ANNUAL REPORT

Contract # 03-5-022-69
Research Unit #3-4
Reporting Period - 5 Sept. 1975-
31 March 1976

# Identification, Documentation and Delineation of Coastal Migratory Bird Habitat in Alaska.

Paul D. Arneson

Alaska Department of Fish and Game

April 1, 1976

## I. Summary

An aerial survey was conducted along the shoreline and in the estuaries of the north side of the Alaska Peninsula during the fall migration of waterfowl. The avifauna of the estuaries at that time was extremely abundant although the peak of migration was not in progress. The migration for some species had already occurred and others were yet to commence. Concurrent habitat surveys revealed large expanses of feeding and likely nesting habitat above high tide but below storm tide levels that were associated with the estuaries or freshwater streams. Entire world populations of certain species and discrete subpopulations of other species utilize these areas for staging prior to migration. An oil spill during the fall could immediately affect 100,000 seaducks inhabiting those waters. The long-term effects of damage to the ecosystem could produce much more devastating results. Destruction of plant and animal food sources in the estuaries would have great long-lasting impact on several populations. The eelgrass beds of Izembek Lagoon are the most renowned food source for many bird species, perhaps the most critical being black brant. Onshore oil and gas development in or near any of the estuaries could cause equal harm to large numbers of birds.

In Lower Cook Inlet it appeared from aerial surveys that the severity of winter could influence how damaging an oil spill would be. Prior to the survey mild weather predominated and ice had retreated in bays. During the short duration of the survey when cold weather prevailed, ice quickly formed, conceivably forming a barrier to oil on the water. This would save shoreline habitat but perhaps concentrate the seaducks and other marine birds where they would be more susceptible. The coast from Port Chatham to Gore Point remained relatively ice-free and there was perhaps a more diverse composition and greater density of birds there than on the ice bound northern portion of Lower Cook Inlet. On a long-term basis, oil development would not be as harmful to the relatively small numbers of birds wintering on nearshore waters of this region as it would be to the food sources.

Without further data analysis of bird surveys on Kodiak Island, absolute densities are not known. However, large groups of murres, cormorants and seaducks were recorded in count areas. Large flocks of other alcids were seen outside the count areas. These are the species most vulnerable to direct oiling and their wintering populations could be substantially reduced on Kodiak in the event of an oil spill. A milder climate resulting in more ice-free bays cause far greater densities and species diversity of wintering birds on Kodiak than on portions of Lower Cook Inlet. Location of onshore oil and gas facilities would determine the extent of potential damage to bird populations. Protected waters in bays are most ideally suited for development but also the greatest densities of birds were found in these waters.

## II. Introduction

There are approximately 54,700 km of tidal coastline in Alaska with an associated 1,425,000 $km^2$ of outer continental shelf (Sowl and Bartonek 1974). This vast coastline and the associated continental shelf provide abundant habitat to millions of seabirds, waterfowl, passerines and other birds at some stage of their life cycle. Sanger (1972) estimated that 51 million seabirds summer in subarctic Alaskan waters and Nisbet (1975) suggested a magnitude of 100 million birds for all Alaskan waters. Most of these except shearwaters breed on islands or other portions of the coastline. According to Sanger (1972), who conducted pelagic boat surveys, about 8 million seabirds winter in Alaska but this estimate may increase when more information is obtained on wintering populations near shore. Over 13 million waterfowl including 1 million geese, 12 million ducks, 70,000 swans and 150,000 cranes utilize Alaskan waters for breeding, migration staging or wintering (A.D.F.& G. 1975). An undetermined number of passerines, raptors and other birds use the littoral zone during some or all seasons of the year.

Most major waterfowl, shorebird and seabird habitats are known, but in most instances bird use or habitat diversity and size are not well quantified. Many areas of lesser importance have not been identified. Since the State of Alaska's jurisdiction extends out three miles from the coast and since this is the area most crucial to all breeding and many feeding marine birds, it is extremely important to fully assess the avifauna of the littoral zone to determine which areas are more critical than others for proper land-use planning.

In order to evaluate coastal areas to determine which areas are more critical than others, it is necessary to synthesize existing literature and unpublished data on the distribtuion, abundance, behavior and food dependencies of birds associated with littoral and estuarine habitat within the study area. Since many areas have not been surveyed either in a particular season or in a quantitative manner, it is also necessary to conduct surveys to determine the seasonal density distribution, migratory routes, chronology of migrations, breeding locales and critical habitats for all bird species utilizing the littoral zone within the study area.

Many factors threaten Alaska's seabird populations but developments by the petroleum industry including onshore and offshore drilling, pipelines, ship transport and various associated activities pose the greatest potential hazard to birds (King and Lensink 1971). Oil spills in marine waters directly affect many species of pelagic feeding and molting birds including shearwaters, fulmars, kittiwakes, phalaropes, gulls, alcids, cormorants and seaducks (Bartonek et al. 1971). The mechanical effect of oil on bird plumage is well documented (see Vermeer and Vermeer 1974). Less obvious are the long-term effects on the ecosystem. Organisms lower on the food chain than the birds may be affected less dramatically but the long-term impact on the avifauna can be great. This may be especially true when oil is washed by tides or winds onto the productive littoral zone. Food organisms-both plant and animal-may be killed, thereby destroying extensive areas of feeding habitat for many ducks, geese and shorebirds (Vermeer and Vermeer 1975).

It is therefore essential to assess all coastline habitats for species composition and abundance of birds on a seasonal basis in order to determine use of the areas and then set priorities as to their importance to birds. This first assessment will be an extensive reconnaissance of the study area. Specific sites found to be more important than others will be studied intensively to determine why birds are attracted to them. More stringent restrictions on oil development could then be set for those areas determined to be most critical.

III. Current state of knowledge

Much of the literature to date deals with pelagic surveys, colony information, general life history and distribution information on seabirds, and censuses of waterfowl-particularly game ducks and geese. Little quantitative information exists or seasonal use of the littoral zone by marine birds. Listed below are brief accounts of what is know about bird use of the intertidal zone of the eight subunits of the study area. Tables in these accounts represent minimal numbers of ducks and geese because coverage was usually sporadic or opportunistic and observers had varying degrees of experience at estimating numbers of birds from aircraft. These tables are included to show the relative importance of a few areas and the paucity of significant information that is available. As will be reported later, methods used, timing and conditions during surveying can greatly affect the numbers of birds observed.

North-Bristol Bay

Summer: A seabird colony on the cliffs of Cape Newenham is one of the largest in the North Pacific (King and Lensink 1971) and other large rookeries are present in the Walrus Islands. Nesting waterfowl are most abundant in the Kvichak Bay and Nushagak Peninsula areas. Nearshore waters are commonly used by feeding birds and to a lesser extent by molting birds.

Winter: During severe winters heavy icing conditions preclude use of this area by wintering birds. They will, however, utilize open leads in the ice or ice-free areas in mild weather.

Migration: Bays and river mouths receive extensive use by waterfowl and shorebirds during both spring and fall migrations. Spring migrants may be held up there while waiting for thawing further north. During fall many migrants may bypass this area for staging if conditions are right for continuing their flight.

Table 1 lists surveys of game ducks and geese done by ADF&G personnel during several different times of the year. Most noteable is the use of Nanvak Bay during the late summer and fall and Nushagak Flats during spring migration. A portion of the nearshore area of this region was surveyed by King and McKnight (1969) who found an average of 47.8 birds per square mile during October. A pelagic survey in May 1972 (USDI-USFWS 1972) revealed 52.1 birds per square mile but most of these were found in nearshore waters on both the north and south ends of the transects.

Table 1: Ducks and geese found in bays of the north side of Bristol Bay by aerial survey.

| Location | Date of Survey 5-4-70 | 6-30-70 | 8-24-70 | 6-7-71 | 9-8-71 |
|---|---|---|---|---|---|
| Nanvak Bay | - | - | 3467 | 200 | 2000 |
| Osviak Bay | - | - | - | 24 | 500 |
| Kanik River | 30 | - | 1804 | - | - |
| Tvativak Bay | 43 | - | 400 | - | - |
| Protection Point | 50 | 705 | 282 | - | - |
| W. Nushagak Flats | 1073 | 681 | 236 | - | - |

North-Alaska Peninsula

Summer: Most of the habitat of the north side of the Alaska Peninsula is not suitable for nesting seabirds. There are, however, rookeries on Amak Island, Unimak Island and Cape Seniavin. An estimated 1120 pelagic and red-faced cormorants plus 15 times as many black-legged kittiwakes were counted at Cape Seniavin on June 8, 1971 (ADF&G 1973). Little is known about the amount of nesting between the stormtide and high tide line by waterfowl, shorebirds and other bird species.

Bristol Bay is used extensively by feeding birds during summer and to some degree by molting waterfowl. Bartonek and Gibson (1972) found 32 species of birds during pelagic boat surveys during July and August 1972 but many of the individuals were on nearshore waters or sighted from land.

Winter: Much of Bristol Bay freezes during cold winters and wintering birds are forced to the southern part of this area. Hundreds of thousands of diving ducks and seabirds use the area as winter habitat (USDI-USFWS 1972). The massive die-off of common murres in April 1970 (Bailey and Davenport 1972) from Unimak Island to Port Heiden due to intense storms revealed that many of the birds were wintering in nearby waters. Total mortality may have been greater than 100,000 murres.

Migration: The most important function of the intertidal zone of the north side of the Alaska Peninsula is as a staging area for migrant birds. The lagoons and estuaries provide excellent habitat for spring migrants waiting for northern areas to thaw. More spectacular are the concentrations of waterfowl using the area in the fall. King and Lensink (1971) stated: "The entire world population of American emperor geese and black brant can be found in this area in October. Most of the cackling Canada geese, large numbers of lesser Canada geese and substantial numbers of snow geese can also be found here in October." Ducks and shorebirds exceed the geese in abundance although the timing of their migration many differ. The most renowned estuary is Izembek Lagoon which contains the largest eelgrass beds in the world. Migrating black brant utilize this plant to acquire sufficient energy stores for their sustained migration across the Gulf of Alaska. Jones (in press) reported that most bird species in the Cold Bay area depend on the eelgrass beds of Izembek Lagoon either directly or indirectly.

Table 2 also points out the importance of estuaries on the Alaska Peninsula to fall migrant waterfowl. Since these counts did not represent total coverage of the areas and other species of birds were not tallied, they do not depict the true value of the estuaries to avian species. Year to year differences likely represent timing of the surveys. They may have just preceded or succeeded a vast waterfowl migration. The survey by King and McKnight (1969), which consisted of transects running from the shoreline out to twelve miles offshore, also demonstrated the importance of this area to migrating birds. Their total population estimate which did not include the estuaries was 385,702 birds. Almost half of this total were scoters.

Table 2. Ducks and geese* found in estuaries of the north side of the Alaska Peninsula and Unimak Island by aerial survey.

| Location | Date of Survey 10-23-68 | 5-13-69 | 10-6-69 | 12-15-69 | 3-3-70 | 6-29-70 | 8-25-70 | 9-24-70 | 10-8-70 | 9-14-71 | 10-4-71 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Egegik | 170 | 1397 | 43,580 | - | 0 | 1671 | - | - | - | - | 4478 |
| Ugashik | 2550 | 1145 | 70,190 | - | 1000 | 1142 | 2128 | 7362 | 75,850 | 3408 | 19,300 |
| Cinder River | 50,000 | 5200 | 115,000 | 1250 | 500 | 869 | 7271 | 20,195 | 25,450 | 3498 | 38,313 |
| Port Heiden | 41,000 | 4800 | 99,350 | 405 | - | 2499 | 5355 | 118,800 | 56,190 | 5762 | 51,765 |
| Ilnik | 38,500 | 3110 | 16,500 | 1156 | - | 3038 | 4460 | 16,965 | 7400 | 7906 | 39,812 |
| Port Moller | 3177 | 3641 | - | 7025 | - | 1461 | - | 35,770 | 44,962 | 6630 | 444,655 |
| Hook Lagoon | - | - | - | - | - | 81 | 1510 | 4550 | - | - | - |
| Kvichak River | - | - | - | - | - | - | 245 | - | - | - | - |
| Urilia Bay | - | - | - | - | - | - | - | - | - | - | 17,000 |
| Swanson Lagoon | - | - | - | - | - | - | - | - | - | - | 9365 |

* The total does not represent a complete count of each area and the experience of observers to estimate numbers varied. All counts were from a fixed-wing aircraft.

South-Alaska Peninsula

Summer: The habitats of the south side of the Alaska Peninsula are not conducive to waterfowl and shorebird nesting, but the topography provides ideal nesting cliffs for seabirds. Over 30 recorded major seabird colonies are found on the shores of the mainland and the many islands in this region. Exposure to the open ocean and inclement weather has prevented thorough searching of this area for nesting birds so more colonies are likely to be discovered. The extent of use by other bird species using the littoral zone is generally unknown at present.

Winter: Warm ocean currents keep this area relatively ice-free in winter resulting in substantial use by wintering birds. Table 3 includes a winter survey of the area and most of the species encountered were sea ducks (eiders, scoters and old squaw) and emperor geese. Seabirds were not recorded on these flights but three areas were suggested as deserving consideration as key waterfowl habitat: Kujulik Bay, Morzhovoi Bay and the Sanak Islands. On the latter, Canada geese, swans and mallards were also found wintering. Quantitative information on wintering seabirds is not available but numbers are likely substantial.

Migration: Few estuaries are present on the south side of the Peninsula for use as staging areas for migrating birds. Nevertheless, the many dabblers observed on the October 1972 survey indicate use is made of river mouths and the lagoons that are present in the area. Black brant also use Morzhovoi and Cold Bays on the western end of the Peninsula.

