IDENTIFICATION, DOCUMENTATION AND DELINEATION OF COASTAL MIGRATORY BIRD HABITAT IN ALASKA

BY

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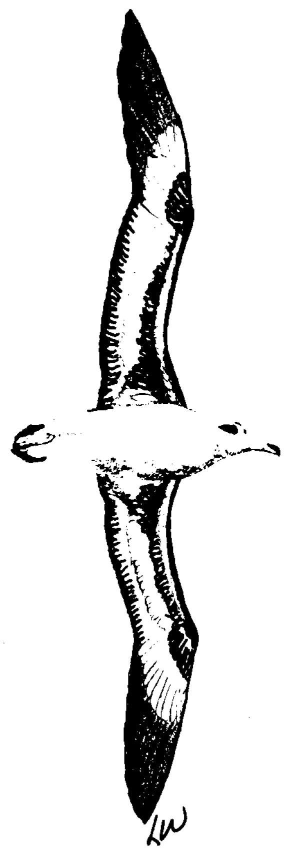

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1 July 1980

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I. SUMMARY OF OBJECTIVES, CONCLUSIONS AND IMPLICATIONS WITH RESPECT TO OCS OIL AND GAS DEVELOPMENT

Between October 1975 and August 1978, 33 coastal surveys were conducted for marine birds in seven regions of southcentral Alaska. The two major objectives of this study were to determine seasonal density and distribution, critical habitats, migratory routes and breeding locales in littoral and estuarine habitats for principal bird species and to delineate bird habitat types seaward of the storm-tide line. In Lower Cook Inlet more specific objectives were outlined.

Bird species were combined into 17 species groups for density analyses and each group was rated for vulnerability to oil spills using the index designed by King and Sanger (1979).

Thirty-nine habitat types were used in the final analyses of habitat preferences of birds. Many habitats corresponded to those used by Hayes et al. (1977) in their oil spill susceptibility index.

Northeast Gulf of Alaska

Spring - In Northeast Gulf of Alaska, a May survey further substantiated the importance of Controller Bay-Copper River Delta-Orca Inlet to migrating birds. In this spring survey, shorebirds were the most dense bird group. The protected mudflats used by shorebirds have a high susceptibility to spilled oil. In adjacent areas at Wingham and Martin Islands gulls and alcids reached high densities. In this region, and in all areas during the time of this study, large gulls were observed to use a variety of habitats, and were therefore, less vulnerable to severe impacts from oil spills. Certain bird species migrating past Cape St. Elias on Kayak Island crossed the remaining portion of the Gulf of Alaska and were, therefore, less vulnerable to impacts of oil and gas development in Northeast Gulf of Alaska than birds following the coastline. South of Kayak Island birds densities were highest in Icy Bay.

Summer - Icy Bay was used in summer by non-breeding sea ducks. Onshore facilities placed there would adversely affect that bird subpopulation. Outer sand beaches were used by gulls and terns.

Kodiak

Winter - Wintering birds in the Kodiak Archipelago were most abundant in the Chiniak/Kizhuyak Bay section. Sea ducks and other waterfowl species were the most numerous wintering birds. Birds were concentrated in protected bay/fjord habitats, and contamination from oil and gas development entering Kodiak's bays could affect large flocks of wintering birds.

Lower Cook Inlet

Spring - In Lower Cook Inlet during spring, shorebirds were abundant on mudflats in all bays on the west side of the Inlet and in Kachemak Bay. Sea ducks were numerous from Anchor Point to Ninilchik and in Kamishak Bay. High densities of scaup, a diving duck, were found in many bays adjoining Kamishak Bay. If impacts from oil and gas development contaminated prey organisms in mud substrates on which many of these shorebirds, sea and diving ducks fed, the effects could be long-lasting. An oil spill during spring could also directly oil several thousand sea and diving ducks.

Gulls were found throughout the Inlet and would, therefore, not be vulnerable to impacts of oil and gas development. However, kittiwakes were concentrated around Tuxedni and southwest Kamishak Bays and would be impacted if oil spills or distrubance occurred in that area.

Summer - Sea ducks were abundant in summer because non-breeding flocks remained in Kachemak and Kamishak Bays and underwent molt there. Flightless waterfowl would succumb to any catastrophic oil spill.

Although gulls were more numerous than other bird groups, they were also more widespread in distribution, selected a wider variety of habitats and could avoid potential threats. Kittiwakes and alcids were most dense near the Chisik Island colony and would be particularly vulnerable to impact at that location.

Fall - In fall, overall bird densities in Lower Cook Inlet dropped markedly from spring and summer population levels. Gulls and sea ducks remained the predominant bird groups but occurred in substantially lower densities than in other seasons. Gulls remained well dispersed, but sea ducks were concentrated in outer and inner Kachemak Bay. Dabbling ducks frequented bay, lagoon and fluviatile waters of Chinitna, Tuxedni and Kachemak Bays. Canada Geese staged on saltmarshes of Tuxedni Bay. McNeil Cove was used by waterfowl and a relatively large number of shorebirds. All these bays contain habitats susceptible to oil spills, and birds most frequently used habitats with the highest susceptibility ratings.

Winter - Birds shifted from the west side of Lower Cook Inlet to the ice-free southeast side in winter. This was true even in relatively mild winters during the study. There were three times the number of birds on the east side as the west. Kachemak Bay (both inner and outer) contained the most birds, and sea ducks predominated. Potential impacts on birds from oil and gas development would be greatest in this area. Spilled oil would contaminate several vulnerable species and their food sources. However, predominant northeast winds in winter may push spilled oil into Shelikof Strait and away from Kachemak Bay.

South-Alaska Peninsula

Fall - On the southern portion of South-Alaska Peninsula in fall, large numbers of geese used susceptible lagoon habitats. Low densities of other species were found.

Winter - In winter, alcids and sea ducks, the two most vulnerable species groups, were the most abundant birds. A few thousand kittiwakes were in the vicinity of colony sites. Mostly exposed (and, therefore, less susceptible to oil spills) habitats were surveyed. The status of bird populations on protected nearshore waters was not determined.

North-Alaska Peninsula

Spring - Estuaries on North-Alaska Peninsula in spring were used by large numbers of geese, gulls and sea ducks. Nelson and Izembek Lagoons supported the most birds. Populations of diving and dabbling ducks and shorebirds were densest in Kvichak Bay where these birds used mudflats of bays and rivers. Any spilled oil entering the estuaries would remain in place a long time, and therefore, oil would impact birds in all seasons for several years. Habitats most used by birds have the highest susceptibility rating to potential impact from oil spills.

Summer - Only offshore waters on the southern end of the Peninsula were surveyed in summer. Densities of 400 to over 1000 shearwaters/km^2 were recorded. Their habits make them relatively vulnerable to oil spilled offshore in summer.

Fall - Bird densities recorded on North-Alaska Peninsula estuaries in fall were the highest observed in all surveys. Geese (mostly Brant, Emperor and Canada) comprised over half the total birds. Sea ducks were second in abundance followed by shorebirds. Izembek Lagoon, Nelson Lagoon, Port Moller and Cinder River contained the highest densities. Birds either used habitats highly susceptible to oil or they were vulnerable due to their propensity for marine waters. Estuaries on North-Alaska Peninsula should be given the greatest degree of protection from impacts of oil and gas development because of the great densities of birds found there and the regional, national and international importance of those birds.

Winter - In winter, bird densities in this region dropped substantially. Nevertheless, sea ducks were common in protected waters, and gulls fed and roosted on exposed sand beaches. Impacts would be less in winter, but spilled oil would likely remain to affect spring and fall migrating bird populations.

North-Bristol Bay

Spring - Spring bird densities in North-Bristol Bay were the lowest of the four regions surveyed in spring. A wide variety of bird groups was found in low to moderate densities. This region, particularly Kvichak Bay, was a part of the migration corridor for shorebirds. Scaup and Black Scoters used inshore waters extensively. Flounder Flats supported high scaup densities on two successive spring surveys. Geese were most abundant in Nanvak Bay, and gull and alcid populations were greatest near Capes Peirce and Newenham colonies. No lease areas are currently being considered near this region and, therefore, the potential for impact is less. Spilled oil from other areas that reached North-Bristol Bay would have changed its consistency and would not likely affect birds greatly.

Aleutian Shelf

Winter - The Aleutian Shelf region was surveyed in winter, and high densities were recorded despite poor survey conditions. Sea ducks were the most abundant group and were found in all sections in almost equal densities. They were found in exposed habitats more than protected.

Emperor Geese and Rock Sandpipers wintered in all sections. Highest densities for six species groups were found on Samalga Island at the western edge of the survey region. A catastrophic oil spill would do the most damage to wintering birds of the region. Most of the Aleutian Shelf habitats are low on the oil spill susceptibility index of Hayes et al. (1977).

II. INTRODUCTION

Alaska's 54,700 km of coastline provides a wide variety of habitats for breeding, migrating and wintering birds. Coastal cliffs, talus slopes, coastal meadows, barrier islands and other physiographic features provide ample nesting habitat. Migrating birds use coastal terrain for migration corridors and frequently stage on such habitats as river deltas and floodplains, lagoons, embayments and intertidal mudflats. The numerous ice-free bays and fjords in the Gulf of Alaska provide wintering habitat for many species of birds. This great habitat diversity supports an equally diverse avifauna. About 134 species of birds common in southcentral Alaska occur on coastal marine environments during at least part of their life cycle.

Because this nearshore and littoral region is so crucial to Alaska's marine birds, it was essential to assess the magnitude of bird use of this area with respect to which geographic areas received most use, and in which habitats within a geographic region bird use was occurring by season. In the past, most bird survey work along the coast had been for waterfowl and in most cases data were not quantitative. Areas of heavy bird use near population centers were obviously documented, but many uninhabited areas had not been looked at, particularly on a seasonal basis. Other surveys only looked at offshore bird use. King and McKnight (1969) specifically tried to determine bird use of nearshore waters by flying a sawtooth pattern out to 19 km in Bristol Bay, but little information was gathered on bird use of littoral and supratidal habitats. This study was designed to quantify bird use along the coast, in nearshore waters, and in supratidal regions.

Objectives of the project and regions studied since the inception of the study have been:

FY 1976-Gulf of Alaska, Bristol Bay; FY 1977-Bristol Bay, Aleutian Shelf.

1. To summarize and evaluate existing literature and unpublished data on the distribution, abundance, behavior and food dependencies of birds associated with littoral and estuarine habitats.

2. To delineate the storm-tide line and characterize vegetative types (bird habitats) seaward of the storm-tide line.

3. To determine seasonal density and distribution, critical habitats, migratory routes and breeding locales for principal bird species in littoral and estuarine habitats.

FY 1978-Lower Cook Inlet

Winter, Kamishak/Outer Kachemak Bays

1. To determine the winter distribution and abundance of marine birds in relation to ice conditions and other environmental parameters.

2. To attempt to determine the cause of various winter bird distribution patterns.

Spring-Kamishak Bay

1. To determine distribution and abundance of waterfowl and shorebirds species.

2. To determine critical habitats for these species groups.

3. To determine periods of peak usage and duration of usage in spring for these species groups.

4. To determine, if possible, food organisms used by these species groups during migration staging.

Summer-Kamishak Bay

1. To determine species composition and abundance of marine birds on colonies.

2. To determine as many aspects as possible of the breeding biology of marine birds on the colonies.

3. To determine, whenever possible, the food habits of nesting marine birds and their young.

4. To determine changes in abundance of breeding populations of marine birds on colonies visited in 1976.

5. To make other incidental observations of habitat use, forage areas, migration areas and abundance of non-colonial marine birds.

Oil and gas development and its various related activities have been recognized as posing the greatest potential threat to marine birds in Alaska. Catastrophic spills could impact large numbers of sea ducks and other seabirds utilizing nearshore areas for foraging. If oil contaminates estuaries or onto mudflats, thousands of waterfowl and shorebirds could be affected. Chronic pollution, although less obvious, may be as devastating to birds as a catastrophic spill. Food organisms will likely be destroyed by small chronic spills, and this, in turn, will have deleterious effects on birds if it continues for long periods of time.

This study helped provide baseline information on seasonal abundance of birds and identify which habitats various species of birds selected during different seasons. Those habitats found most important to birds can, hopefully, be protected in the event of a spill or avoided by onshore development and vessel traffic.

III. CURRENT STATE OF KNOWLEDGE

Most of the information on bird use of coastal habitats in southcentral Alaska has been summarized in previous annual reports of this research unit (Arneson 1976, 1977 and 1978). In general, few bird surveys were conducted which included all species using subtidal, littoral and supratidal habitats. Most surveys had been for popular game ducks and geese, and often these surveys were only qualitative in nature. Other bird research has been on specific sites covering limited geographic area and dealt with one or few species. Also, little work has been done on a seasonal basis; in particular, winter months have been neglected.

For the Northeast Gulf of Alaska lease area, including Prince William Sound, the best bird information is found in Isleib and Kessel (1973). Their species accounts of each bird included use by season, relative magnitude of this use and habitats used. They emphasized the importance of the Copper River Delta and Orca Inlet where densities of 250,000 shorebirds per square mile were recorded and where as many as 20 million birds staged during spring migration.

Until Outer Continental Shelf Environmental Assessment Program (OCSEAP) bird research began, little was reported about coastal use by birds of the Kodiak Archipelago except in winter. The U.S. Fish and Wildlife Service conducted winter boat surveys in 1973 and 1975 and the Alaska Department of Fish and Game has conducted aerial counts of waterfowl. In 1977 an aerial survey by the U.S. Fish and Wildlife Service duplicated their earlier boat surveys in coverage; however differences in species composition were evident between boat and aircraft surveys (Trapp 1977). The aerial survey recorded more dabbling and diving ducks, Harlequin Ducks, scoters and gulls while boat surveys, which did not get into shallow or estuarine waters, reported more eiders, Oldsquaws and alcids. Densities recorded for the 1973 and 1975 boat surveys were 129 and 147 birds/km^2, respectively, while the 1977 aerial survey had 101 birds/km^2. No intensive coastal surveys have been made in other seasons of the year along most of the Kodiak Archipelago.

