but known colonies shown on the map have a nesting population of more than 1.2 million birds. Major species are Horned and Tufted Puffin, Fork-tailed and Leach's Storm Petrels, Common and Thick-billed Murres, and Cassin's Auklet.

Figure 2



Distribution and Abundance of Seabirds in the Region of Unimak Pass During Winter. The population on censused areas totaled between 2.5 and 5 million birds and total area covered by the map probably supports between 7.5 and 15 million birds. Populations are much smaller in winter when shearwaters and other species migrate south. The most abundant species occurring in winter are murres and several species of auklets. In winter several species of ducks, including Oldsquaws, Common and King Eiders, and scoters are also found at sea, usually in shallow regions near shore or at the edge of pack ice. Winter populations are frequently under stress because of cold, and frequent storms, therefore, are more vulnerable to additional man-caused stresses than at other seasons. Data are based on [illegible] conducted from oceanographic vessels during November



Essential Habitat. The shallow lagoon systems of the Alaska Peninsula provide critical staging areas for migrant waterfowl and shorebirds. The entire world population of Black Brant, about 110,000, stage in Izembek Bay in April and May and again from late August to November. Other waterfowl dependant on lagoon systems of the Alaska Peninsula include 95,000 Emperor Geese, 200,000 Steller's Eiders, and 235,000 Black Scoters. Up to 300,000 King Eiders winter offshore. Intertidal habitats support large numbers of Bar-tailed Godwits, Black Turnstones, Dunlins, and Rock and Western Sandpipers.