Kodiak-Afognak

Summer: The steep rocky coastline and many small islands of Kodiak-Afognak Islands are quite conducive to seabird nesting. Over 85 colonies have been recorded and many more will likely be reported with further intensive surveys. In July and August 1975 Dick et al. (1975) visited 59 colonies in Chiniak and Marmot Bays and reported the most abundant species to be tufted puffins, black-legged kittiwakes, glaucous-winged gulls and common murres. Nesting habitat for waterfowl and shorebirds is limited but several species do breed on Kodiak and Afognak Islands.

Nearshore waters provide feeding habitat for many breeding and non-breeding birds. Pelagic boat surveys were conducted in summer 1975 in the region (USFWS 1975) with the following results: "Densities of birds were consistently high near the Barren Islands and Afognak Island and along the entire outer coast of Kodiak Island. Densities are probably significantly higher in the inshore waters and the populations represented by a greater number of species but these areas were not surveyed to the same extent as were the offshore waters."

Winter: More winter bird surveys have been conducted for Kodiak than any other portion of the state. Table 4 lists the results of ADF&G surveys for waterfowl and Table 5 lists boat surveys for all species by Kodiak National Wildlife Refuge personnel (USFWS in prep.). Many species use the littoral zone and coastal waters of Kodiak in winter. Most

Table 3. Ducks and geese found in bays of the south side of the Alaska Peninsula by aerial survey.

| Location | Date of Survey 3/20-23/70 | 10/11-12/72 |
|---|---|---|
| Puale Bay | | 685 |
| Portage Bay | | 184 |
| Wide Bay | 462 | 631 |
| Agripina Bay area | 465 | 200 |
| Chiginagak Bay area | 505 | 352 |
| Yantarni Bay area | 625 | 141 |
| Amber Bay | 465 | 240 |
| Aniakchak Bay | 1145 | 449 |
| Cape Kumlik | 198 | |
| Sutwik Island | 263 | |
| Kujulik Bay | 3915 | 391 |
| Cape Kumlium | 250 | |
| Hood Bay | 20 | |
| Chignik Bay | 430 | 35 |
| Chignik Lagoon | | 1153 |
| Castle Bay | 95 | 287 |
| Castle Cape to Seal Cape | 65 | |
| Kuiukta Bay | 5 | |
| Mitrofania Bay & Island | 38 | |
| Ivanoff Bay | 65 | 1043 |
| Stepovak Bay | 42 | 862 |
| Grub Gulch Bay | | 241 |
| Clark Bay | | 104 |
| Orzinski Bay | 124 | 85 |
| American Bay | | 62 |
| Chichagof Bay | | 76 |
| Dorenoi Bay | 295 | 32 |
| Balboa Bay | 510 | |
| Beaver Bay | 123 | 224 |
| Shumagin Islands | 4086 | |
| Canoe Bay | | 1362 |
| Pavlof Bay | | 715 |
| Pavlof Islands | 1118 | |
| Deer Island | 345 | |
| Sandman Reefs | 412 | |
| Sanak Islands | 2762 | |
| Cold Bay | 462 | 3057 |
| Morzhovoi Bay | 2925 | 4439 |
| Otter Cove | 434 | |

Table 4. Ducks and geese found in bays of Kodiak Island by aerial survey.

| Location | Date of Survey 1-19-66 | 2-11-66 | 3-14-66 | 11-11-66 | 3-12-69 | 1-21-71 | 2-18-72 |
|---|---|---|---|---|---|---|---|
| Sharatin Bay | | | 30 | | 2 | 175 | |
| Kizhuyak Bay | | | 149 | | 4 | 79 | |
| Settler Cove | | | | | 8 | | |
| Spruce Bay | | | | | 75 | | |
| Viekoda Bay | | | 2 | | 30 | 85 | |
| Terror Bay | 270 | 385 | 616 | 288 | 102 | 155 | |
| Uganik Island | | | 231 | | 23 | | |
| N.E. Arm Uganik | | | 205 | | | | |
| E. Arm Uganik | 573 | 392 | 489 | 229 | 125 | 576 | |
| S. Arm Uganik | | | 15 | | | | |
| Spiridon Bay | | | 101 | | 6 | 138 | |
| Zachar Bay | 111 | 668 | 470 | 612 | 235 | | |
| Larsen Bay | 197 | | 6 | 184 | | 1058 | |
| Uyak Bay | 991 | 1237 | 1378 | 1325 | 490 | | |
| Karluk Lagoon | | | 90 | | | | |
| Sturgeon Lagoon | | | | | 235 | | |
| Halibut Bay | | | | | 75 | | |
| Sukoi Lagoon | | | | | 300 | | |
| Alitak Lagoon | | | | | 150 | | 85 |
| Tugidak Island | | | | | 600 | | 390 |
| Sitkanak Lagoon | | | | | 50 | | |
| Deadman Bay | | | | | | | 125 |
| Olga Bay | | | | | | | 170 |
| Portage Bay | | | | | 75 | | 145 |
| Kaiugnak Bay | | | | | 175 | | 175 |
| Three Saints Bay | | | | | | | 310 |
| Barling Bay | | | | | 100 | | 50 |
| Midway Bay | | | | | 30 | | 120 |
| Amee Bay | | | | | 15 | | |
| Port Holbron | | | | | 8 | | |
| McDonald Lagoon | | | | | 45 | | |
| Hidden Basin | | | | | 123 | | |
| Kiliuda Bay | | | | | 410 | | 528 |
| Shearwater Bay | | | | | 130 | | |
| Gull Cape | | | | | | | 75 |
| Eagle Harbor | | | | | 50 | | |
| Ugak Bay | | | | | | 469 | |
| Saltery Cove | | | | | 60 | | |
| Pasagshak Bay | | | | | | 125 | |
| Narrow Cape | | | | | | 258 | |
| Chiniak Cape | | | | | | 257 | |
| Kalsin Bay | | | | 35 | | 360 | |
| Middle Bay | | | 261 | 175 | | 181 | |
| Women's Bay | | | 30 | | | 375 | |
| Monashka Bay | | | | | 160 | | |

Table 5. Marine bird survey via M/V Aleutian Tern by Kodiak National Wildlife Refuge personnel, Jan. 25-Feb. 8, 1973 and Feb. 5-22, 1975.

| | 1973 | 1975 |
|---|---|---|
| Loon sp. | 424 | 83 |
| Grebe sp. | 7 | 72 |
| Red-necked | 1 | |
| Cormorant sp. | 1982 | 1728 |
| Emperor Geese | 621 | 52 |
| Mallard | 700 | 2556 |
| Pintail | 200 | 4 |
| Gadwall | 30 | 75 |
| Dabbler sp. | - | 50 |
| Scaup (Greater) | 80 | 15 |
| Goldeneye sp. | 1142 | 1205 |
| Common | 146 | |
| Barrows | 24 | 30 |
| Bufflehead | 36 | 27 |
| Harlequin | 691 | 675 |
| Eider sp. | 67 | 1745 |
| Common | 4512 | 58 |
| King | | 4654 |
| Steller's | 340 | 1176 |
| Old squaw | 7863 | 9410 |
| Scoter sp. | 3192 | 994 |
| Black | 2154 | 1402 |
| White-winged | 3059 | 2073 |
| Surf | 1194 | 327 |
| Merganser sp. | 39 | 27 |
| Common | 21 | 21 |
| Red-breasted | 13 | 34 |
| Hawk sp. | | 3 |
| Marsh | | 1 |
| Bald Eagle age? | 4 | 8 |
| Adult | 183 | 179 |
| Immature | 37 | 50 |
| Golden Eagle | | 1 |
| Sandpiper sp. | | 50 |
| Gull sp. | 124 | 1589 |
| Glaucous-winged | 32 | 923 |
| Mew | 356 | 731 |
| Murre sp. | 8420 | 14,994 |
| Common | | 179 |
| Thick-billed | 66 | |
| Pigeon guillemot | 46 | 106 |
| Horned Puffin | | 1 |
| Tufted Puffin | | 1 |
| Crested Auklet | 15,083 | 7011 |
| Murrelet sp. | 63 | 280 |
| Ancient | 3 | |
| Magpie | 28 | 84 |
| Raven | 8 | 3 |
| Crow | 524 | 879 |

emperor geese are found on the lowland areas at the south end of the island, mallards and other dabblers inhabit the deltas of fresh water streams and lagoons, and auklets prefer tidal upwelling areas of Whale Passage and Alitak and Uyak Bays. Seaducks and other alcids are well dispersed in bays throughout the island.

Migration: No extensive staging areas are found on Kodiak but many migrants stop over either in the spring or fall. Detailed records of the chronology of migration have been kept for the past three years by Richard A. MacIntosh, National Marine Fisheries Service biologist. Some species that frequent the island in the spring such as black brant bypass the island in their southern fall migration.

Lower Cook Inlet

Summer: Fourteen colonies of nesting seabirds were listed by ADF&G (1973) within the boundaries of Lower Cook Inlet (as delineated by this report) but many more subcolonies have been discovered the past two summers by the USFWS in the Barren Islands (Bailey 1975a). Bailey's summer estimate of birds on the Barren Islands includes 205,000 tufted puffins, 91,000 common murres, 33,800 black-legged kittiwakes and 15,700 horned puffins. In another study of the colonies on Tuxedni National Wildlife Refuge, Snarski (1971) estimated 45,000 black-legged kittiwakes, 20-25,000 common murres and 4-5000 horned puffins. It is unknown how far these birds travel from their nests to feed but it may be as far as 12 miles or more. In a report by Bailey (1975b) of six air transects flown 12 miles out from the Barren Islands, affinity for shore was less evident than in other areas because shearwaters predominated in the transects. In their combined surveys greatest densities were within three miles of shore. The seabird density for July in this area was an astounding 1,238 birds per square mile.

Winter: Too few winter bird surveys have been done to adequately assess the importance of Lower Cook Inlet to wintering populations. Transects flown by ADF&G at the mouth of Kachemak Bay in December 1968 revealed 9,966 ducks (including dabblers, divers and sea ducks). Another 10,000 scoters were seen near Dangerous Cape of which only 1500 were in the transect. Nearshore waters appear to have large numbers of sea ducks and larids and some wintering shorebirds but few alcids.

Migration: Massive concentrations of waterfowl and shorebirds use river deltas for feeding prior to migration in both spring and fall. Table 6 lists a few superficial surveys done primarly during migration periods. The most important of these areas are the Kenai RiverFlats, Fox River Flats, Bachatna Flats and Drift River Flats. Several others are important in Upper Cook Inlet.

South-Kenai Peninsula

Summer: Little is recorded for summer bird populations in this region except for 13 known major seabird colonies. Likely many more colonies are present along this rocky coastline and a more intensive search for them is planned. Little habitat is available for dabblers and shorebirds

Table 6. Ducks and geese found in bays in Lower Cook Inlet by aerial survey.

| Location | Date of Survey 8-25-69 | 9-9-69 | 10-2-69 | 4-16-70 | 6-1-70 | 8-12-70 | 9-28-70 | 2-9-71 | 5-12-71 | 10-5-71 | 11-3-72 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Redoubt Bay | 1626 | 2632 | 2630 | 1170 | | 1917 | 2587 | | | 3531 | |
| Kalgin Island | | | | 50 | 39 | 71 | | | | | |
| Fox River Flats | | | | | | | | 915 | 1650 | | 1950 |
| Aurora Lagoon | | | | | | | | 50 | 0 | | 334 |
| Halibut Cove | | | | | | | | 185 | 250 | | 408 |
| China Poot Bay | | | | | | | | 110 | 0 | | 682 |
| Neptune Bay | | | | | | | | | | | 18 |
| Sadie Cove | | | | | | | | 56 | 5 | | |
| Tutka Bay | | | | | | | | 165 | | | |
| Kasitsna Bay | | | | | | | | | | | 390 |
| Jackolof Bay | | | | | | | | 160 | | | |
| Seldovia | | | | | | | | 195 | 128 | | |
| Port Graham | | | | | | | | 208 | 1025 | | |

except at the heads of some bays. Breeders from nearby colonies and some non-breeders from other parts of Alaska feed in nearshore waters. These would generally consist of alcids, larids, cormorants and some seaducks.

Winter: Little is known of wintering bird populations in this region. Since it is warmed by ocean currents, the bays are relatively ice-free and many seaducks, alcids, larids, cormorants and loons likely inhabit nearshore areas while dabbler and diving ducks occupy heads of bays and lagoons. Unknown numbers of shorebirds, particularly rock sandpipers and black oystercatchers, would also be present.

Migration: Although no extensive areas for staging are present, many migrating birds pass over or by this region. In fall some waterfowl cross the Kenai Mountains over Upper Russian Lake on the Kenai Peninsula and follow the Resurrection drainage down to Seward and out to the ocean. The reverse may be true in spring and other birds may also use this corridor. Other birds follow the outer coastline to Lower Cook Inlet but it is likely few stop to feed in this area.

Prince William Sound

Summer: Isleib and Kessel (1973) published a comprehensive account of bird species found within this area during all seasons. Their annotated list of birds contains all species found and an estimate of the birds' abundance in factors of 10 for all seasons. Isleib (1971) stated that of the 208 species known to occur in the area, 100 are present in summer. Several species utilize inshore areas for feeding. Eight major colonies are listed for the area (ADF&G 1973) but many more are likely present. The most abundant species found on these rocky rookeries are alcids, larids and cormorants. The 250,000 marbled murrelets found on a USFWS survey in 1972 constituted the largest avian biomass in Prince William Sound (Isleib and Kessel 1973). Large concentrations of non-breeders, particularly scoters, also use the area in summer.