Prior to 1976, little coastal bird work had been done in the Lower Cook Inlet lease area except for cursory surveys of the Kachemak Bay region. A study was conducted in 1976 by the Marine and Coastal Habitat Management Section, Alaska Department of Fish and Game (ADFG) in cooperation with this research unit to assess seasonal distribution and abundance of marine birds. Data from that study were summarized in Erikson (1977) and the habitat preference and density information will be presented in this report.

No specific surveys have been conducted along the south side of the Alaska Peninsula for bird habitat preference, and little work has been done on distribution and abundance by season. Effort has been directed at documenting seabird colony locations in summer. Although incidental information has been gathered on general distribution and abundance of other marine birds besides seabirds in summer, few data have been gathered in other seasons. Waterfowl surveys were conducted in winter 1970 and fall 1972 in many of the bays on the south side of the Alaska Peninsula but no records were kept of other bird species.

More surveys have been conducted, for the north side of the Alaska Peninsula so there is more knowledge of bird distribution and abundance. Surveys by ADF&G in the late 1960's and early 1970's documented use of the estuaries by waterfowl. Other investigators have reported use of nearshore and pelagic waters by marine birds (King and McKnight 1969, Bartonek and Gibson 1972). Little habitat is available for nesting seabirds but extensive estuarine saltmarshes and mudflats provide ideal staging habitat for waterfowl and shorebirds.

Habitat on the north side of Bristol Bay is more diversified and thus supports breeding seabirds as well as staging waterfowl and shorebirds. The ice pack during severe winters precludes much bird use of this area in winter. Again, waterfowl surveys in the early 1970's provided most of the knowledge of birds using coastal areas, although many colonies had been documented and pelagic surveys conducted.

Bird use of the final region under consideration, the Aleutian Shelf lease area, has received little quantitative assessment. Murie (1959) summarized most qualitative data for parts of the region and colonies have been documented for some of the islands (Sowls et al. 1978). Otherwise, very little is known of seasonal bird use of coastal areas within this region.

IV. STUDY AREA

Coastal bird surveys under this research unit were conducted in the Gulf of Alaska and Bristol Bay from Cape Fairweather to Cape Newenham (Fig. 1). The study area was further subdivided into seven survey regions: 1-Northeast Gulf of Alaska, 2-Kodiak Archipelago, 3-Lower Cook Inlet, 4-South-Alaska Peninsula, 5-North-Alaska Peninsula, 6-North-Bristol Bay and 7-Aleutian Shelf.

Northeast Gulf of Alaska - This region is bounded on the south by Cape Fairweather and on the north by Cordova (Fig. 2). Much of the area consists of exposed sand or gravel beaches which are the result of downdrift from glacial outwash streams. The coastline is broken by two major glacial fjords, Icy Bay and Yakutat Bay, and by two large river deltas, the Copper and Bering Rivers. Extensive mudflats are found at the mouths of both rivers and also in adjoining Orca Inlet. Frequent seismic activity often changes these habitats quite drastically. An earthquake in 1899 uplifted the head of Yakutat Bay over 14 meters (Ruby 1977). The Good Friday Earthquake of 1964 uplifted the Copper River Delta and surrounding areas nearly 2 meters, causing brackish areas to become freshwater.

Storms, which are frequent and severe in fall and winter, also alter the geomorphology through erosion and deposition.

Kodiak Archipelago - Two major islands, Kodiak and Afognak, and several minor islands make up this mountainous archipelago (Fig. 3). The major islands are nearly bisected by long, narrow fjords and bays. Afognak Island and the extreme northeastern part of Kodiak Island are heavily forested with Sitka spruce (*Picea sitchensis*). The remainder of Kodiak is largely alpine tundra, and dense alder (*Alnus crispa*) thickets with cottonwood (*Populus balsamifera*) groves at heads of bays. Beach rye (*Elymus* sp.) and sedge/grass areas are found in small lagoons and on sandspits, but these habitats are not abundant on Kodiak. Nearly 60 percent of the archipelago has a rocky substrate--exposed or sheltered rocky headlands or eroding wave-cut platforms (Hayes and Ruby 1979). Gravel and mixed sand/gravel are the next most abundant substrates. Sand beaches are scarce and are generally found only on the south end of the island.

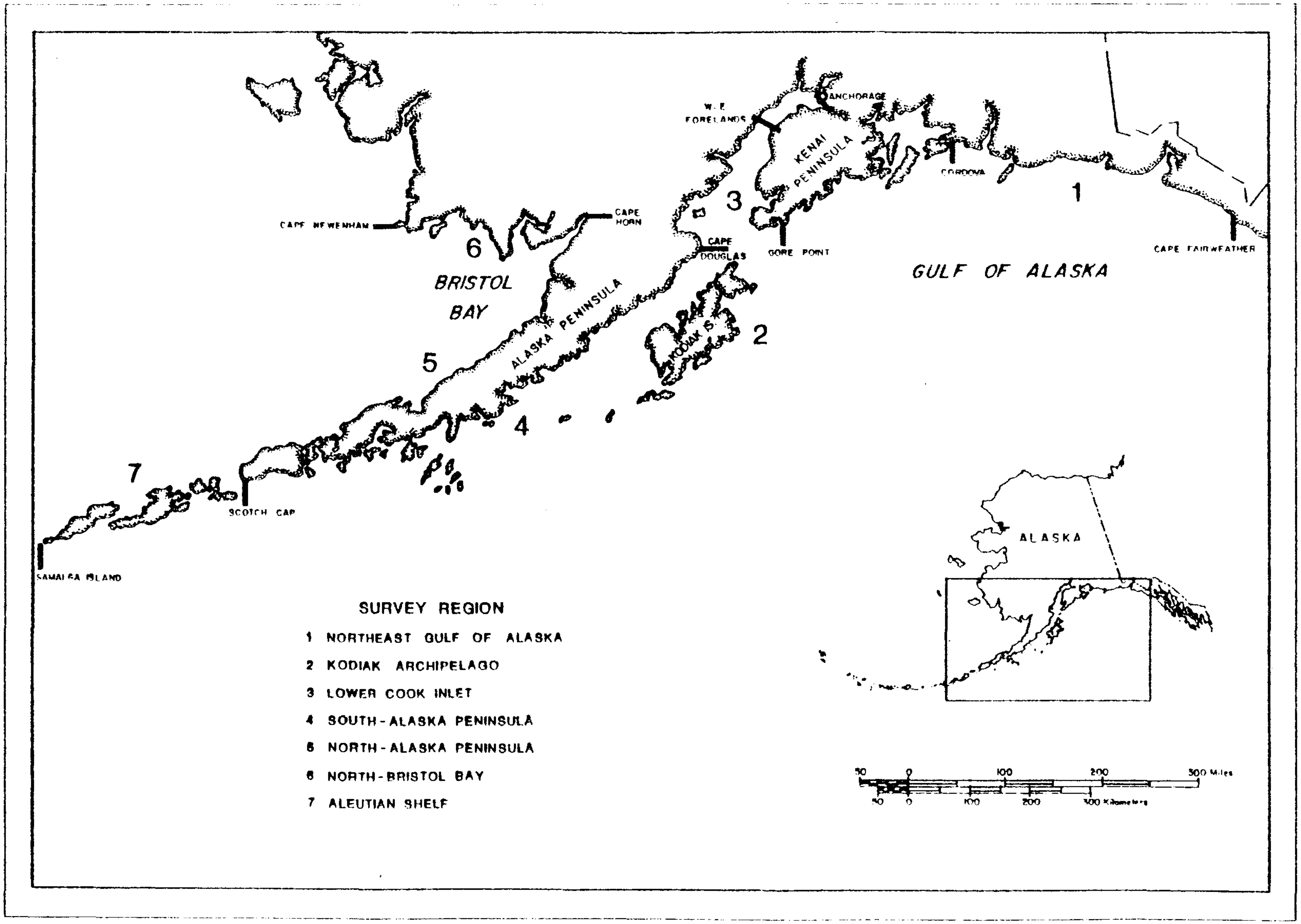


Fig. 1. Study area in southcentral Alaska subdivided into survey regions.

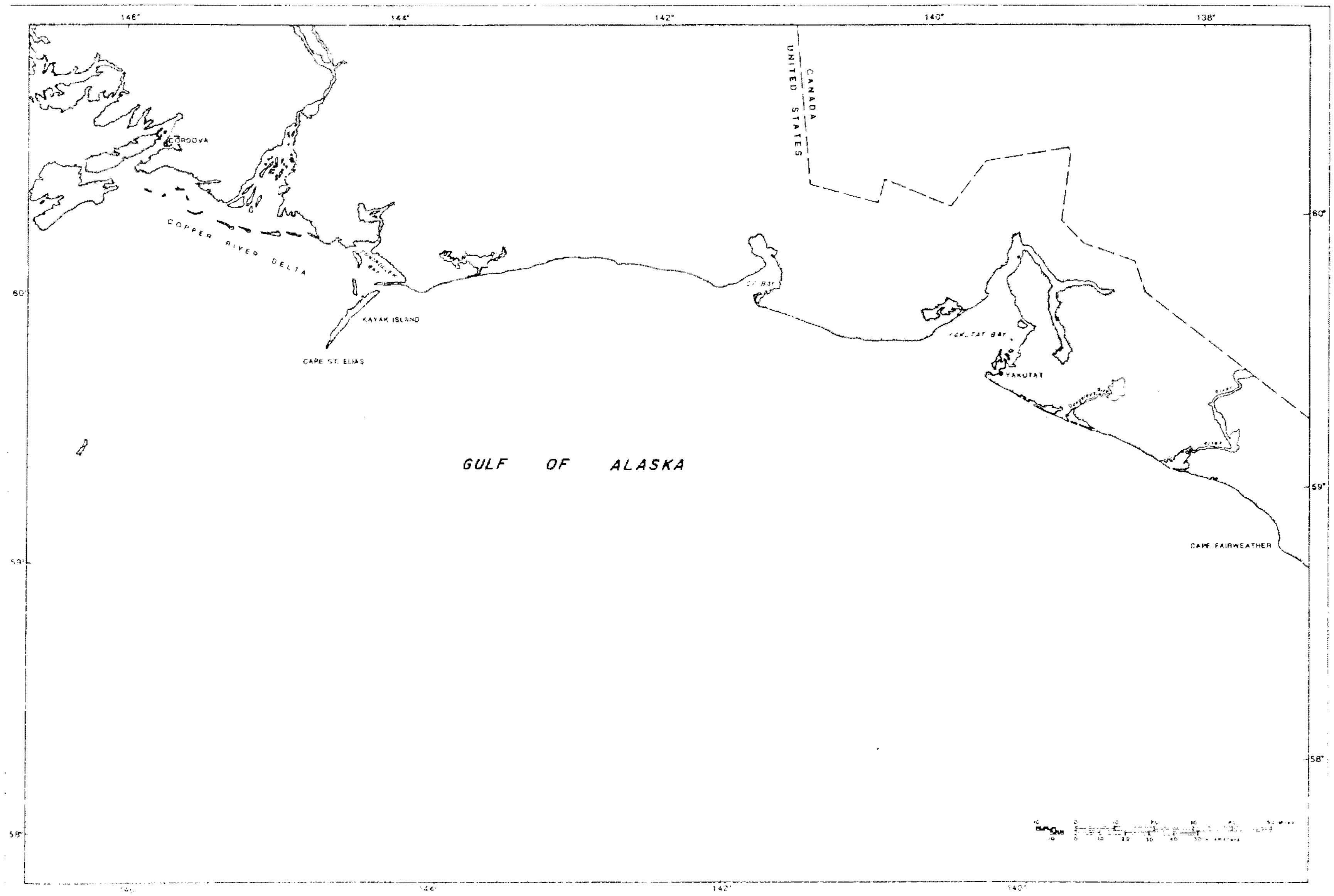


Fig. 2. Survey Region 1: Northeast Gulf of Alaska with place names.

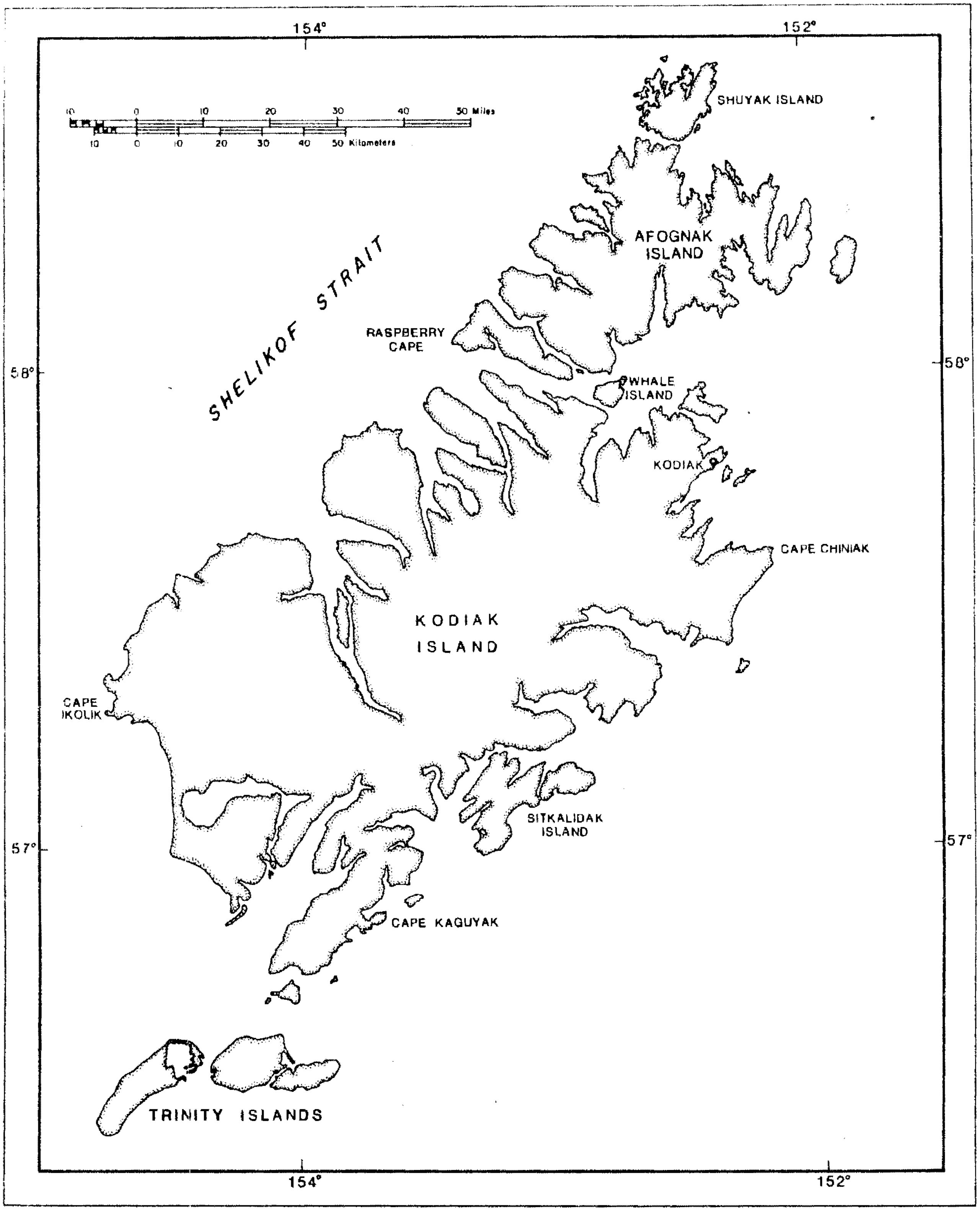


Fig. 3. Survey Region 2: Kodiak archipelago with place names.