Winter: With protected, ice-free bays, inlets and fiords Prince William Sound offers excellent winter habitat for many species of waterbirds. According to Isleib (1971) 71 species overwinter in the vicinity. Most summering species remain and are joined by loons, grebes and shorebirds. Many dabblers winter along stream mouths along with Canada geese and many shorebirds.

Migration: Most migrants in both summer and fall are only transients through this area, preferring extensive staging habitats in adjacent regions. Many species travel up and over the mountains to the north and west of Prince William Sound using corridors such as Portage Pass. Other groups of birds follow the outer islands over to the Kenai Peninsula or bypass the area by flying over the Gulf of Alaska.

Northeast Gulf of Alaska

Summer: The Copper River Delta is by far the best habitat in this region for breeding and staging birds, although the 1964 earthquake raised the land 6-8 feet and caused slight changes in species composition of nesting birds. Most of the world's population of dusky Canada geese now numbering 17,000-26,000 (breeding population), nests on the Delta. Their numbers have not changed significantly since the earthquake and the same is true for trumpeter swans (Mickleson in prep.) An aerial survey of swans in 1974 revealed 282 birds with 52 active nests (Mickleson in prep.). About 5,000 pairs of ducks are summer residents of the Delta (Michelson 1975) and their numbers were reduced significantly by the earthquake. At least seven species of shorebirds breed on the Delta but their numbers have not been estimated.

In other parts of NEGOA breeding and summering birds occur in protected waters of river deltas and bays but their numbers have not been estimated. On a flight over Russell Fiord 4300 molting scoters were observed by ADF&G biologists in July 1975. As many as 10,000 breeding pairs of glaucous-winged gulls occur in NEGOA with most of these on the islands near Copper River Delta (Samuel M. Patten, Jr. pers. comm.).

Winter: Because of exposure to the open ocean, few birds winter in this region. Little is recorded for wintering populations in southern portions of NEGOA.

Migration: The primary use of this region is for staging both in spring and fall. Tremendous concentrations of waterfowl and shorebirds utilize the tidal and marsh areas of this region. Densities of 250,000 shorebirds per square mile were recorded in May 1964 (Isleib and Kessel 1973). Fall migration is not as intense and concentrated with the chronology differing greatly between species. The Copper River Delta and Orca Inlet are the most prominent of the staging areas and host as many as 20 million birds (Isleib and Kessel 1973). Other deltas and bays are utilized farther down the coast but little is known of the magnitude of their use. For example, a concentration of 10,000 arctic terns remained several days near Ocean Cape on the east side of Yakutat Bay in July 1968 (Islieb and Kessel 1973). During some fall migrations, birds overfly the area entirely, attemping instead to get farther south while suitable weather conditions prevail.

IV. Study Area

The portion of Alaskan coastline under direction of the Anchorage ADF&G office for this study is bounded on the north by Cape Newenham and on the south by Cape Fairweather and includes Kodiak-Afognak Islands (Fig. 1). ADF&G's responsibility in the arctic, directed by the Fairbanks' office, is reported by George Divoky. Studies of the Alaskan coast from Cape Newenham to Cape Prince of Wales are under the direction of the USFWS.

A further breakdown of the Gulf of Alaska and Bristol Bay into eight subunits is shown in Fig. 2: Area 1, Northeast Gulf of Alaska,

Figure 1. Study area for OCSEAP coastal marine bird project, Alaska Department of Fish and Game, Anchorage Office, Cape Newenham to Cape Fairweather.

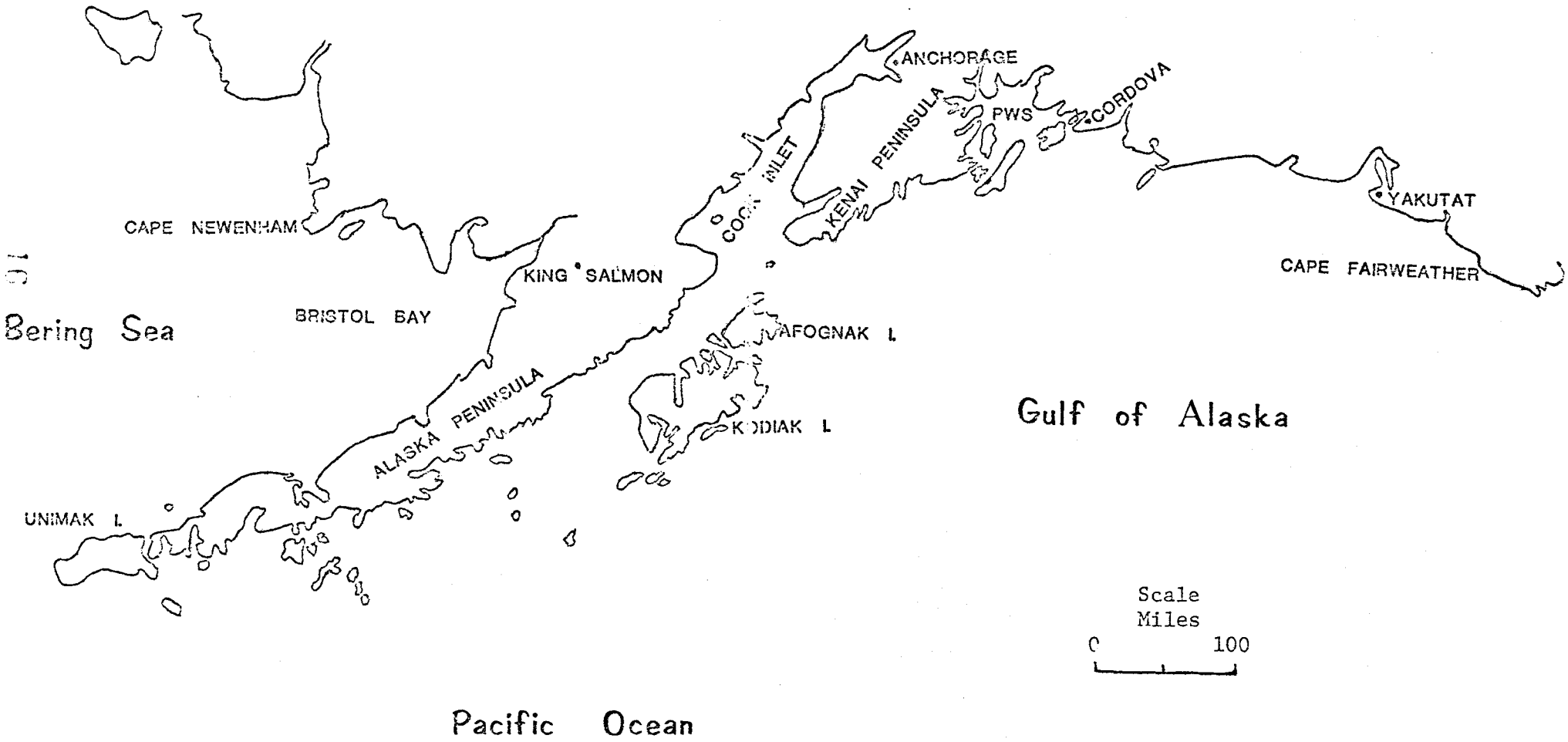
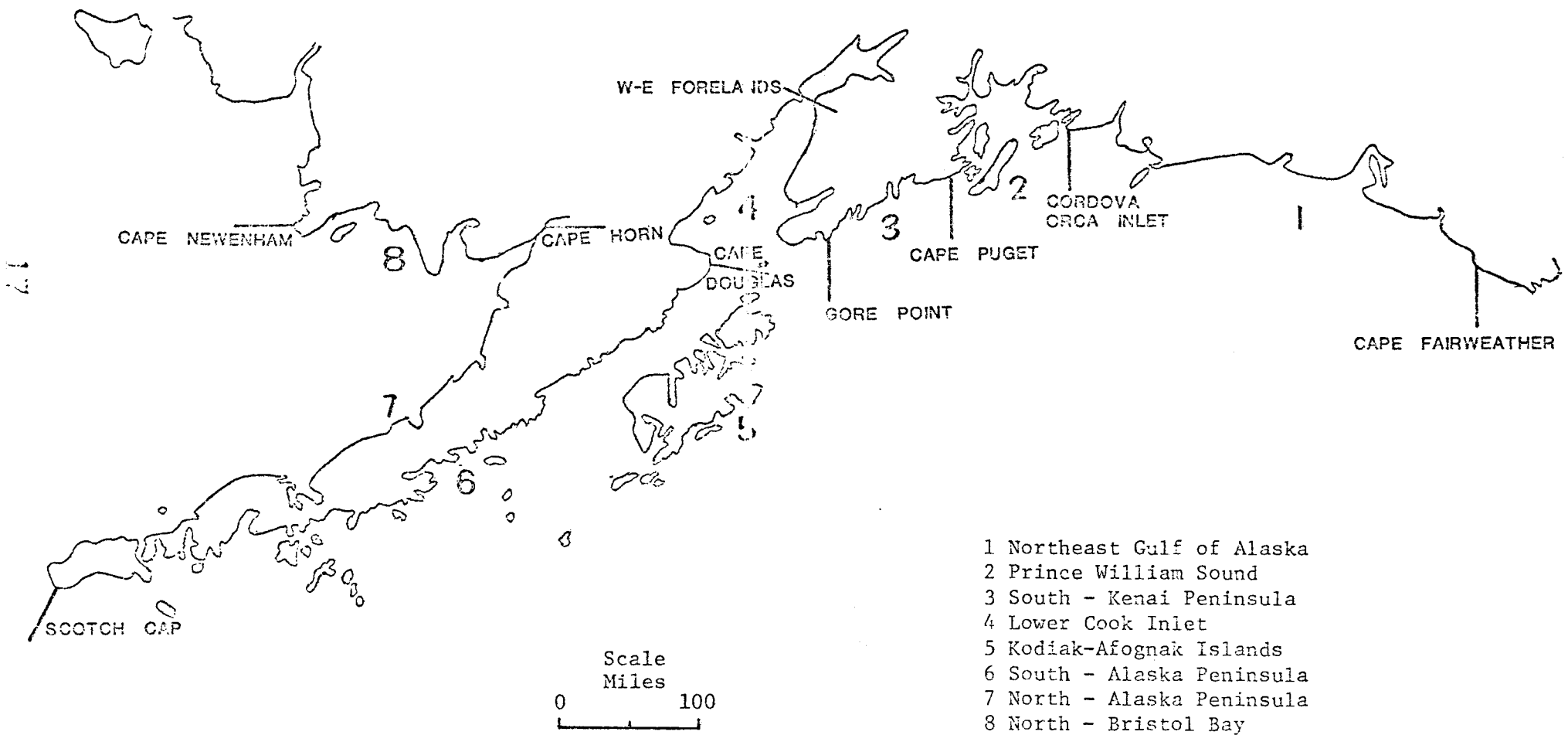


Figure 2. Subunits of study area for OCSEAP coastal marine bird project, Alaska Department of Fish and Game, Anchorage Office.



includes the coastline from Cape Fairweather to Cordova including Orca Inlet; Area 2, Prince William Sound, includes the coastline and islands from Cordova to Cape Puget; Area 3, South-Kenai Peninsula, includes the coastline from Cape Puget to Gore Point; Area 4, Lower Cook Inlet, includes the coastline from Gore Point to East Forelands, across to West Forelands, thence down to Cape Douglas, back to Gore Point to include the Barren Islands; Area 5, Kodiak-Afognak Islands, includes the coastline of the entire Kodiak Archipelago; Area 6, South-Alaska Peninsula, includes the coastline from Cape Douglas to Scotch Cap; Area 7, North-Alaska Peninsula, includes the coastline from Scotch Cap to Cape Horn; Area 8; North-Bristol Bay, includes coastline from Kvichak River opposite Cape Horn to Cape Newenham.

V. Methods

All known sources of information on birds in the eight subunits have been or will be searched as intensively as possible. These includes many unpublished records that are filed with various government agencies. Field notes of many ornithologists or other persons whose avocation is ornithologically-related provide valuable information. Published journal articles and reports are also being collected and synthesized.

Aerial surveys are being used in determining seasonal densities, migratory routes, breeding locales and critical habitats. Amphibious aircraft are used in rocky coastal areas and single-engine aircraft on wheels along sandy coastline. Aircraft speed may vary from 80 to 120 knots but an altitude of 100 ft. (30m) is maintained as much as is practicable. Observers are used on both sides of the aircraft.

Techniques vary with the type of habitat being surveyed. While surveying long, straight beaches the aircraft flies slightly seaward of the waterline and the shoreside observer enumerates all birds visible to the beach ridge. The oceanside observer records all birds within 1/8 mile (200m) of the aircraft and notes concentrations outside of this zone. This distance may have to be shortened to 100 meters on faster flying aircraft. In extensive estuaries where total counts would not be possible, transects are flown at equidistant intervals and birds and recorded by both observers within 1/8 mile of the aircraft. Upland vegetation inundated by storm tides is also surveyed. A new technique is being tried on Kodiak as explained in Part X of this report.

All observations are recorded on cassette-type tape recorders. Information recorded is: bird identification to lowest taxa possible (order, family, genus, species); bird numbers, habitat type in which the bird is found. Other information including activities, sex, color phase, etc., as outlined in the data processing format. Weather observations are recorded at the start of each flight and a coded survey conditions number is noted as often as conditions change. Time is recorded each time a new station is started and ended.

Because of the speed at which observations must be made from aircraft, only a limited number of environmental parameters can be recorded. Choppy water and diving birds can make species identification and number estimation difficult. Photographs are taken where it is practical-largely for enumeration of large flocks.

A second survey is conducted at higher altitudes (300-400 ft) to map habitat types and to denote the storm tide line wherever possible. Mapping is done on USGS 1:63,360 maps on areas where this scale map was available. This process need be only conducted once per area but cannot be done in the winter.

The method used by Arbib (1972) to practice estimating numbers by throwing beans or other small objects in order to establish a picture in one's mind of a given number of objects has been and continues to be practiced in order to become as proficient at enumerating bird numbers as possible.

The order in which areas for surveying were selected was based largely on the presumed importance of the area to bird populations, the vulnerability of the area to oil development and the proposed schedule of oil lease sales. The amount of existing knowledge about certain areas also played a role as did the extent of current research being conducted by other organizations or individuals. Bird populations in Prince William Sound, for example, have been studied for the past several years by U.S.F.W.S. personnel because of the termination of the Alaska pipeline in Valdez. M.E. (Pete) Isleib continually monitors bird populations in Prince William Sound and the Northeast Gulf of Alaska so more is known of birds in these areas.

## VI. Results

Due to the delay in receiving final data processing formats, most of the recorded information collected so far has not been transcribed from the tapes to avoid duplication of effort. Brief summaries of total birds seen during the first survey in October 1975 on the north side of the Alaska Peninsula are listed in Tables 7 and 8. And a track of this survey, in which over 40 species were observed, is shown in Appendix Figure A-9.

Habitat was delineated for most of the trackline including the coast from the Naknek River to Cape Horn. In areas where only 1:250,000 scale maps were available, mapping of the storm tide line and sedge meadow areas became impossible. Summations of the habitat types found on the shoreline and in the estuaries are shown in Tables 9 and 10, respectively.

In cooperation with the Habitat Section, an ADF&G a survey was done of wintering populations in Lower Cook Inlet on February 9, 10 and 18, 1976. A trackline of this survey is shown in Appendix Figure A-4. Data for this survey have not been transcribed as yet.

A third survey was started during the last week of February but bad weather delayed flights and the urgency of writing this report precluded completion of the survey. The number of sample units that were completed are shown in Appendix Figure A-6 and in Part X, this report. It is hoped the survey can be completed before spring migrants move into the area.

Table 7. Total number of birds observed during aerial surveys along beach of the north side of the Alaska Peninsula, October 1975.

| Section of Beach | Sandy Beach | Open Water | Mouth of Stream |
|---|---|---|---|
| Naknek River to Smoky Point | 2,238 | 2,836 | 735 |
| South Spit to South End of Cinder River | 439 | 5,604 | |
| South End Cinder River to Ilnik* | 1,442 | 413 | 40 |
| Ilnik to Cape Leontovich | 1,192 | 19,975 | 368 |
| Cape Leontovich to Cape Krenitzin | 2,076 | 2,858 | 93 |
| Chunak Point to Otter Point | 549 | 187 | 44 |
| Total | 7,936 | 31,873 | 1,280 |

*Right side of aircraft only because of recorder malfunction.

Table 8. Total number of birds observed in estuaries during aerial surveys of the north side of the Alaska Peninsula, October 1975.

| Estuary | Sedge Meadow | Mudflat | Beach | Open Water | Total |
|---|---|---|---|---|---|
| Egegik (transects*) | 460 | 2,836 | 2,195 | 188 | 5,679 |
| Ugashik (transects*) | 12,609 | 4,567 | 2,124 | 1,145 | 20,445 |
| Cinder River (transects**) | 1,576 | 9,824 | 61 | 15,680 | 27,141 |
| Port Heiden (transects*) | 2,713 | 3,989 | 233 | 4,535 | 11,470 |
| Seal Islands (total count) | 3,134 | 2,968 | 6,989 | 12,993 | 26,084 |
| Port Moller (total count) | 0 | 116 | 3,915 | 9,117 | 13,148 |
| Herendeen Bay (total count) | 0 | 25 | 1,158 | 8,513 | 9,696 |
| Mud Bay - Deer Island (total count) | 0 | 4,827 | 857 | 11,678 | 17,362 |
| Nelson Lagoon (total count) | 2,535 | 13,126 | 3,122 | 45,213 | 63,996 |
| Izembek Lagoon (total count) | --- | --- | --- | --- | 342,507 |

* Not complete coverage: 200 meters on either side of aircraft along transects.

** One side of aircraft only due to recorder malfunction.

Table 9. Quantity of various habitat types for the outside beach of the north side of the Alaska Peninsula.

| Section of Beach | Habitat Types: Distance in Kilometers | | | Habitat Types: Area in Hectares | | |
|---|---|---|---|---|---|---|
| | Sandy Beach | Rocky Beach | Gravel Beach | Sedge Meadow | Beach Rye | Mud Flats |
| Cape Horn to Naknek River | 16.45 | 0 | 0 | 2874.9 | 0 | 0 |
| Naknek River to Bishop (at Egegik Bay) | 67.1 | 0 | 0 | 1509.9 | 0 | 0 |
| Goose Point (at Egegik Bay) to Smoky Point (at Ugashik Bay) | 67.1 | 0 | 0 | 3703.7 | 854.7 | 543.9 |
| South Spit (at Ugashik Bay) to Meshik (at Port Heiden) | 97.7 | 0 | 0 | 699.3 | 2393.2 | 0 |
| Strogonof Point (at Port Heiden) to Entrance Point (at Port Moller) | 134.6 | 0 | 9.0 | 1090.4 | 1963.2 | 0 |
| Lagoon Point (at Nelson Lagoon) to Moffet Point (at Izembek Lagoon) | 109.0 | 0 | 0 | 2356.9 | 543.9 | 233.1 |
| Cape Galzenap (at Izembek Lagoon) to Cape Krenitzin (at Bechevin Bay) | 36.7 | 0 | 0 | 0 | 0 | 0 |
| Chunak (at Bechevin Bay) to Otter Point (at Unimak Island) | 25.2 | 0 | 0 | 0 | 0 | 0 |

Table 10. Quantity of various habitat types for the major estuaries of the north side of the Alaska Peninsula.

| | Habitat Types | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Distance in Kilometers | | | | | | Area in Hectares | | | | | |
| Estuary | Sandy Beach | Gravel Bench | Rocky Beach | Mud/Sedge Meadow Ecotone | Mud/ Beach Rye Ecotone | Total | Sedge Meadow | Sand | Beach Rye | Mud Flat | Total | Estuary Area* | Possible Estuary Influence |
| Egegik | 13.4 | 0 | 0 | 11.8 | 0 | 25.2 | 3833.3 | 0 | 51.8 | 4327.9 | 8213.0 | 9764 4 | 0 |
| Ugashik Bay | 50.9 | 0 | 0 | 118.5 | 4.5 | 173.9 | 8282.9 | 2416.5 | 4009.3 | 3056.2 | 17764.9 | 19281.1 | 5128.2 |
| Cinder River | 16.2 | 0 | 0 | 71.1 | 12.5 | 99.8 | 4662.0 | 385.9 | 2305.1 | 5027.2 | 12380.2 | 10800.4 | 0 |
| Port Heiden | 30.0 | 0 | 0 | 61.6 | 14.3 | 105.9 | 7964.3 | 598.3 | 1087.8 | 11106.1 | 20756.5 | 27255.0 | 0 |
| Seal Islands | 31.1 | 0 | 0 | 58.7 | 33.8 | 123.6 | 3952.4 | 1383.0 | 823.6 | 1551.4 | 7710.4 | 9521.0 | 0 |
| Port Moller Total Estuary | 216.7 | 65.7 | 10.9 | 40.3 | 0 | 333.6 | 3095.0 | 2463.0 | 543.9 | 37135.9 | 40621.1 | 75370.1 | 11940.1 |
| Port Moller (East) | 55.8 | 49.3 | 7.1 | 2.9 | 0 | 115.1 | 261.6 | 157.9 | 0 | 13014.9 | 13424.4 | 31883.4 | 0 |
| Herendeen/ Mud Bays Deer Is. | 73.8 | 16.4 | 3.8 | 0 | 0 | 94.0 | 1201.7 | 0 | 0 | 8218.2 | 9419.9 | 27350.8 | 0 |
| Nelson Lagoon | 87.1 | 0 | 0 | 37.4 | 0 | 124.5 | 1631.7 | 2305.1 | 543.9 | 13286.9 | 17767.6 | 16135.9 | 0 |

*Includes open water portion

## VII. Discussion

The outer coastline habitat is relatively homogeneous the entire length of the north side of the Alaska Peninsula. Some bird species were fairly evenly distributed throughout the area but fewer birds were found on the uppermost third of the Peninsula. Larids in particular were evenly dispersed overall except they tended to congregate on roosting sites at mouths of streams all along the Peninsula. On the outer coasts seaducks (primarily scoters) congregated more in areas where the shoreline was steepest as at Capes Greig and Seniavin. Emperor geese and shorebirds were generally only found on the exposed beaches in association with estuaries. Many birds such as alcids, procellarids and seaducks were likely missed that were beyond visibility from the aircraft flying along the beach. Snow buntings were the only common passerine seen and were fairly abundant along beach ridges in the beach rye.

Bird densities within estuaries were much greater than those of the beach survey. Seaducks seemingly congregated on the leeward side of barrier islands and spits near the mouth of the estuary. This may have been related to the height of tide or activity at the time of survey, however. Flocks of several thousand eiders and scoters were observed at the ends of several sand spits.

Steller's eiders were by far the most abundant eider seen. Common eiders were much less abundant and only a few king eiders were seen.

Canada geese inhabited the mudflat-sedge meadow ecotone or sedge meadows innundated by tidal waters. Emperor geese roosted on outer sandy beaches or on mudflats but also joined Canadas in sedge meadows or fed on tundra berries. Few alcids and procellarids were observed in estuaries except at the large estuarine complex at Port Moller. Shorebirds dispersed over mudflats when the tide was out but congregated in tight flocks to roost on the sandy beaches at high tide.

Delineation of the storm tide line was easy where debris had collected over the years. In other areas the mark was difficult to discern and was estimated by looking at vegetation coloration. It may have been grossly misjudged in these areas which normally were the sedge-meadow habitat type of estuaries.

Results of the two winter bird surveys wait further data analysis. In Lower Cook Inlet most bays on the eastern side were choked with ice but old squaws did venture into broken and slush ice. Volcanic ash fallout from Mt. Augustine delayed surveys in Kamishak Bay and it was not determined what effect the ash had on seabirds. An amazingly large group of shorebirds roosted on the ice of Tuxedni Channel near a small, open lead. The entire vicinity was frozen except for the mudflats of Squarehead Cove. Kachemak Bay continually froze during the surveys but old squaws were found in the broken ice. Substantial numbers of mallards were observed on the flats of China Poot Bay and vicinity and also at heads of bays around to Port Dick. The usual diving and seaducks were found along the entire ice-free coast. Little ice was found beyond Port Chatham except

in shallow lagoons with a fresh water source. Few alcids were located except in Sadie Cove and mew gulls were fairly common at stream mouths and at Homer Spit along with glaucous-winged gulls. No notable observations can be made about the Kodiak survey until transcription of the data, but large numbers of alcids (common murres mostly) and seaducks were found around the entire island. Large numbers of dabbling ducks also utilized the sedge-meadow habitat. Small numbers of emperor geese were observed at several locations on the island.

Because of adverse weather, aerial bird surveys in Alaska must often be conducted under less than ideal conditions. One must fly in unfavorable weather and at times of the day or stages of the tide when bird distributions make surveying difficult or inaccurate. The diurnal distribution varies with species and untimely surveys may result in missing a large segment of a population which has recently moved out to sea or up on the tundra to feed or roost. Some species are best surveyed during high tide while others are more easily surveyed at low tide. A slight chop on the water during the survey may make small dark alcids or other species nearly impossible to see. It is for these reasons that in order to derive meaningful data, surveys must be conducted as often as time and money will allow under varying conditions.

Because of abnormal weather conditions, migration timing may change slightly from one year to the next or normal staging areas may not be visited. This past year (1975) for example snow geese did not follow their "usual" pattern and most bypassed the Egegik, Ugashik and Cinder River areas. Only a few hundred were observed on the survey in October. This fall's counts were too late in the season to record terns or many shorebirds and too early for king eiders. Surveys at the wrong time would grossly underestimate the importance of that area to migrating birds.

Aerial surveys may not record some bird species that could easily be affected by oil development. Some of the species not generally assumed to be associated with the littoral zone or marine habitats are belted kingfishers, several species of swallows, winter wren, American robin, varied thrush, and several species of fringillids. These species are often seen feeding along coastlines and still others may nest in the upland between high tide and storm tide lines. Site-specific, ground studies may be necessary to determine the degree of use by these species.

The distribution of birds within bays or estuaries may also be a function of how susceptible they would be to oil development. Birds feeding on sessile mussels or other food organisms in nearshore waters may be more drastically affected than those feeding in the middles of bays on planktonic organisms. Again, site-specific projects would be needed to determine how potential oil impacts would be affected by spatial distribution of birds.

## VIII. Conclusions

From the aerial bird surveys conducted since the start of this project on September 5, 1975 and without the results of complete data analysis, the following conclusions are implied:

1. The estuaries of the north side of the Alaska Peninsula are extremely important to fall migrant waterfowl and shorebirds.