Maritime climates prevail on the Kodiak Archipelago. Warm ocean currents moderate winter conditions and, therefore, bays and fjords freeze over only during the most severe cold spells. Winds are strongest from westerly directions in winter and from the east during summer storms (Hayes and Ruby 1979).

Lower Cook Inlet - For this study, Lower Cook Inlet was defined as those portions of the inlet below the Forelands, as far as Cape Douglas on the western side and to Gore Point on the southeast (Fig. 4). It included all of Kachemak Bay exclusive of the Barren Islands. Lower Cook Inlet is physically more diverse than other regions studied. The southeast portion is predominantly sheltered rocky bays and fjords. With its maritime climate, these waters are generally ice-free in winter and provide winter habitat for several marine bird species. From Homer to Kenai, the shoreline is mostly sand beaches with a bluff at the high tide line. Waters are increasingly turbid to the north and in winter ice floes from Upper Cook Inlet are frequently found as far south as Ninilchik. Two large river deltas, Kenai and Kasilof, comprise the most productive bird habitat in this portion of coastline. In contrast to the straight, sandy northeast side, the west side of Lower Cook Inlet is broken up by several bays which are relatively shallow and have extensive intertidal mudflats on their periphery. Winter weather in this area is more severe than on the east side, and bays are frequently ice-choked.

Because of the Aleutian Range on the west and Kenai Mountains on the east, winds are generally funneled up and down the inlet, predominantly southwest in spring and summer, and northeast in fall and winter (Hayes et al. 1977). Bays on the west side frequently have localized, strong westerly winds in summer as air masses from Bristol Bay move through mountain passes.

South-Alaska Peninsula - This area (Fig. 5), like Kodiak and southeast Lower Cook Inlet, has numerous rocky bays and fjords with few large lagoons and proportionately fewer sandy beaches. Maritime weather keeps the area relatively ice-free in winter, but strong winds, heavy precipitation, and fog make it inhospitable for much of the year. Few permanent settlements have been established along the entire coastline. These conditions make it difficult to obtain bird information on a seasonal basis, yet conditions are not too severe to preclude substantial bird usage.

North-Alaska Peninsula - The north side of the Alaska Peninsula (Fig. 5) differs considerably from the south side. Most exposed portions are long sand or sand/gravel beaches with low beach ridges or high bluffs at the high tide line. No trees occur along the coast and the vegetation is largely that of arctic tundra and scrub thickets. Several large lagoons and embayments partitioning the coastline provide a wide variety of important bird habitats. At the mouths of these estuaries there are barrier islands and/or spits, and around their perimeters there are mudflats, sedge marshes and river floodplains. Rocky habitats are present only in Port Moller, at the southern portion of the Peninsula and on Unimak Island. Unimak is included in this region because of its similarities and proximity to the Alaska Peninsula.

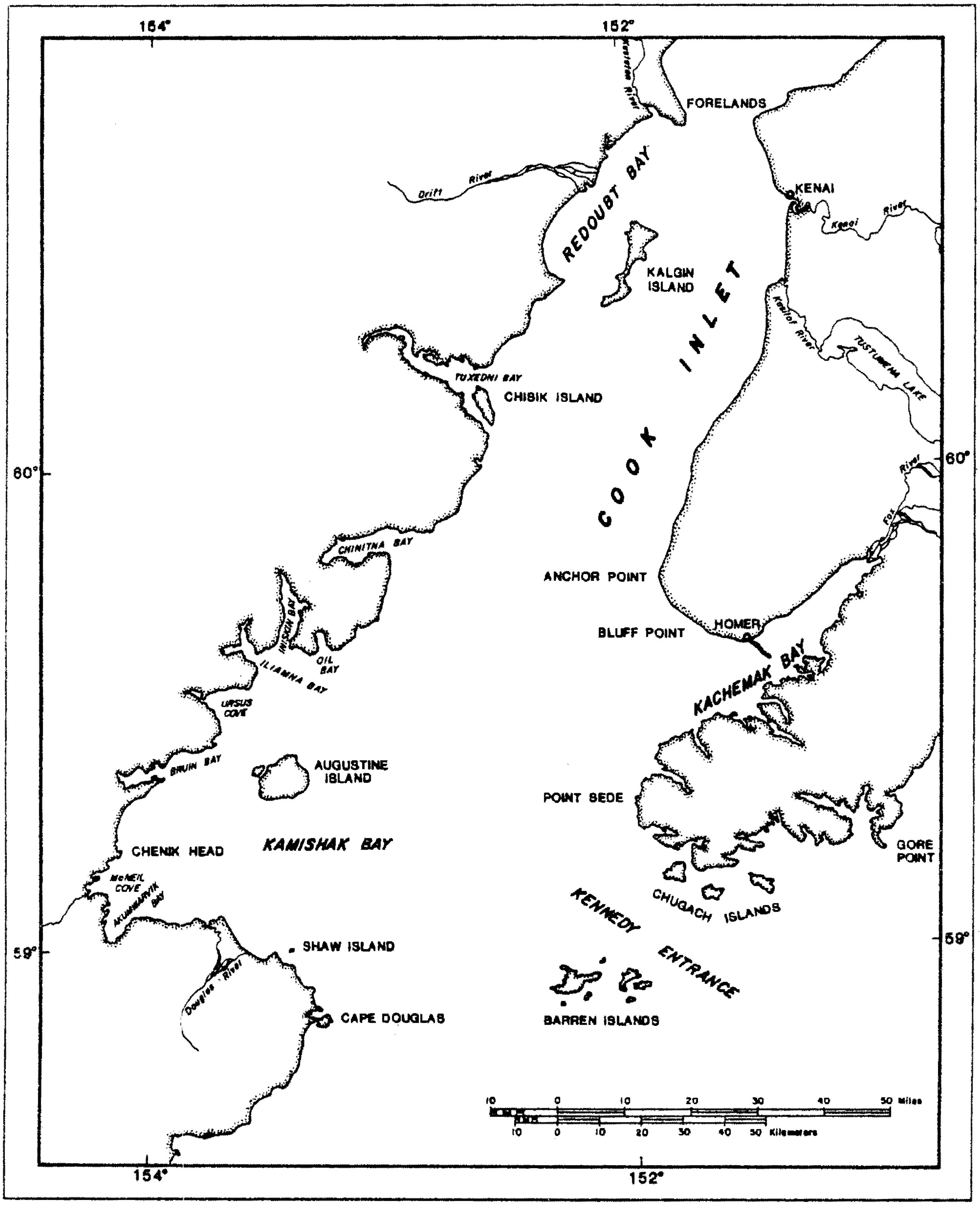


Fig. 4. Survey Region 3: Lower Cook Inlet with place names.

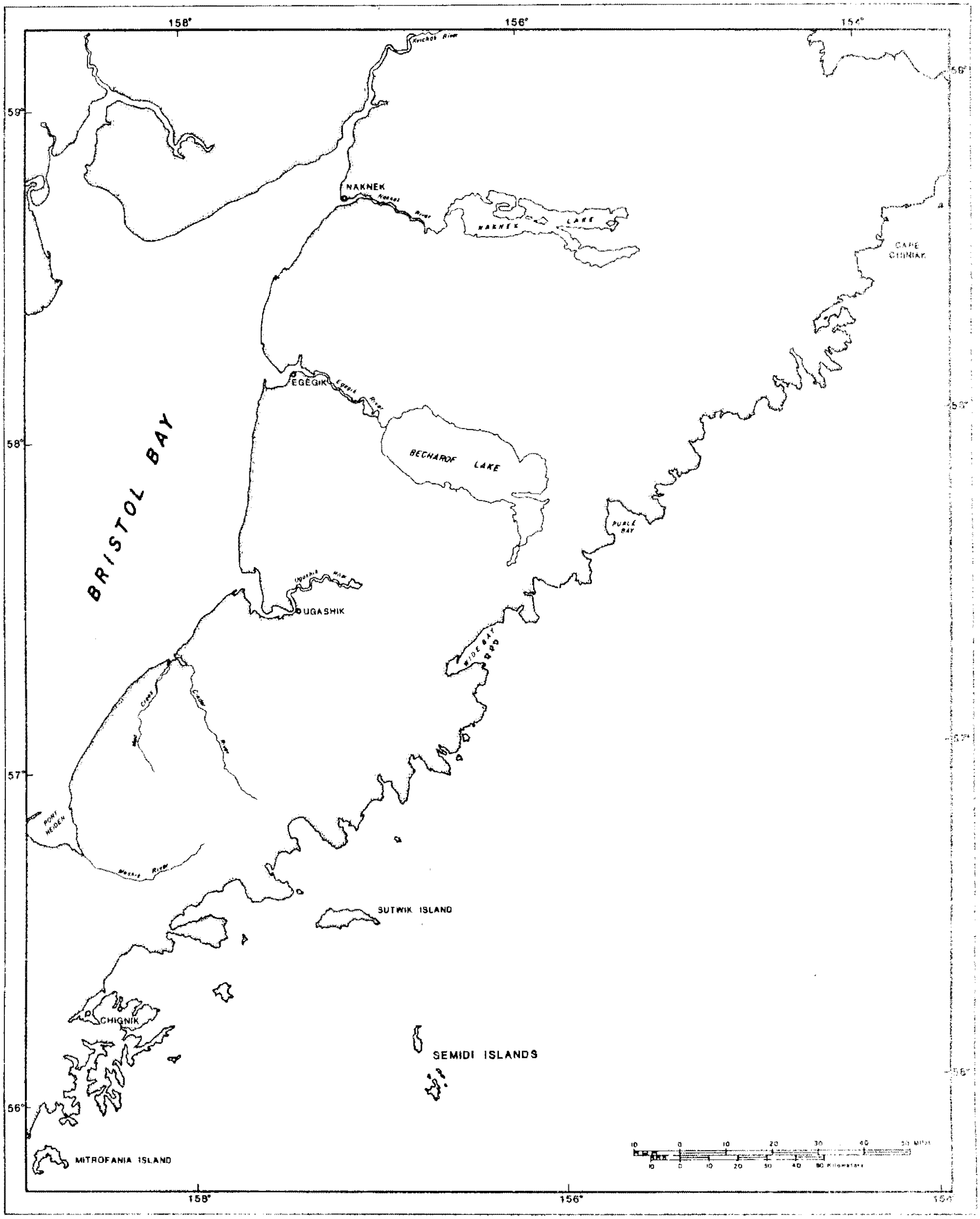


Fig. 5 Survey Regions 4 and 5: South- and North-Alaska Peninsula with place names.

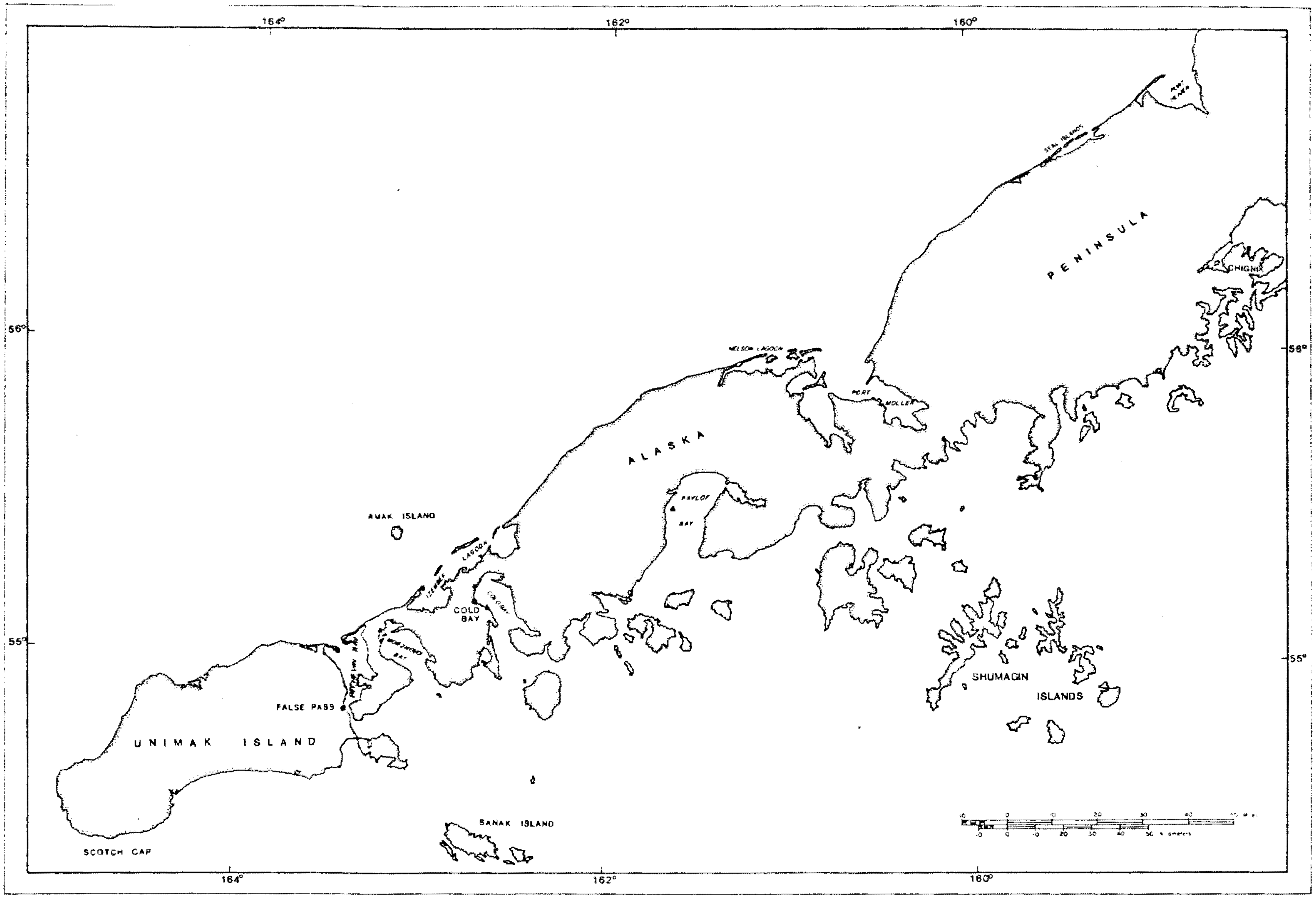


Fig. 5 (cont.). Survey Regions 4 and 5: South- and North-Alaska Peninsula with place names.