2. Port Moller-Herendeen Bay-Mud Bay-Nelson Lagoon complex appeared to have the greatest species diversity but Izembek Lagoon had the greatest bird density.

3. Certain portions of the outer beaches and mouths of streams are heavily utilized by other species of birds (e.g. gulls, cormorants, scoters and eiders) in fall.

4. A better method of determining the storm tide line is needed where debris is not present.

5. Winter severity can greatly affect the extent of use of Lower Cook Inlet by wintering birds.

6. The nearshore waters of Lower Cook Inlet appeared to be a more important wintering area for waterfowl and gulls than for alcids.

7. Large numbers of alcids, larids, cormorants and waterfowl and lesser numbers of geese and shorebirds winter on Kodiak Island.

8. Bird distribution within a given bay or estuary should be determined more accurately to ascertain more precisely their susceptability to oil development.

## IX. Needs For Further Study

Since aerial surveys began, several areas needing further study have been disclosed. As mentioned in previous sections, flights cannot always be timed to coincide with the proper activity patterns of all birds of the littoral zones. Population estimates may therefore be low. To help solve this problem more site-specific studies should be carried out to learn more about diurnal movements of birds with regard to tide levels, time of day differences and how far the different species are flying to feed. What the birds are feeding on and where within the bay or estuary they spend most of their time feeding and roosting could also be determined at that time. Equipped with better knowledge of these parameters and by recording tide level and time of each survey, perhaps an estimate or correction factor can be applied to more accurately express utilization of an area by birds.

The speed at which many aerial observations must be made often makes species identification and enumeration difficult. Concurrent ground and

boat surveys could check the accuracy of the aerial surveys. If the counting error is relatively constant a correction factor could be developed to correct likely underestimations.

With the development of onshore support facilities in the petroleum industry, increased air traffic in the vicinity of these facilities is likely. Studies to determine what effects aircraft have on birds-particularly breeding birds-would be very beneficial. Corridors may have to be established during nesting season if low flying aircraft are determined to be severely detrimental to birds.

Little is mentioned in OCSEAP work statements about studies to determine effects of oil on vegetation, particularly that from high tide to the storm tide line. With the ecosystem principal and trophic levels firmly in every PI's mind, more should be found out on what oil does to growth and reproduction in plants that may be food or cover for birds and other animals. Concomitant studies of bird use in this vegetative region should also be accomplished.

If oil spills in the northern part of the Gulf eventually end up on Kodiak Island as suggested, the Chiniak-Marmot-Tonki-Perenosa Bay region may end up as the "trap." Baseline beached bird (and other debris components) surveys should be extended to include the most vulnerable areas. Kamishak Bay in Lower Cook Inlet is another likely "trap" and areas where weather-killed birds have washed up on shore e.g. Montague Island (January 1970, Kenneth Mitchell, U. S. Forest Service in Isleib and Kessel 1973) or Harbor Point (April 1970 in Bailey and Davenport 1972) may also be collecting points for flotsam.

Sex and age differences in migration patterns of birds are well known. From winter surveys conducted so far it appeasd there may be a preponderance of females and immature males of king and common eiders in certain locations. If the females of a certain species were congregating in a relatively small area, an oil spill could conceivably impair the breeding potential of the population by killing off a large portion of females. Perhaps sex ratios of wintering birds should be looked at more closely for any potential problem areas.

Many bird species assemble in tight masses and flush or dive wildly at the approach of a censusing aircraft. Black brant in Izembek Lagoon are an example of this. Possibly inexpensive photo techniques similar to those being tried in Minnesota to census waterfowl (Meyer in press.) could be used to more accurately determine the number of individuals present. Transects lines could be established that could monitor populations before and after oil development. Behavior of the birds in relation to tides would have to be considered. Certain other species may lend themselves well to censusing by this technique.

Invertebrate work statements were not detailed enough to find out what OCSEAP projects involve the study of larval and adult insects in the intertidal and supratidal zone. Some species of insects may be a mainstay in the diet of certain birds using the upland below the stormtide line. It is a portion of the food chain that may warrant further study.

X. Summary of 4th Quarter Operations.

1. On February 9, 10, and 18, 1976 a DeHavilland Beaver was chartered from Kachemak Air Service in Homer to fly surveys in Lower Cook Inlet. February 22 - March 6 was spent in Kodiak attempting to do surveys with an Alaska Department of Public Safety Crumman Goose.

2. On the Lower Cook Inlet surveys, David Erikson and Warren Ballard, both ADF&G biologists, were used as observers. On the Kodiak survey, Vernon Berns, U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, was the second observer.

3. A wheeled plane was used for the Lower Cook Inlet survey and therefore the technique of flying near the shoreline was used as described for the beach survey on the Alaska Peninsula. The seaside observer enumerated birds within 200 meters of the aircraft and the shoreside observer counted all those to the high tide line.

   On Kodiak a new technique was attempted. The entire Archipelago was stratified into eight habitat types and count units within each type were marked off using identifiable geographic features to mark the starting and ending points of each unit. These count units were then numbered and totaled. The habitat types and total numbers of units were:

| Strata Code | Stratum | Number of Sample Units |
|---|---|---|
| A | Outside Waters - Forested | 20 |
| B | Inside Waters - Forested | 44 |
| C | Heads of Bays - Forested | 4 |
| D | Outside Waters - Rock/tundra/alder | 46 |
| E | Inside Waters - Tundra/alder | 86 |
| F | Mudflats Heads Bays - Tundra/alder | 20 |
| G | Estuaries/lagoons | 30 |
| H | Low Tundra/mud-sand Beach | 17 |

With the help of Dr. Samuel J. Harbo, Jr., Univ. of Alaska biometrician, relative bird densities for each strata were decided upon and the minimum number of units to be sampled was finalized:

| Stratum | Density Rating | Strata | Number Sampled |
|---|---|---|---|
| A | 1 | A | 4 |
| D | 1 | B | 12 |
| H | 2 | C | 4 (all units) |
| B | 8 | D | 6 |
| E | 8 | E | 24 |
| F | 8 | F | 6 |
| G | 8 | G | 8 |
| All "C" units to be censused. | | Total | 68 |

It was felt that weather, time and money would not allow a complete census of the islands so a stratified-random sampling design was used.

Units to be sampled were selected using a table of random numbers. Open water portions needed to be surveyed so an amphibious aircraft was used and an attempt was made to count all birds within the count unit. Because the necessity of writing this report precluded the completion of the survey (at least temporarily), it is unknown whether this technique is a useful one for that type of coastline.

Office-type duties during this quarter included literature search and review, establishment of a systematic reprint file, and gathering as much unpublished material as possible, particularly in Kodiak. Problems with data processing formats also took up much time.

4. Tracklines for the Lower Cook Inlet survey are shown in Appendix Figure A-4. The sample units surveyed so far in Kodiak are marked on Appendix Figure A-6.

5. Approximately 112 stations or count areas in Lower Cook Inlet were censused covering about 625 miles of shoreline. An estimated 25 species were identified in primarily four habitat types.

   On Kodiak, 40 of the ramdomly selected plus five other sample units have been censused to date. About 30 species were observed in five habitat types. In this survey a definite trackline is not involved.

LITERATURE CITED

Ak. Dept. Fish and Game. 1973. Alaska's Wildlife and Habitat. Juneau. 144 pp plus maps.

Ak. Dept. Fish and Game. 1975. A fish and wildlife resource inventory of the Northeast Gulf of Alaska. Publ. under contract to the Alaska Dept. Environ. Cons. for Coastal Zone Data Develop. pp. 264-358.

Arbib, R. 1972. On the art of estimating numbers. American Birds 26(4): 706-712 & 814.

Bailey, E.P. 1975a. Breeding bird distribution and abundance in the Barrier Islands, Alaska. Loose leaf pub. 31 pp. plus figures.

_____. 1975b. Seabird surveys. Cape Lisburne to the Barren Islands. U.S.F.W.S. Prog. Rept. Loose leaf pub. 17 pp.

_____ and G.H. Davenport. 1972. Die-off of common murres on the Alaska Peninsula and Unimak Island. Condor 74(2):215-219.

Bartonek, J.C., J.G. King and H.K. Nelson. 1971. Problems confronting migratory birds in Alaska. Trans. N. Am. Wildl. Nat. Resour. Conf. 36:345-361.

_____ and D.D. Gibson. 1972. Summer distribution of pelagic birds in Bristol Bay, Alaska. Condor 74(4):416-422.

Dick, M., I.M. Warner and R. MacIntosh. 1975. Preliminary report on the distribution and abundance of breeding seabirds in Chiniak and southern Marmot Bays, Kodiak Island, Alaska, 1975. Loose leaf pub. 13 pp.

Isleib, M.E. 1971. Utilization of Northern Gulf of Alaska. U. of Alaska. Loose leaf pub. 14 pp.

Isleib, M.E. and Brina Kessel. 1973. Birds of the North Gulf Coast - Prince William Sound Region, Alaska. Univ. of Ak. Biol. Papers No. 14. 149 pp.

Jones, R.D., Jr. (in press) The avian ecology of Izembek Lagoon In Laughlin, W.S. ed. Aleutian population and ecosystem analyses. IBP Systems Synthesis Volume.

King, J.G. and D.E. McKnight. 1969. A waterbird survey in Bristol Bay and proposals for future studies. Loose leaf pub. 11 pp.

King, J.G. and C.J. Lensink. 1971. An evaluation of Alaskan habitat for migratory birds. Loose leaf pub. 46 pp.

Meyer, M.P. (in press) 35 mm aerial photography applications to wildlife population and habitat analysis. Misc. Jour. Series Paper. Univ. of Minn. Agr. Expl. Sta. 12 pp.

Mickelson, P.M. 1975. Impact on the Chugach National Forest of outer continental shelf oil and gas leases. Cordova Work Center Report. USDA. Chugach National Forest. 28 pp.

_____. (in prep.) Wetland habitat management on the Copper River Delta. Loose leaf pub. n.p..

Nisbet, C.T. 1975. Conservation of marine birds in northern North America--- A summary. Loose leaf pub. 16 pp.

Sanger, G.A. 1972. Preliminary standing stock and biomass estimates of seabirds on the Subarctic Pacific region. Pages 589-611 In A.Y. Takenouti et al. eds. Biological oceanography of the North Pacific. Idemitsu Shoten. Tokyo.

Snarski, D.A. 1971. Observations of birds on Tuxedni National Wildlife Refuge and vicinity. Admin. Rept. U.S. Fish and Wildl. Service, Anchorage. Loose leaf pub. n.p.

Sowl, L.W. and J.C. Bartonek. 1974. Seabirds - Alaska's most neglected resource. Trans. N. Am. Wildl. Nat. Resource Conf. 39:117-126.

U.S. Dept. of Interior, U.S. Fish and Wildl. Service. 1972. Bristol Bay waterbird survey. Operation Report. River Basin studies, Southeast Alaska. n.p.

U.S. Fish and Wildlife Service. 1975. Shipboard and aerial surveys of birds in N.W. Gulf of Alaska April through Oct. 1975. Loose leaf pub. n.p.

U.S. Fish and Wildlife Service (in prep.) 1975 Narrative Report, Kodiak National Wildlife Refuge.

Vermeer, Rebecca and K. Vermeer. 1974. Oil pollution of birds: an abstracted bibliography. Canadian Wildlife Service Manuscript Reports. No. 29. 69 pp.

_____. 1975. Oil threat to birds on the Canadian West Coast. Canadian Field-Natur. 89:278-298.

# APPENDIX

Maps of subunits within study area with trackline and sampled units of completed surveys and most place names used in the text of the report.

Figure A-1. Subunit 1 - Northeast Gulf of Alaska, Cape Fairweather to Cordova with associated geography.

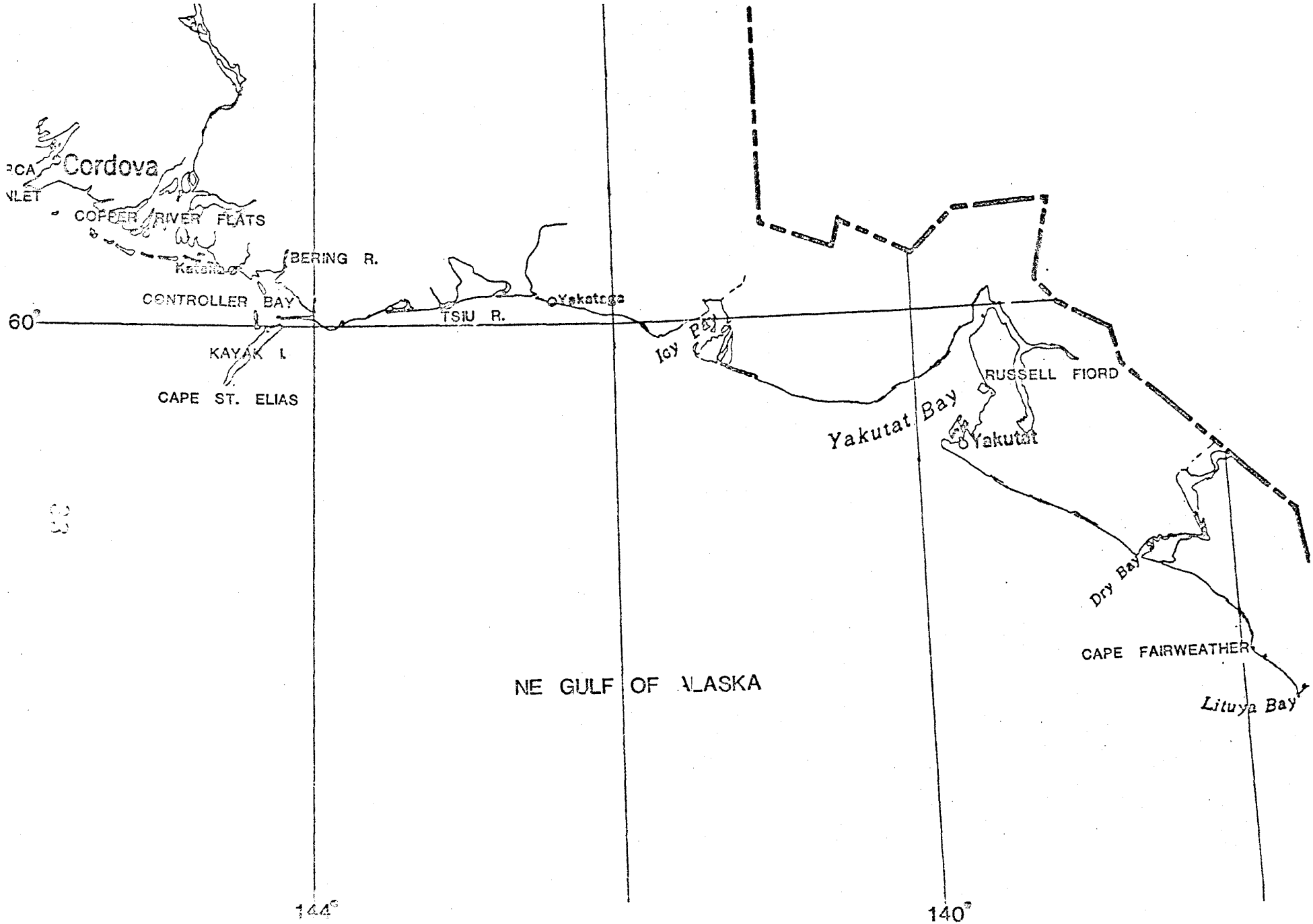


Figure A-2. Subunit 2 - Prince William Sound and associated geography.

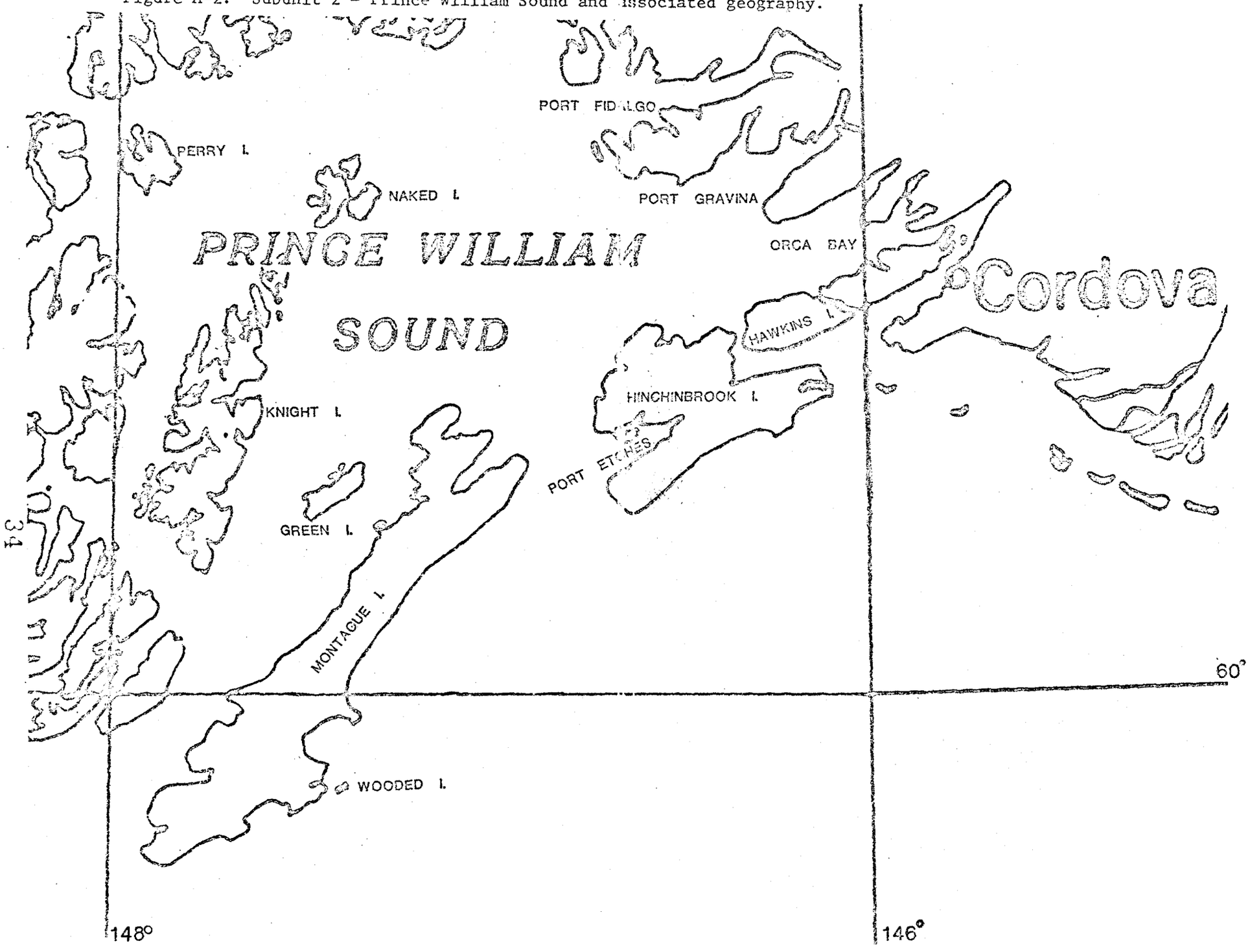


Figure A-3. Subunit 4 - Lower Cook Inlet with portion of subunit 3, South Kenai Peninsula with associated geography.

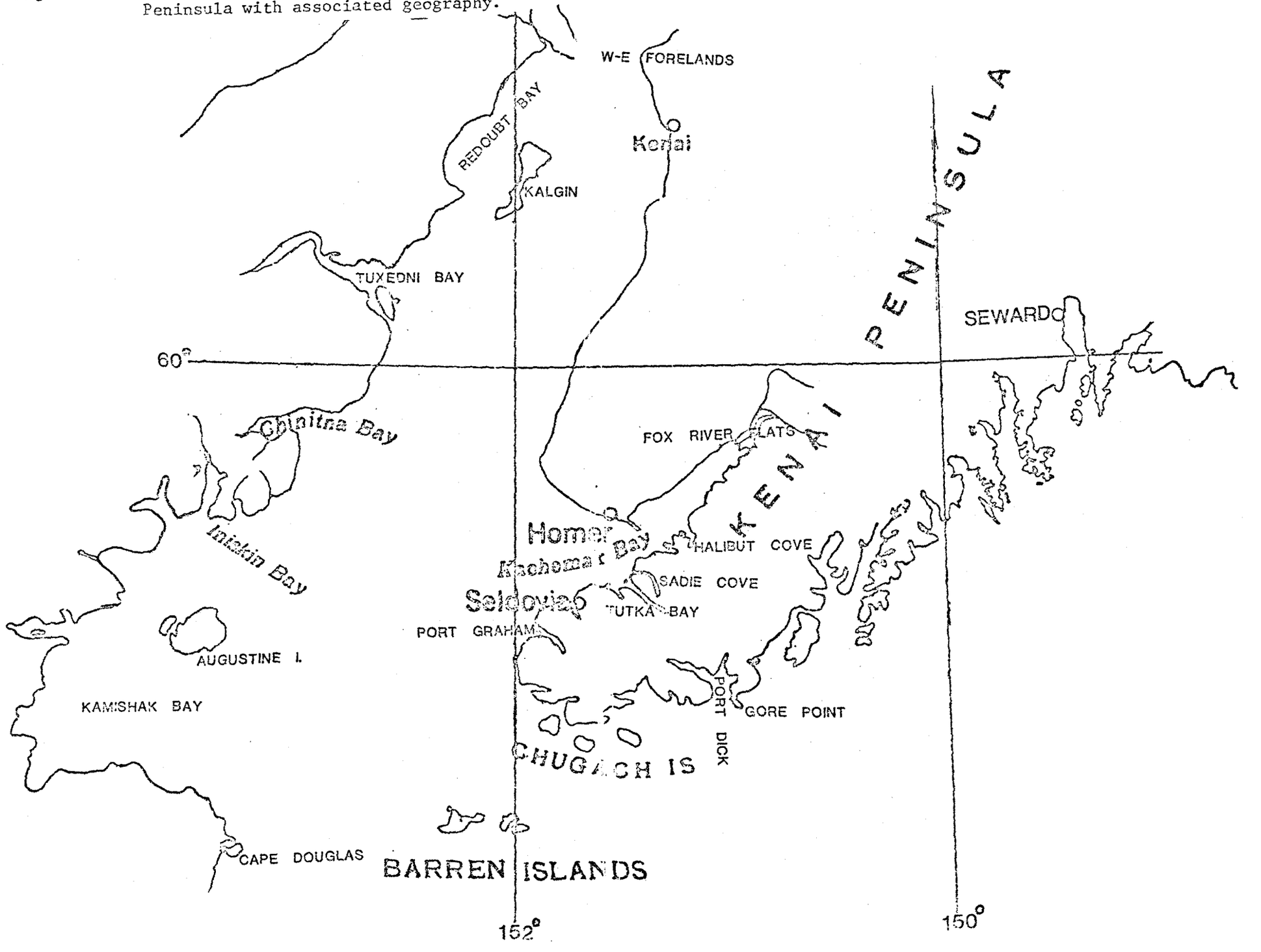


Figure A-4. Trackline of aerial marine bird survey on shoreline of Lower Cook Inlet, February 1976.

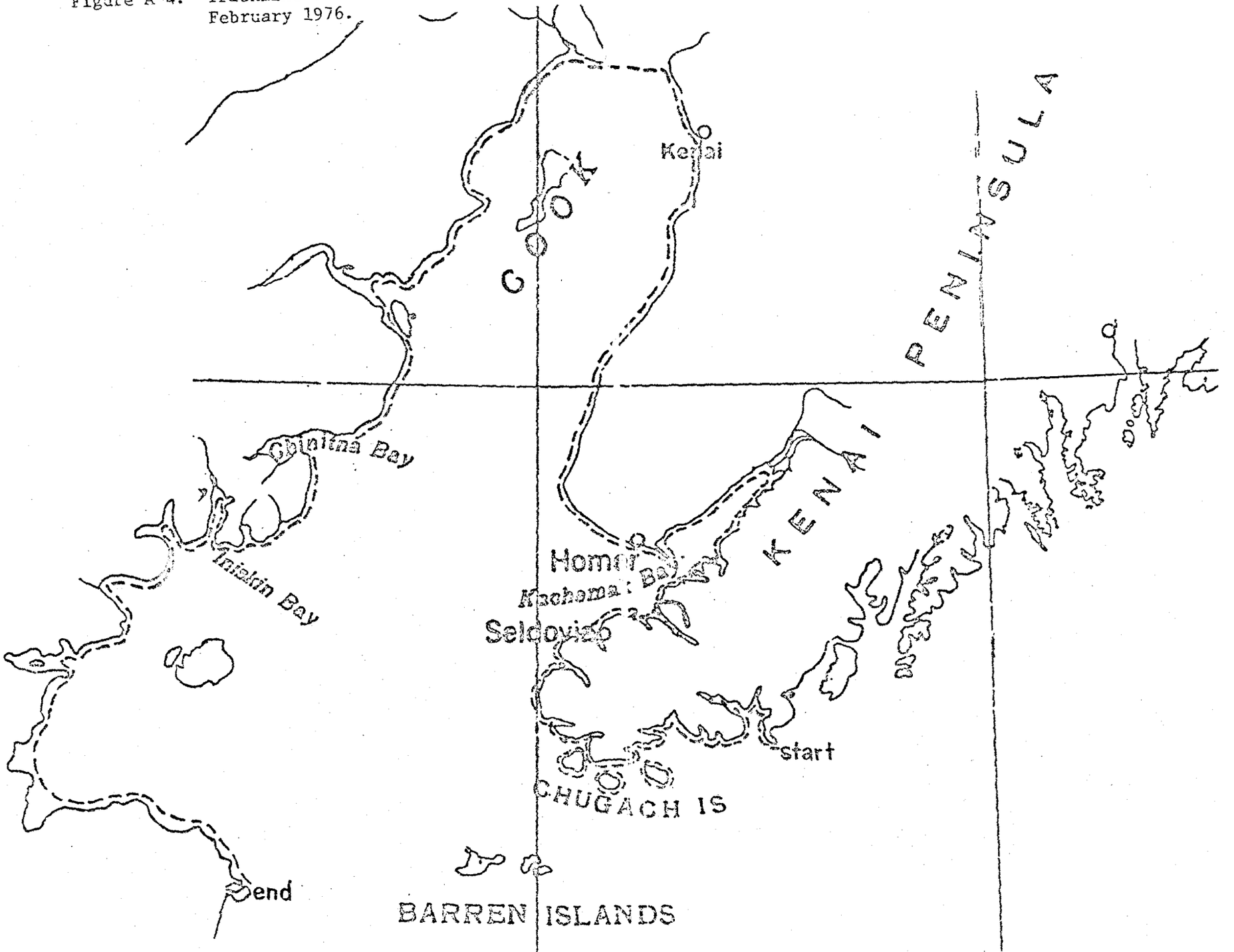


Figure A-5. Subunit 5 - Kodiak-Afognak Islands and associated geography.