During severe winters all estuaries are ice-filled and pack ice covers Bristol Bay to the southern portion of this region. Low pressure systems frequently move up the coast bringing strong southeasterly winds and heavy precipitation.

North-Bristol Bay - This region includes a variety of habitats between the Kvichak River and Cape Newenham (Fig. 6). The eastern portion largely consists of extensive sand beaches with several large river deltas. Rocky cliffs are more common on the western portion with the largest at Capes Peirce and Newenham. A few small lagoons and bays are found in this section of coast, but only limited protected waters are available to birds. Rock cliffs which are common on Hagemeister and the Walrus Islands, provide abundant nesting habitat for seabirds.

Weather is similar to that on the Alaska Peninsula. Frequent storms come into Bristol Bay bringing heavy precipitation and strong southeast winds. The area is normally ice-covered in winter when pack ice moves down from the north.

Aleutian Shelf - Only the portion of the Aleutian Islands from Unimak Pass to Samalga Island was covered in this study (Fig. 7). Much of the coastline in this area is rock, either cliffs or boulder beaches. Gravel beaches are common at heads of the many bays, but sand beaches are rare. Few lagoons or embayments are present, and those that exist are quite small.

Storms are frequent in the Aleutians with high winds and heavy precipitation. Fog often enshrouds the islands. Because of the maritime climate, winter temperatures are moderate and there is little ice build-up in bays.

Strong tidal currents pass between islands and likely cause upwelling of food organisms for birds.

V. METHODS

Aerial Surveys

Several aerial bird survey techniques were used in the course of this project, depending upon the region surveyed and circumstances. Twin-engine amphibious and single-engine, fixed-wing aircraft and a helicopter were utilized at different times. Airspeed varied from 95 to 225 km/hour and survey altitude from 30 to 45 meters.

Along straight beaches with narrow supratidal zones, the survey aircraft flew 100-200 meters seaward of the waterline. The most frequently used technique involved observers on both sides of the aircraft. The shoreside observer enumerated all birds visible to the high waterline while the oceanside observer recorded all birds within 200 meters of the aircraft. For analyses, it was assumed the shoreside observer was looking at a mean width of 170 meters. Therefore, the total width of the "transect" was 370 meters parallel to the coast. Concentrations of birds outside this zone were recorded, but were not included in analyses.

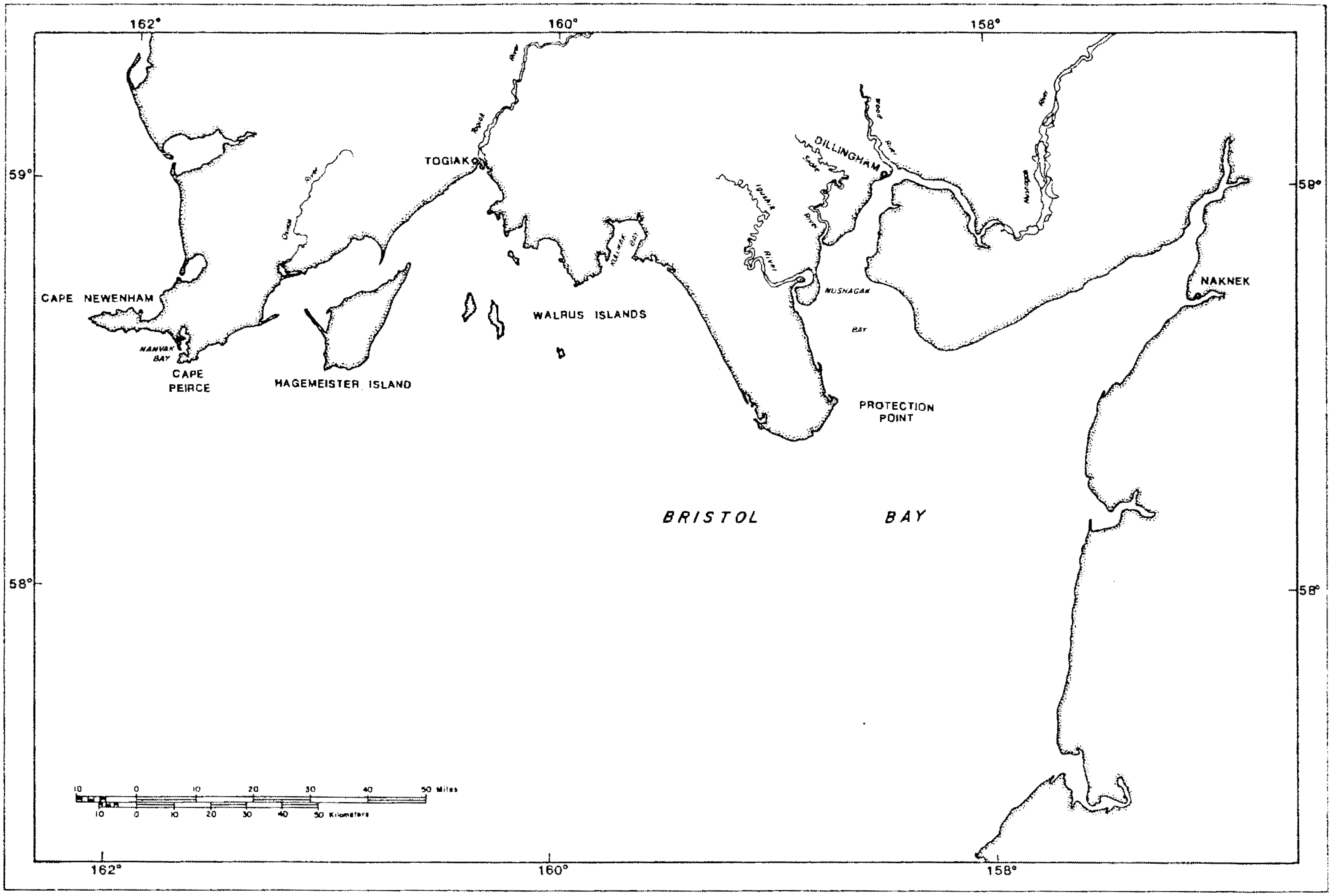


Fig. 6. Survey Region 6: North-Bristol Bay with place names.

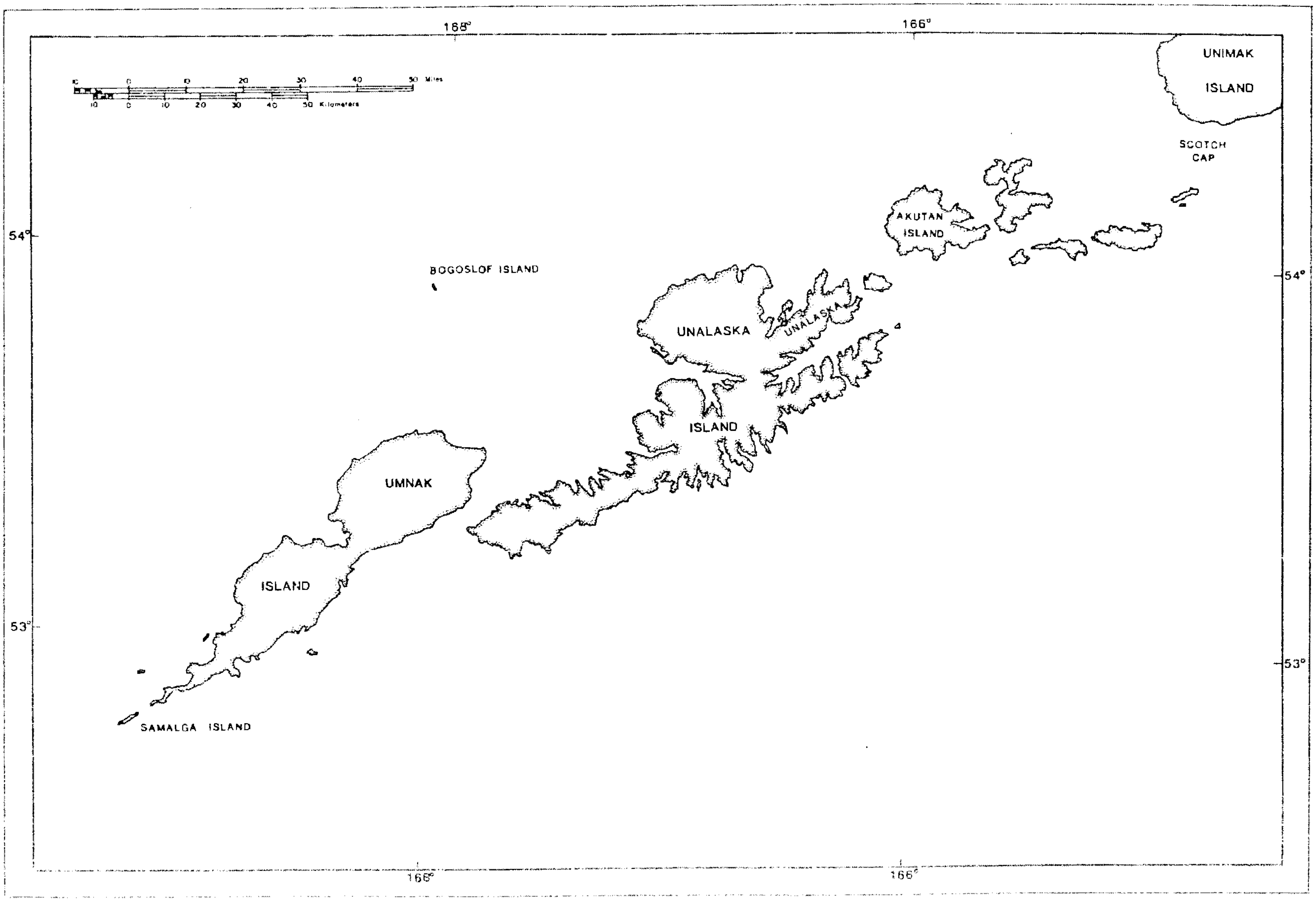


Fig. 7. Survey Region 7: Aleutian Shelf with place names.

In estuarine and coastal floodplain habitat, a total count of birds was attempted; or in some cases, transects were flown. Techniques for obtaining a total count entailed flying back and forth over the estuary or supratidal zone at close enough intervals to get "total" coverage.

While flying over open water between islands or while purposely flying pelagic, nearshore transects, both observers attempted to record all birds within 200 meters of the aircraft. Poor observation conditions or faster flying aircraft necessitated reduction of this zone to 100 meters.

For the winter survey of the Kodiak Archipelago, it was assumed that frequent poor winter weather conditions would preclude the practical use of the standard shoreline survey technique. Therefore, a stratified random census technique was used. The region was separated into eight basic habitat units, stations were numbered and the stations to be surveyed were randomly selected using a table of random numbers. We flew only preselected count units plus a few extra units suspected of being important to birds.

Only one observer was present on certain surveys, particularly when aircraft of opportunity were used (e.g. on marine mammal surveys). When this occurred, a fixed-distance (100 or 200 meters) technique was used when transects or offshore areas were flown. While flying along the coast, the observer counted all birds within the zone from the aircraft to the high tide line. For analysis, it was assumed that the width of the zone in the latter case was 170 meters. In this way, all density figures are based on area and not solely on distance.

Station Designation

The shoreline of each region was subdivided into "stations" or count units to facilitate recording bird locations. A requirement of the station designation scheme was that unit boundaries be easily identifiable at low altitudes while counting birds. Therefore, recognizable geographic features were used as starting and ending points and stations were of variable size. In most instances they were between 2 and 16 kilometers in length.

For analyses in this report, stations were combined into more meaningful and manageable sections of coastline. An attempt was made to maintain similar physiographic features within each section or at least to use logical starting and ending points.

Parameters Recorded

All observations were recorded on cassette-type tape recorders. Information recorded included the following: bird identification to lowest taxon possible (order, family, genus, species), bird numbers and habitat type in which the bird was found. Any other useful information including activity, sex, color phase and counting method was recorded when obtainable. Weather observations were recorded at the start of each flight and a coded survey condition was noted as often as conditions changed. Time was recorded at the start and end of each station.

Survey Priorities

Priority of selection of regions for surveying was based largely upon presumed importance of the area to bird populations, vulnerability of the area to oil development and the proposed OCS planning schedule for oil lease sale areas (the earliest lease sale areas were surveyed first). The amount of existing knowledge about certain areas and the extent of current research being conducted by other organizations or individuals also influenced which areas most needed research emphasis.

Species Group Designations

Because of the large quantity of data generated by the surveys and because of limited time and space for this report, certain abbreviations in the analyses were necessary. First, birds were consolidated into 17 ecological groupings plus an eighteenth "catch-all" group. The groupings were those Which are most frequently seen in coastal environments. The eighteenth group consists of birds that did not fit into the previous 17 groups (such as ptarmigan [*Lagopus* spp.] or Belted Kingfishers [*Megaceryle alcyon*]) and unidentified birds. Few swans (*Olor* spp.) or jaegers (*Stercorarius* spp.) were observed but their numbers were combined with their nearest phylogenetic relatives, geese and gulls, respectively. In many cases, data on a species or species group basis were available but could not be presented here. For this report, dabblers (or dabbling ducks) included: Mallard (*Anas platyrhynchos*), Gadwall (*A. strepera*), Pintail (*A. acuta*), Green-winged Teal (*A. crecca*), Northern Shoveler (*A. clypeata*), European Wigeon (*A. penelope*) and American Wigeon (*A. americana*). Divers (or diving ducks) included: Canvasback (*Aythya valisineria*), Redhead (*A. americana*), Ring-necked Duck (*A. collaris*), Greater Scaup (*A. marila*), Lesser Scaup (*A. affinis*), Common Goldeneye (*Bucephala clangula*). Barrow's Goldeneye (*B. islandica*) and Bufflehead (*B. albeola*). Sea ducks included: Oldsquaw (*Clangula hyemalis*), Harlequin Duck (*Histrionicus histrionicus*), Steller's Eider (*Polysticta stelleri*), Common Eider (*Somateria mollissima*), King Eider (*S. spectabilis*), Spectacled Eider (*S. fischeri*), White-winged Scoter (*Melanitta deglandi*), Surf Scoter (*M. perspicillata*) and Black Scoter (*M. nigra*). Mergansers included: Common Merganser (*Mergus merganser*) and Red-breasted Merganser (*M. serrator*) Raptors included hawks, eagles, falcons and owls.

Habitat Type Designation

The habitat preference analysis also required abbreviation. During surveys, 473 different habitat combinations were recorded using the scheme in Table 1. These were consolidated into 39 habitat types plus four partially identified types (Table 2). Four habitat types were excluded because a total of less than 200 birds was seen on them. The substrate for each habitat type was designated as often as possible to be able to compare those habitats with the oil spill vulnerability index of Hayes et al. (1977).

Table 1. Four digit coding system used to classify habitats during coastal bird surveys. For each bird observation, one item for each column was recorded.

CODE	WATER TYPE	PHYSIOGRAPHIC FEATURE	SUBSTRATE TYPE	COVER TYPE
0	Indeterminable from air	Indeterminable from air	Indeterminable from air	Indeterminable from air
1	Undetermined	Undetermined	Undetermined	Undetermined
2	Combination of below	Combination of below	Combination of below	Combination of below
3	Bay	Beach	Mud	Bare
4	Lagoon	Coastal Floodplain	Sand	*Elymus* - beach rye
5	Embayment	Salt Chuck	Gravel	*Carex* - sedge
6	Fjord	Inter-tidal area	Large rocks	*Zostera* - eelgrass
7	Unprotected shoreline	Tide Upwelling	Mud and sand	Mixed grass
8	Brackish pond or lake	Sand Spit	Sand and gravel	Mixed forbs
9	Fresh water pond or lake	Barrier Island	Sand, gravel and rocks	Algae - kelp
A	Lotic Environment	Other Island	Water	Coniferous trees
B	Open water (Pelagic)	River Delta	Land ice	Deciduous trees
C	-	Stream Delta	Sea ice (floating)	-
D	-	Cliff	-	-
E	-	Manmade structure	-	-
F	-	River Bank	-	-

Table 2. Coastal habitats used in analyses of bird surveys.

I. Offshore Waters (pelagic and inshore transects)

II. Exposed Inshore (coastal) Waters
   A. Open Water
   B. Tideflats (Mud and Mud/Sand)
   C. Beach
      (1) Sand and Sand/Gravel
      (2) Gravel and Sand/Gravel/Rock
      (3) Rock
   D. Islands (Barrier and other) and Pinnacles
      (1) Upland Soil*
      (2) Sand Beach
      (3) Gravel Beach
      (4) Rock Beach

III. Protected Nearshore Waters (estuarine)
   A. Bays and Fjords
      (1) Open Water
      (2) Tideflats (Mud and Mud/Sand)
      (3) Beach
         a. Sand and Sand/Gravel
         b. Gravel and Sand/Gravel/Rock
         c. Rock
      (4) Islands (Barrier and other) and Pinnacles
         a. Upland Soil
         b. Sand Beach
         c. Gravel Beach*
         d. Rock Beach
   B. Lagoons and Embayments
      (1) Open Water
      (2) Tideflats (Mud and Mud/Sand)
      (3) Beach
         a. Sand and Sand/Gravel
         b. Gravel and Sand/Gravel/Rock
         c. Rock
      (4) Islands (Barrier and other) and Pinnacles
         a. Upland Soil
         b. Sand Beach
         c. Gravel Beach

IV. Sedge/grass Saltmarshes (includes those from exposed inshore waters, bays and fjords, lagoons and embayments, brackish and freshwater ponds and tideguts/sloughs).

V. Fluviatile Waters (streams and rivers)
   A. Exposed Deltas
      (1) Open Water
      (2) Bare Substrate
         a. Mud
         b. Sand
         c. Gravel
         d. Rock*
   B. Protected Alluvia (river waters, banks, floodplains and deltas from bays, fjords, lagoons and embayments).
      (1) Open Water
      (2) Bare Substrate
         a. Mud
         b. Sand
         c. Gravel
      (3) Vegetated Floodplain

VI. Dry Coastal Upland (includes tundra, subterranean soil)*

VII. Unidentified Habitats
   A. Exposed Inshore
   B. Bay/Fjord
   C. Lagoon Embayment
   D. Protected Alluvial

* Habitats dropped from analyses because of low bird usage

Season Designation

The following definitions were used for seasons: spring-April, May; summer-June, July, August; fall-September, October, November; winter-December, January, February, March. This breakdown is arbitrary, and migrating birds did not strictly follow this pattern. Many marine birds did not reach their wintering areas until well into November so this month was included as a "fall" month. During the course of the study, there were three unusually mild winters. Therefore, cold weather did not force certain bird species to final wintering areas until late in the fall or early winter.

Habitat Mapping

The second major objective of this project was to map habitat types in the high tide to supratidal zones of the coastline. This was done in snow-free months from aircraft at an altitude of 90-120 meters. Information on substrate type, height and slope of the bank at high tide line, type of vegetation and stormtide line were color-coded onto USGS 1:63,360 or 1:250,000 maps. Information concerning the mapping project, including areas of coverage, was summarized in Arneson (1977). Formal presentation of this information is beyond the scope of this report. An atlas on both scales of maps is located at Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, Alaska.

VI. RESULTS

From October 1975 to August 1978, 33 surveys were conducted by observers from this research unit (Table 3). Twenty-nine surveys were conducted using fixed-wing aircraft, two using a rubber raft, one using a helicopter and one from a stationary platform. For analyses, the latter survey was omitted, and the other surveys were combined by season within each region.

For correct interpretation of the tables and figures in this report, it is essential to understand more about our data collection procedures and how bird behavior or distribution patterns may affect the results. In many cases, surveys in the same lease area and in the same season but different years were not duplicated station by station. Therefore, different amounts of a given habitat were searched, perhaps biasing results toward, or away from, certain habitats. For example, there were two types of surveys done in successive fall seasons on North-Alaska Peninsula. The first year the entire coastline and all estuaries were surveyed. To save time (i.e. money) the second year, we spent more time searching estuaries (where most birds are normally found). Therefore, habitats found in estuaries will be overemphasized and exposed beaches underemphasized in the habitat-usage analysis. Also, when we flew surveys in conjunction with marine mammal surveys, we searched types of habitats different from our normal coastal bird surveys. One must be familiar with survey trackline maps for each region to properly interpret the tabular and pictorial data.

Information on the quantities of each habitat type that were searched for each survey was not collected. Also, the time spent surveying specific habitat types was not recorded. Therefore, data on habitat usage presented in the following discussion only reflect habitat types in which the birds were found at the time of the survey.

When the coastline was flown in summer, we did not normally count birds in breeding colonies. For large colonies, it was impossible to get an accurate count from the air. Also, it was often hazardous for the aircraft to get too close. We did, however, count concentrations of roosting or feeding birds in the vicinity of colonies.

Birds' habitat preference and behavior also affected our counts. For example, tubenoses seldom occur nearshore and, therefore, we found them in large numbers only when doing pelagic transects. Shorebirds were most easily counted when they flushed. Consequently, when they remained on the ground, particularly the rock-dwelling species, they were frequently underestimated or likely overlooked entirely. Passerines were likely present in larger numbers than we found, but they, too, were small and were seldom observed unless flushed. Bird species which dove at the approach of aircraft were also likely underestimated. This was probably most true for grebes, cormorants and several sea duck species. Bird distributions also changed with the tides, time of day, and weather conditions and a one-time survey may have missed the period of peak occurrence.

Table 3. List of all surveys conducted in southcentral Alaska for Research Unit #3.

File Identification Number	Date of Survey	Season	Region Surveyed	Observers	Type of Survey	Number of Stations Surveyed	Total Time in Survey Hrs. Min.
FY 1976							
FG7601	13-27 Oct 75	F	N. AK Pen., S. AK Pen.	P. Arneson, M. Johnson, D. Timm, J. Sarvis	Shoreline, Transects	157	Unknown
FG7602	9-11, 18 Feb 76	W	Lower Cook Inlet	P. Arneson, D. Erikson, W. Ballard	Shoreline	120	10:00
FG7603	22 Feb-3, 21-24 Mar 76	W	Kodiak/Afognak	P. Arneson, V. Berns, W. Donaldson, R. MacIntosh	Stratified-Random Shoreline	76	9:51
FG7604	1-9 May 76	Sp	Northeast Gulf of AK	P. Arneson, D. Kurhajec, M. Isleib	Shoreline	142	13:06
FG7605	3, 4-7, 11 May 76	Sp	Lower Cook Inlet	D. Erikson, W. Ballard	Shoreline	148	11:43
FG7606	17-20 May 76	Sp	N. Bristol Bay	P. Arneson, D. Kurhajec	Shoreline	110	9:20
FG7607	21-25 June 76	Su	Lower Cook Inlet	P. Arneson, D. Erikson	Shoreline	180	12:46
FG7608	24 July 76	Su	Northeast Gulf of AK	D. Kurhajec	Shoreline-One Side	26	2:02
FG7609	30-31 July 76	Su	N. AK Peninsula	P. Arneson	Pelagic Transects-One Side	39	6:18
FG7610	16 June 76	Su	N. AK Peninsula	D. Kurhajec	Pelagic Transects-One Side	7	:33
FG7611	5,6 March 76	W	Lower Cook Inlet	D. Erikson, W. Ballard	Pelagic Transects	5	2:01
FG7612	1 April 76	Sp	Lower Cook Inlet	P. Arneson, D. Erikson	Pelagic Transects	28	4:37
FG7613	10 May 76	Sp	Lower Cook Inlet	D. Erikson, W. Ballard	Pelagic Transects	8	2:38
FG7614	24 June 76	Su	Lower Cook Inlet	P. Arneson, E. Erikson	Pelagic Transects	8	2:28
FG7615	30 Sept 76	F	Lower Cook Inlet	D. Kurhajec, D. Erikson	Pelagic Transects	8	2:29
FY 1977							
FG7701	30 Sept-2 Oct 76	F	Lower Cook Inlet	D. Kurhajec, D. Erikson	Shoreline	176	10:44
FG7702	13, 14&16 Oct 76	F	N. AK Peninsula	P. Arneson, D. Kurhajec	Shoreline-Estuaries	38	10:01
FG7703	28 Feb-4 Mar 77	W	N. AK Peninsula, Aleutian Shelf	P. Arneson, D. McDonald	Shoreline	167	8:48
FG7704	4 March 77	W	N. AK Pen., S. AK Pen.	P. Arneson, D. McDonald	Shoreline	59	3:34
FG7705	16-18 March 77	W	S. and N. AK Pen.	P. Arneson	Pelagic Transects, Shoreline	102	11:19
FG7706	6,7 May 77	Sp	N. AK Peninsula, N. Bristol Bay	P. Arneson, D. McDonald	Shoreline (helicopter)	28	4:52
FG7707	10-12 May 77	Sp	N. AK Peninsula	P. Arneson, D. McDonald	Shoreline	136	12:20
FG7708	13 May 77	Sp	N. Bristol Bay	P. Arneson, D. McDonald	Shoreline	41	3:18
FG7709	17 June-14 July 77	Su	N. Bristol Bay	P. Arneson, D. McDonald	Pelagic Transects (raft)	18	5:41
FY 1978							
FG7801	22 Nov 77	F	Lower Cook Inlet	P. Arneson, M. Allen	Shoreline/Pelagic Transects	34	4:22
FG7802	12 Jan 78	W	Lower Cook Inlet	P. Arneson, M. Allen	Shoreline/Pelagic Transects	35	4:45
FG7803	3 Mar 78	W	Lower Cook Inlet	P. Arneson, M. Allen	Shoreline/Pelagic Transects	35	4:28
FG7804	28 Apr 78	Sp	Lower Cook Inlet	P. Arneson, R. Johnston	Shoreline	17	:55
FG7805	1 May 78	Sp	Lower Cook Inlet	P. Arneson, R. Johnston	Shoreline	30	1:51
FG7806	4 May 78	Sp	Lower Cook Inlet	P. Arneson, R. Johnston	Shoreline	33	1:36
FG7807	11 May 78	Sp	Lower Cook Inlet	P. Arneson, R. Johnston	Shoreline	35	2:05
FG7808	7 Jun-16 Aug 78	Su	Lower Cook Inlet	P. Arneson	Shoreline, Pelagic Transects (raft) Walking	81	69:46
FG7809	19 Jun-13 Aug 78	Su	Lower Cook Inlet	P. Arneson	Stationary	26	8:52

On the density maps that follow, it was impossible to plot all station densities. Therefore, only sectional densities are presented. If high densities occurred within each section, their locations were plotted on the maps. The scheme used to designate high densities combined a minimum density with a minimum number of that species grouping. Any value exceeding both those assigned in Table 4 was plotted on the density maps as a "site of high density."

NORTHEAST GULF OF ALASKA (NEGOA)

Two surveys were conducted in the NEGOA region (Fig. 8). The spring 1976 survey covered the entire area thoroughly. In Controller Bay, Copper River Delta and Orca Inlet equidistant transects were flown because the areas were too large for total coverage. Only one observer was present on the summer 1976 survey, and only three sections of exposed beach and the southern portion of Icy Bay were surveyed. For data summary, the coastline was subdivided into 11 sections (Fig. 9).