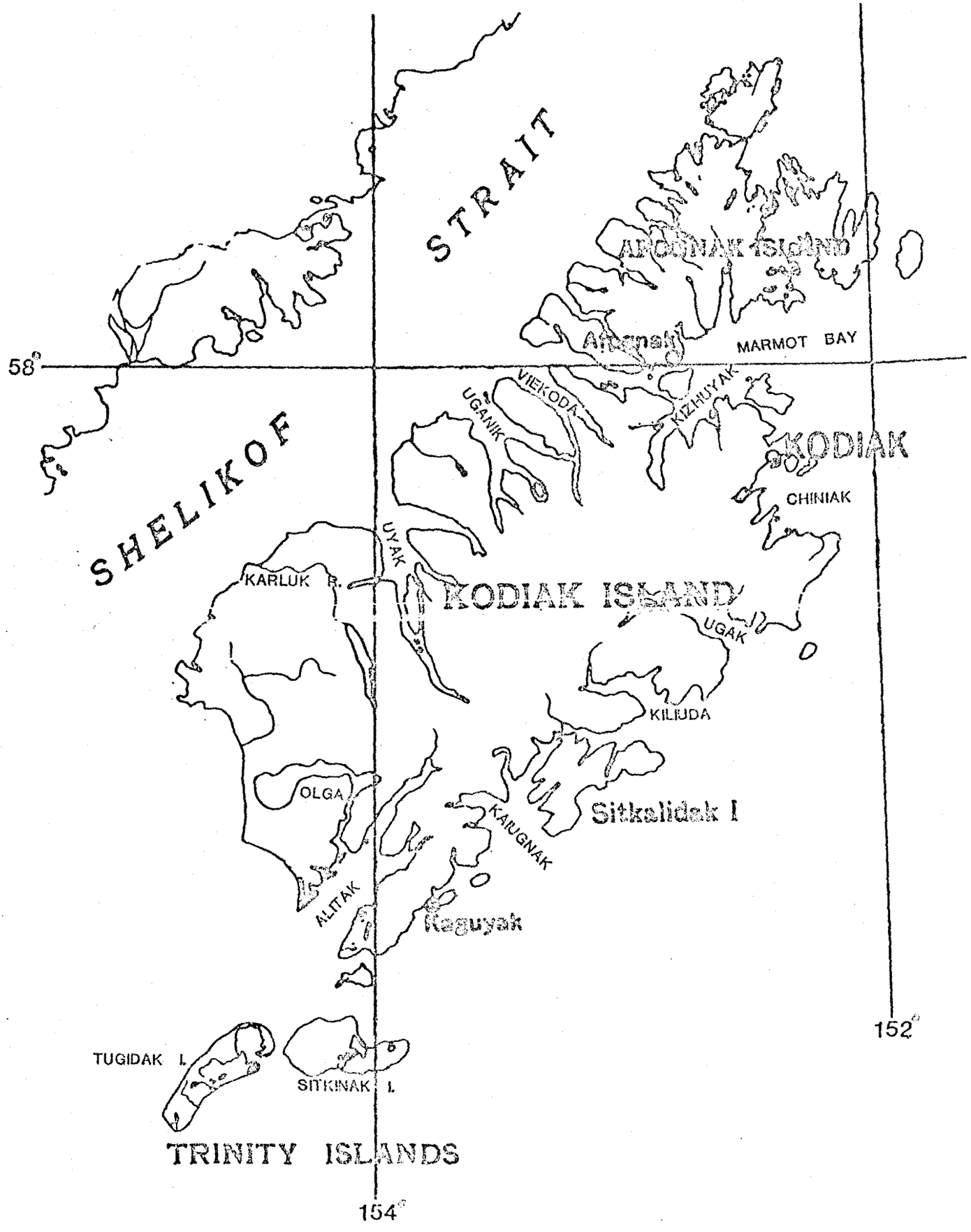


Figure A-6. Count units sampled on marine bird survey, Kodiak Island, February 23-March 6, 1976.

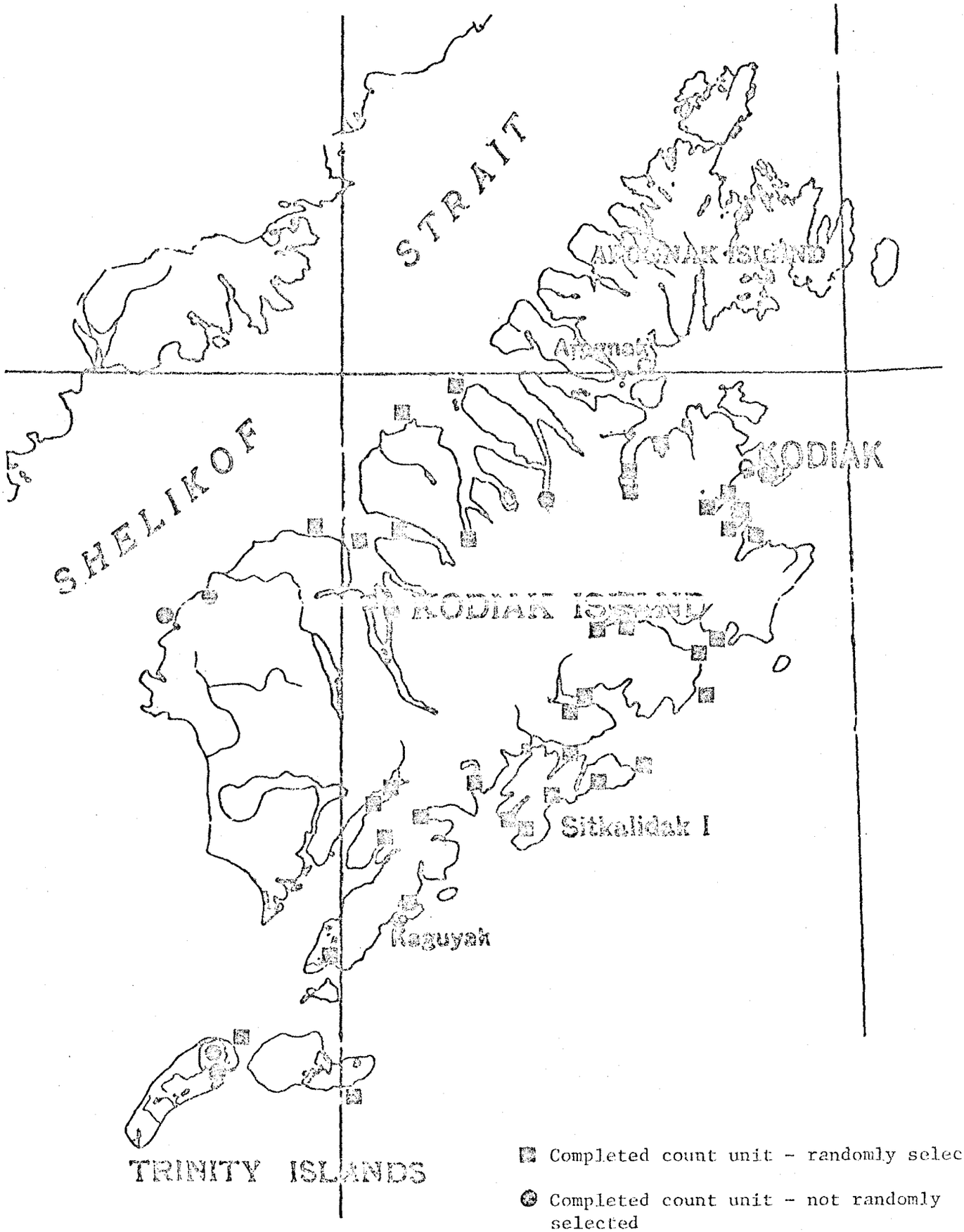


Figure A-7. Subunit 6 - South Alaska Peninsula, Cape Douglas to Scotch Cap with associated geography.

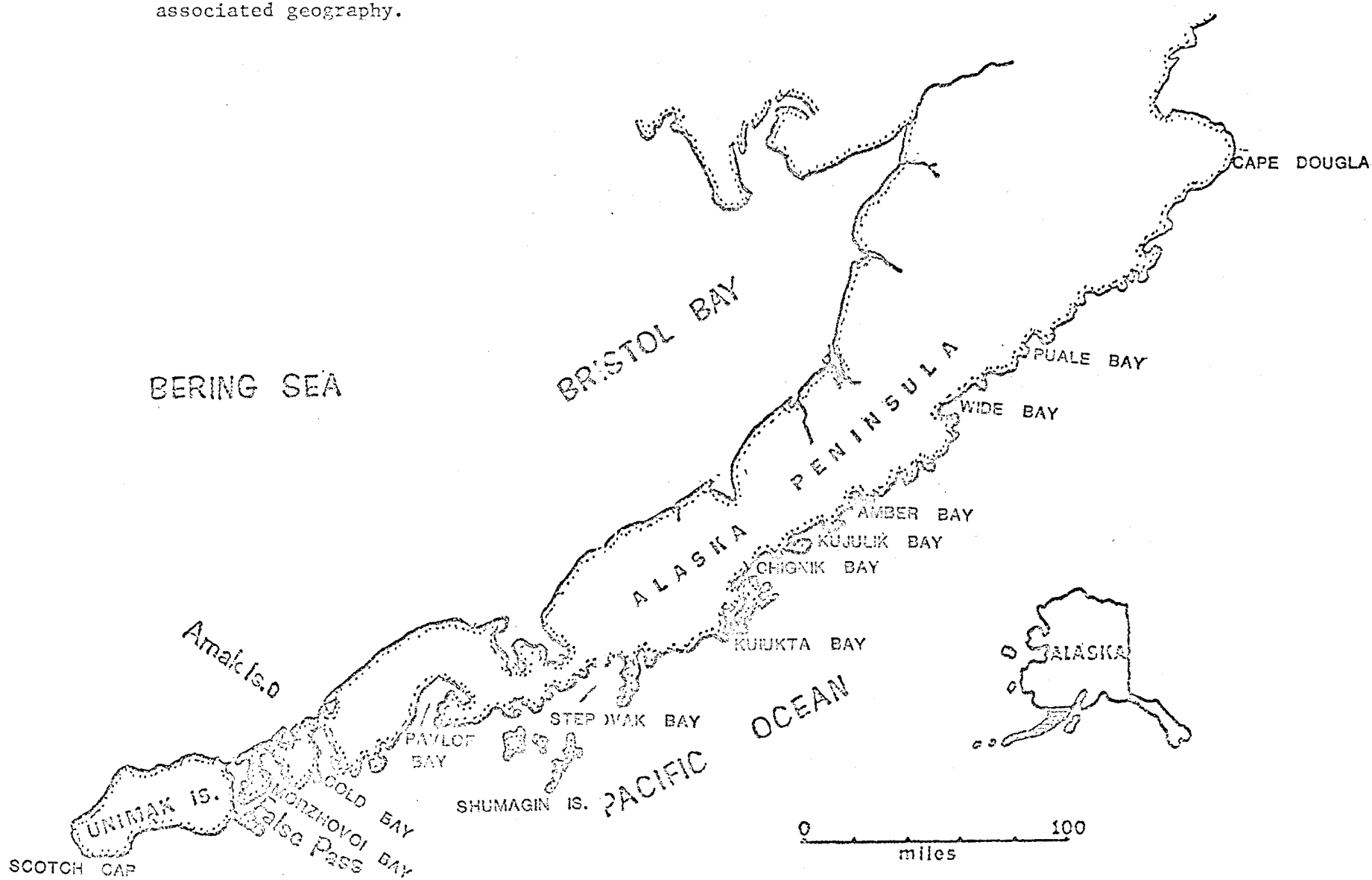


Figure A-8. Subunit 7 - North Alaska Peninsula, Scotch Cap to Cape Horn with associated geography.