SPRING

Density - An overall bird density of 151 birds/km^2 was found for NEGOA in spring 1976 (Table 5). Maps of bird densities by sections are shown in Figs. 10-27. Shorebirds and gulls were the most abundant groups with 67 and 45 birds/km^2, respectively. Shorebird populations were most dense on the Copper River Delta, Orca Inlet and Controller Bay (Fig. 22) where large areas of intertidal mudflats are found. Large flocks of Black-legged Kittiwakes (*Rissa tridactyla*) roosted on the beach and water near their colony on Martin Islands in Section 9. Because the area was small in this section, densities of gulls (774 birds/km^2) for this section were magnified. The inclusion of counts of birds near colonies in Section 7 also helped increase gull densities to 163 birds/km^2. Sections 7 and 9 also had the highest alcid densities of 81 and 33 birds/km^2, respectively. Alcids (mostly murres) had arrived at their colony sites by the early May survey but roosted mainly on adjacent waters.

Densities for all other bird groups were much less. This was more a result of the timing of the survey in relation to spring migration than to lack of use of the area. For example, geese and dabblers moved through the area in late April. The survey in early May was timed to catch the peak of shorebird migration, and it also occurred during peak tern and, possibly gull, migrations. The mean density was 9/km^2 for sea ducks and 7/km^2 for dabblers, divers and terns. Sea duck densities were highest in Icy Bay at 46 birds/km^2. Total numbers of sea ducks were greatest in Section 3, Russell and Nunatak Fjords. Scoters were the most abundant (84%) sea duck and Surf Scoters were the prevalent (76%) identified scoter.

Dabbling ducks were densest in Controller Bay (Section 8) with 17 birds/km^2 and most numerous in Section 3 (2020 individuals). Pintails were the most numerous (721) dabbler species identified in NEGOA followed by American Wigeon (549) and Mallards (473). Diving ducks, primarily Greater Scaup were densest (23 birds/km^2) and most numerous (2288 individuals) in Russell and Nunatak Fjords (Section 3). Goldeneyes were the next most abundant diver but were one-fourth as numerous as scaup.

Table 4. Minimum density and total number criteria used to designate sites of high density.

	Minimum density (birds/km^2)	Minimum number in station
Loon	20	40
Grebe	10	20
Tubenose	1000	1000
Cormorant	100	100
Goose and Swan	500	1000
Dabbler	500	1000
Diver	250	500
Sea Duck	500	1000
Merganser	25	50
Raptor	5	15
Crane	20	50
Shorebird	1000	2000
Gull and Jaeger	750	1000
Tern	100	250
Alcid	1000	1000
Corvid	50	50
Other Passerine	50	100

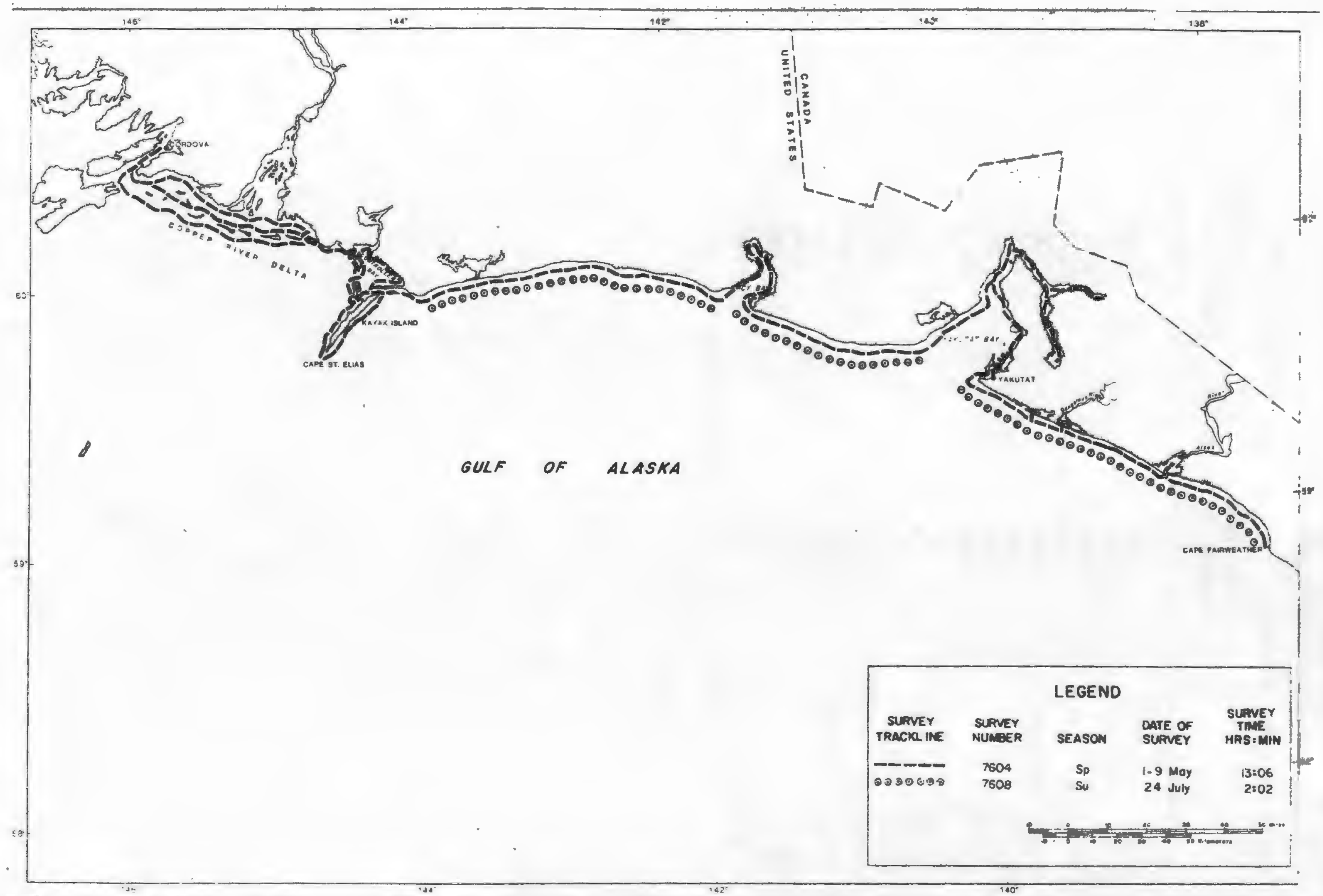


Fig. 8. Tracklines of aerial bird surveys in Northeast Gulf of Alaska, 1976.

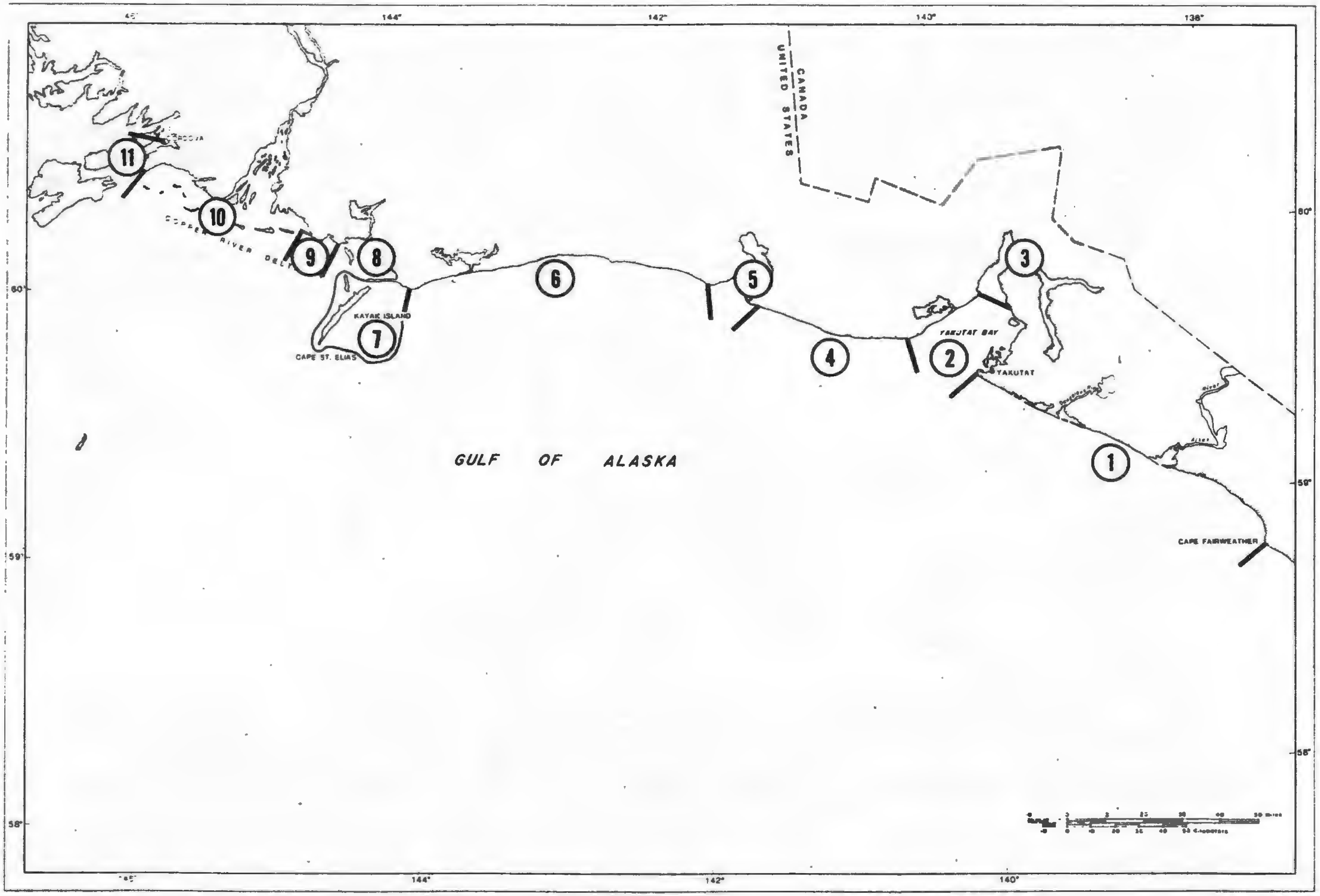


Fig. 9. Physiographic subdivision of Northeast Gulf of Alaska for bird density analysis. Each numbered section contains several survey stations.

Table 5. Bird density by section of coastline in Northeast Gulf of Alaska, spring and summer 1976. See Figure 9 for section boundaries. (T=trace).

	Spring Densities (birds/km^2)												Summer Densities (birds/km^2)				
	Section of Coastline												Section of Coastline				
Bird Group	1	2	3	4	5	6	7	8	9	10	11	Total	1	4	5	6	Total
Loon	T	2	T	T	1	T	T	1	1	1	T	1	T	T		T	T
Grebe		T	T				T	T	T	T	T	T					0
Tubenose												0					0
Cormorant	T	1	T	T	T		7	T	1	T	1	1	1				1
Goose and Swan	2	T	T	2	2	3	2	2	T	4	1	2					0
Dabbler	3	15	6	2	3	4	5	17	1	14	8	7					0
Diver	2	3	23	1	15	1	6	15	1	11	15	7					0
Sea Duck	T	4	26	T	46	3	30	3	27	4	20	9	3	2	252	88	49
Merganser	2	T	1	T	T	1	1	1	T	1	T	1					0
Raptor	T	T	T	T	T	1	T	T	1	T	T	T	T	T	T	T	T
Crane		T								1		T					0
Shorebird	24	4	22	2	38	24	98	138	7	222	316	67	T	13		14	7
Gull and Jaeger	7	7	20	38	55	81	163	12	774	32	76	45	106	4	59	677	284
Tern	7	4	2	23	34	5	T	2	T	4	T	7	33	4	19	48	32
Alcid		T	T		T		81		33		T	4					0
Corvid	T		T		T	T	T		T	T		T		T			T
Other Passerine	T				T	T	T		T	T		T		T			T
Other Bird								1		T		T					0
TOTAL	48	41	101	69	194	122	393	192	849	296	440	151	143	22	330	827	373