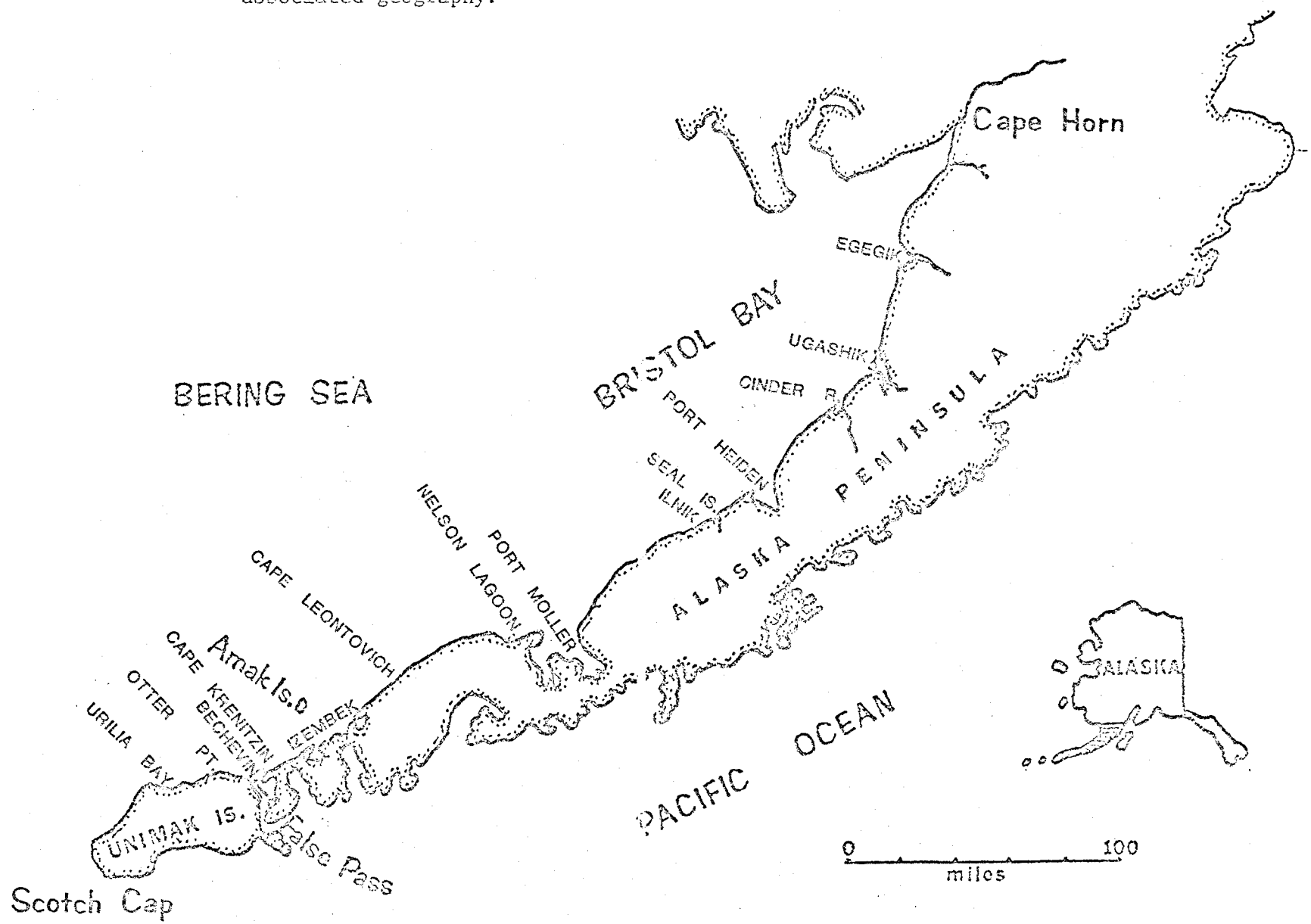


Figure A-9. Trackline of aerial marine bird survey on north shoreline of Alaska Peninsula, October 1975.

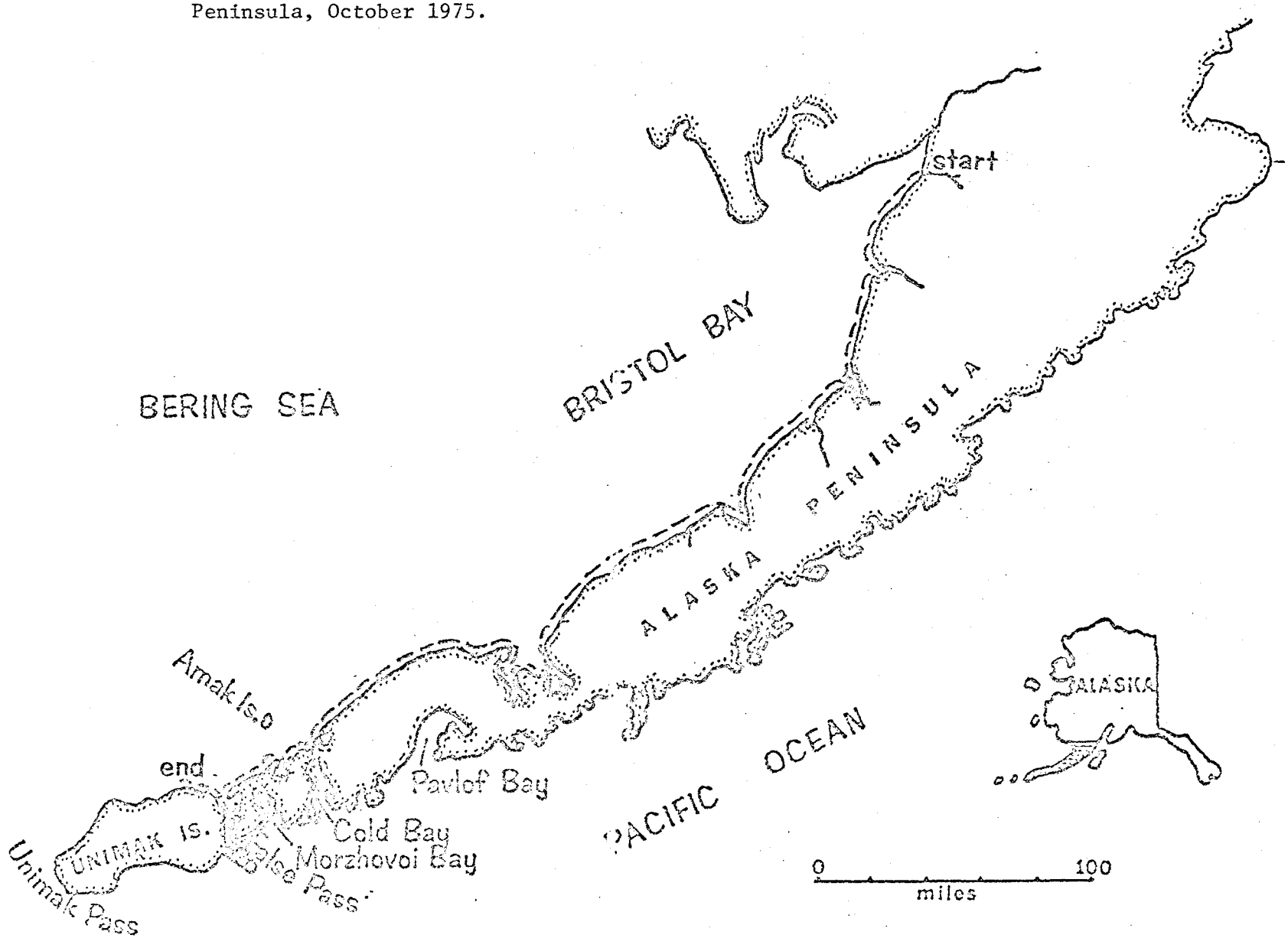
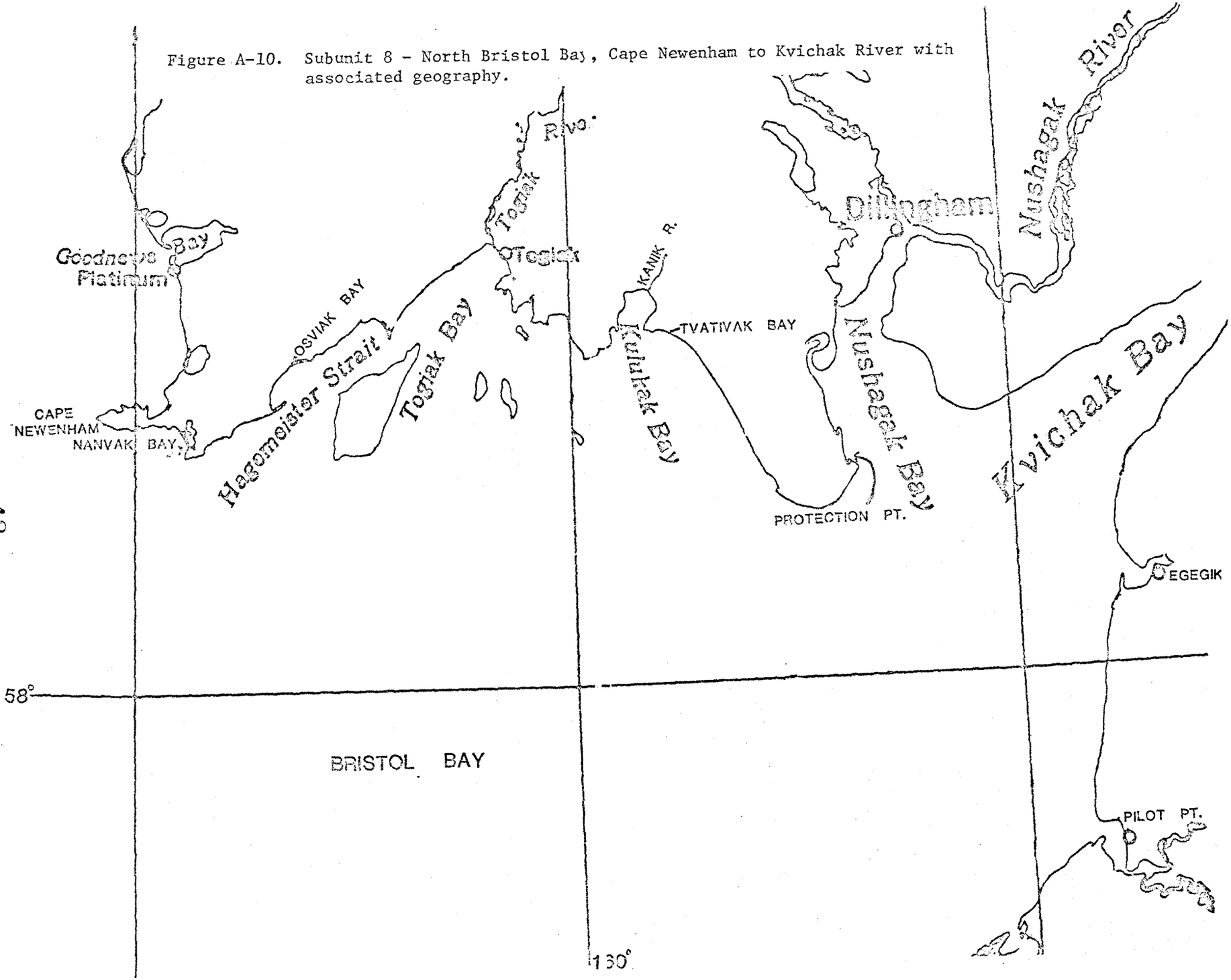


Figure A-10. Subunit 8 - North Bristol Bay, Cape Newenham to Kvichak River with associated geography.



RU#3/4
APPENDIX

# STATE OF ALASKA

**DEPARTMENT OF FISH AND GAME**

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502



April 12, 1976

Dr. Herb Bruce, Project Manager
National Oceanic and Atmospheric Administration
OCS Environmental Assessment Program
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Since the completion of my annual report (RU 3/4), I received the most recent update of Lensink's and Bartonek's seabird colony report. In many cases this greatly increases the number of colonies as I had listed in the annual report so I thought perhaps an amendment to my report would be in order.

Enclosed is a copy of an appendix that could be attached to the end of the annual report bringing it up to date for the eight subunits of the study area if you thought it was necessary to do so. I was not sure how far along the review of annual reports prior to printing are but thought possibly this appendix could still be added without too much difficulty or confusion.

Thanks for your help in this matter.

Sincerely,

Paul Arneson

Paul D. Arneson
Game Biologist

Enclosures

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiak-Afognak | 57 |
| 6. South-Alaska Peninsula | 101 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

# STATE OF ALASKA

**DEPARTMENT OF FISH AND GAME**

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502


RU#3/4
AMMENDMENT

April 12, 1976



Dr. Herb Bruce, Project Manager
National Oceanic and Atmospheric Administration
OCS Environmental Assessment Program
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Since the completion of my annual report (RU 3/4), I received the most recent update of Lensink's and Bartonek's seabird colony report. In many cases this greatly increases the number of colonies as I had listed in the annual report so I thought perhaps an amendment to my report would be in order.

Enclosed is a copy of an appendix that could be attached to the end of the annual report bringing it up to date for the eight subunits of the study area if you thought it was necessary to do so. I was not sure how far along the review of annual reports prior to printing are but thought possibly this appendix could still be added without too much difficulty or confusion.

Thanks for your help in this matter.

Sincerely,

Paul Arneson

Paul D. Arneson
Game Biologist

Enclosures

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

Appendix II. Additions and corrections to seabird colony numbers.

Since the completion of this annual report, the most recent update of numbers of seabird colonies in the Gulf of Alaska was made available. In most cases this greatly increases the number of breeding colonies as listed in the text of the report except for Kodiak-Afognak where many subcolonies were included inflating the number above that listed below. The following is the most current list of numbers of colonies occurring within the eight subunits as delineated in this report. More colonies will be discovered in future field seasons as more search efforts is put into seldom explored areas.

| Subunit | Seabird Colony Number* |
|---|---|
| 1. Northeast Gulf of Alaska | 15 |
| 2. Prince William Sound | 73 |
| 3. South-Kenai Peninsula | 11 |
| 4. Lower Cook Inlet | 18 |
| 5. Kodiąk-Afognak | 57 |
| 6. South-Alaska Peninsula | 161 |
| 7. North-Alaska Peninsula | 4 |
| 8. North-Bristol Bay | 15 |
| Total | 354 |

* All colonies from Cape Fairweather to Unimak Island are found in Lensink, C. J. and Bartonek, J. C. 1976. Preliminary catalog of seabird colonies and photographic mapping of seabird colonies. Annual Report. Outer Continental Shelf Environmental Assessment Program. Research Units: 338/343. U. S. Department of Commerce, NOAA. 138 pp.

# Environmental Assessment of the Alaskan Continental Shelf

## Volume 2. Marine Birds

*Fourth quarter and annual reports for the reporting period ending March 1976, from Principal Investigators participating in a multi-year program of environmental assessment related to petroleum development on the Alaskan Continental Shelf. The program is directed by the National Oceanic and Atmospheric Administration under the sponsorship of the Bureau of Land Management.*

ENVIRONMENTAL RESEARCH LABORATORIES / Boulder, Colorado / 1976