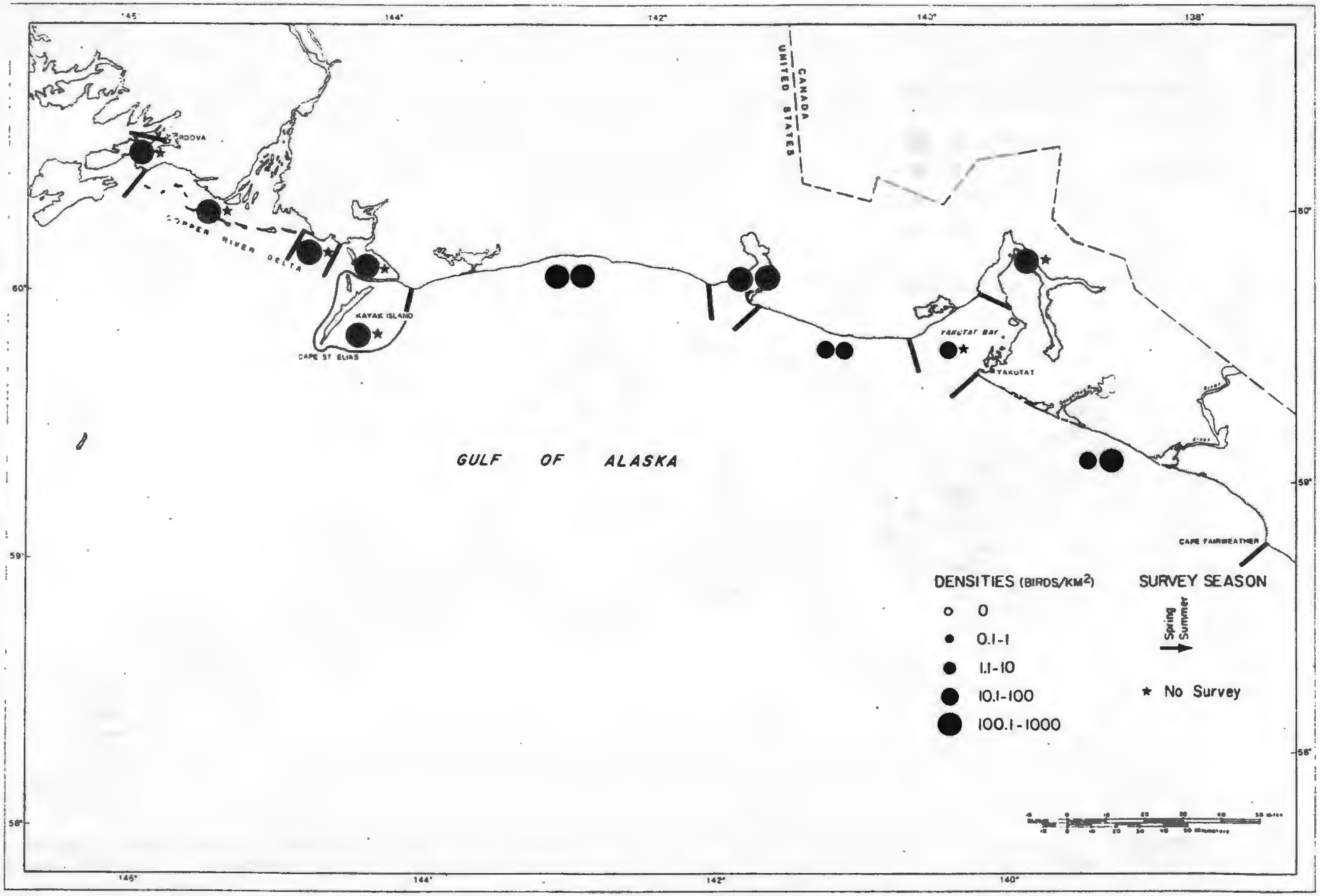


Fig. 10. Total bird density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

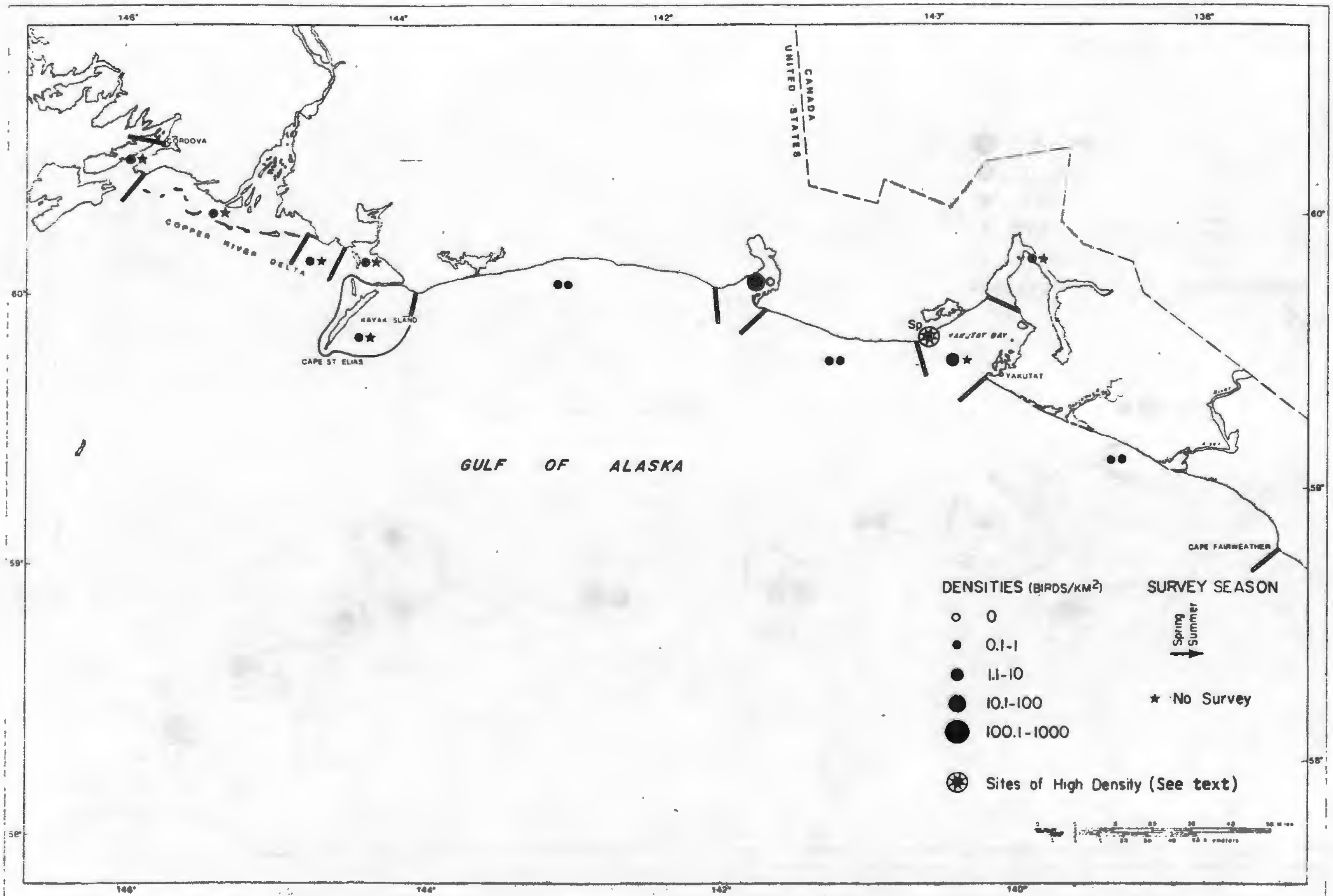


Fig. 11. Loon density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

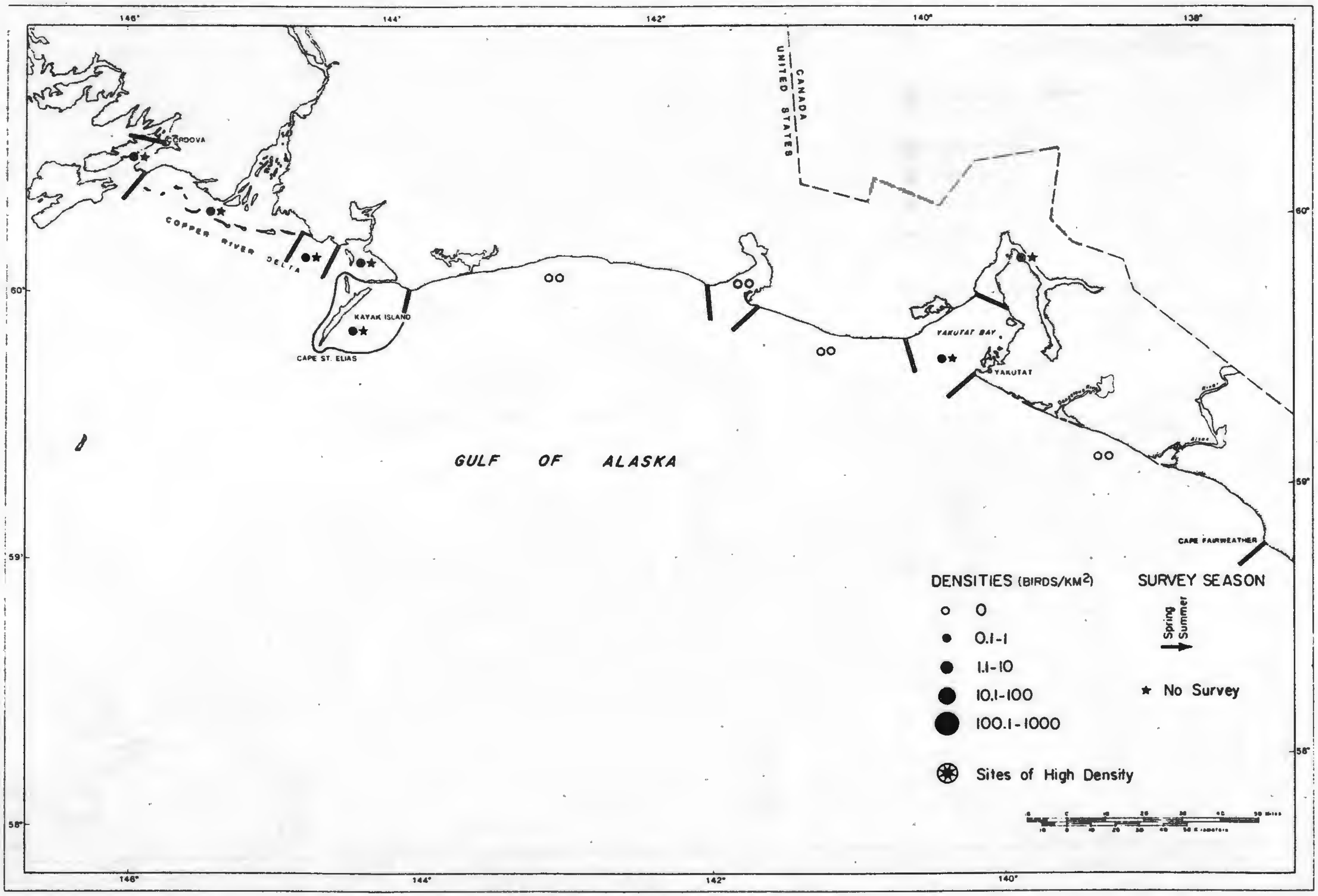


Fig. 12. Grebe density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

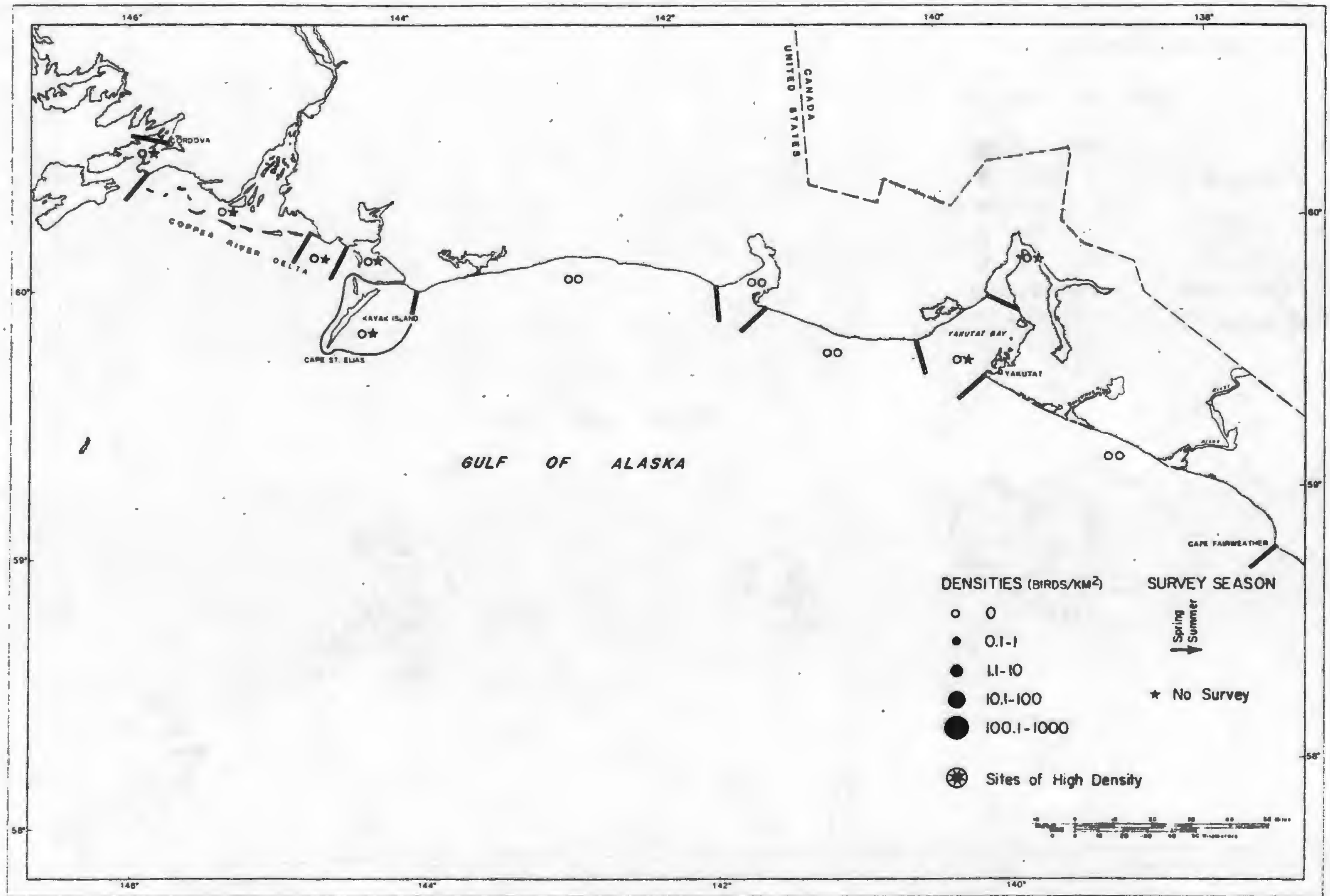


Fig. 13. Tubenose density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. No tubenoses were sighted.

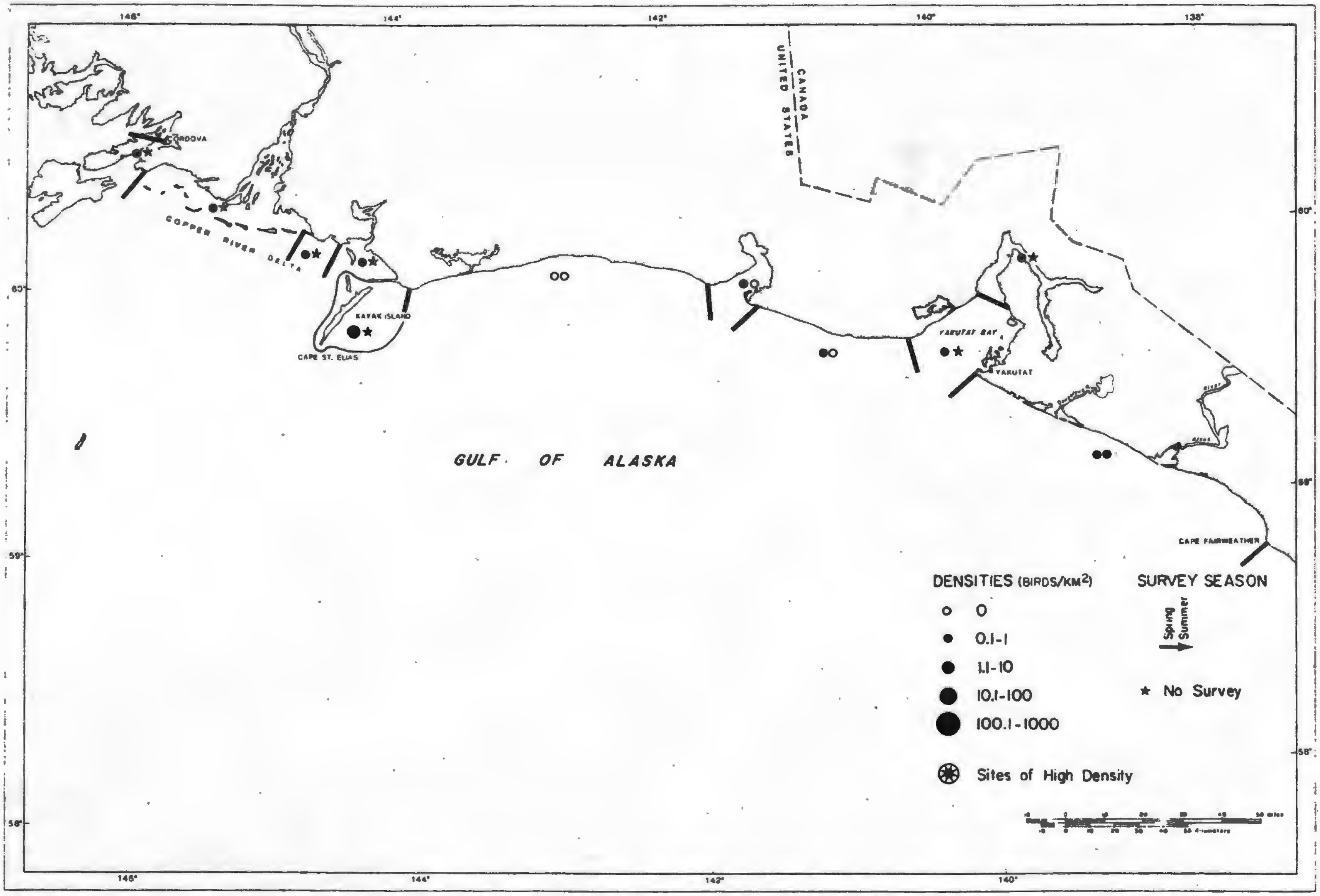


Fig. 14. Cormorant density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

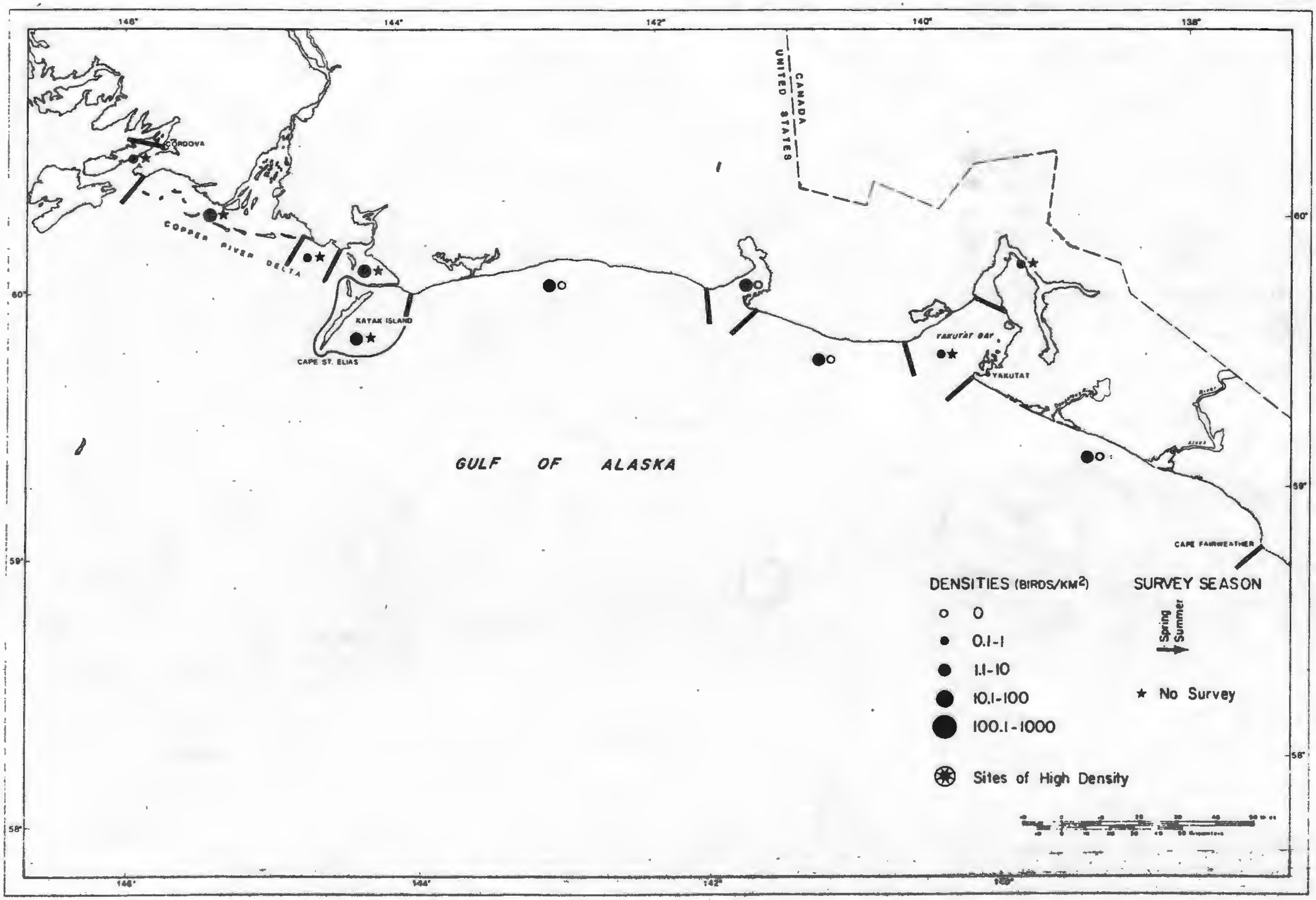


Fig. 15. Goose and swan density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

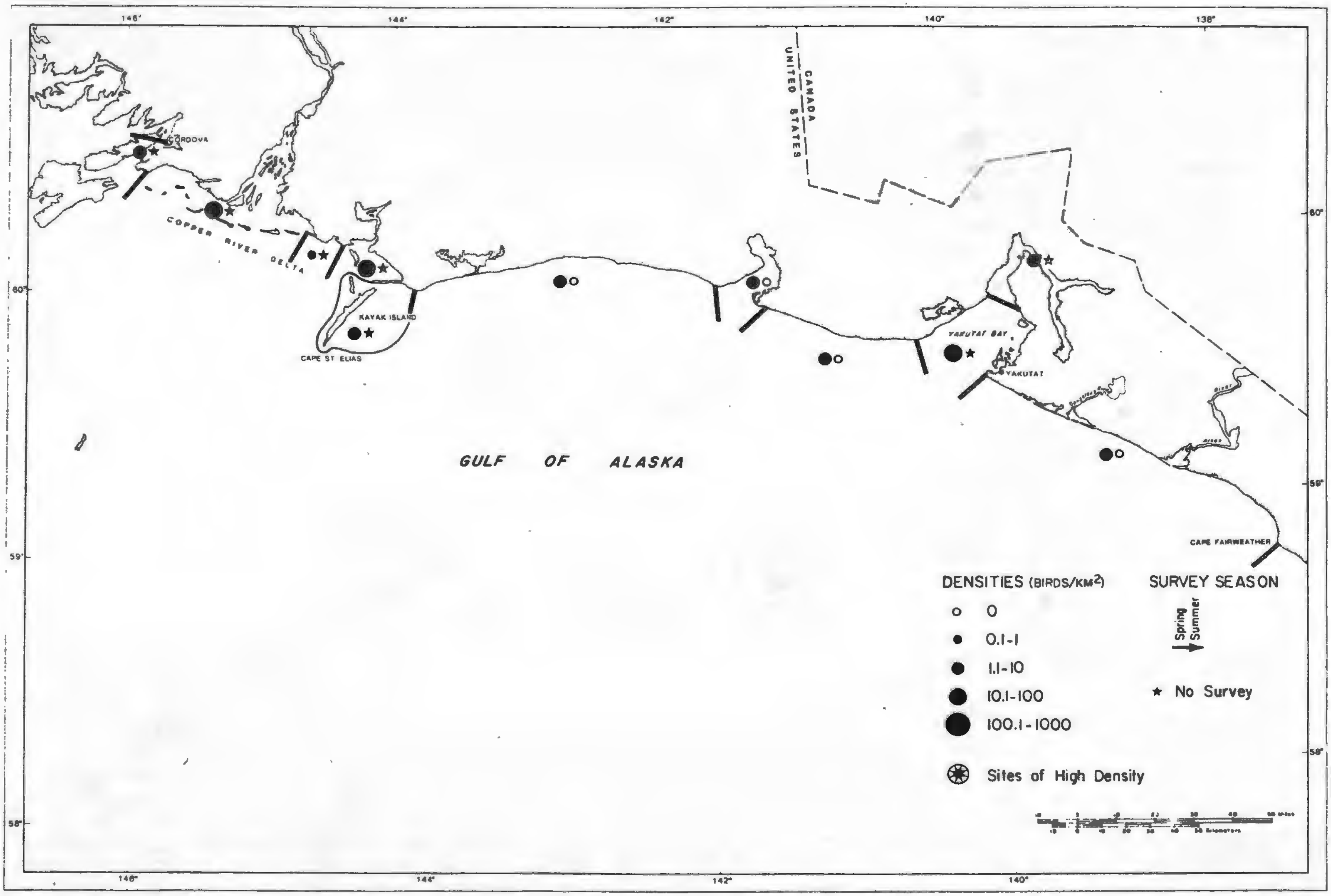


Fig. 16. Dabbling duck density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

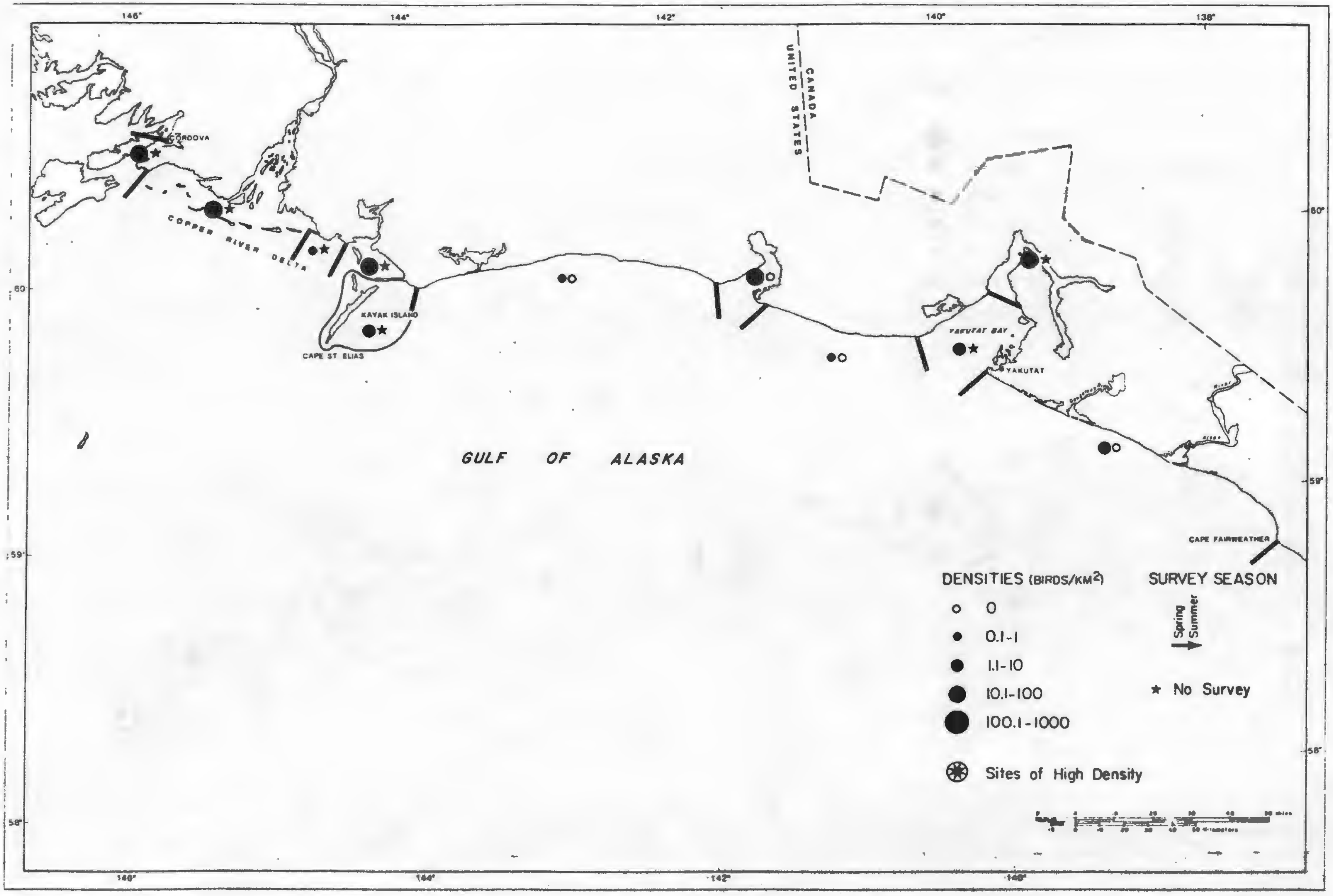


Fig. 17. Diving duck density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

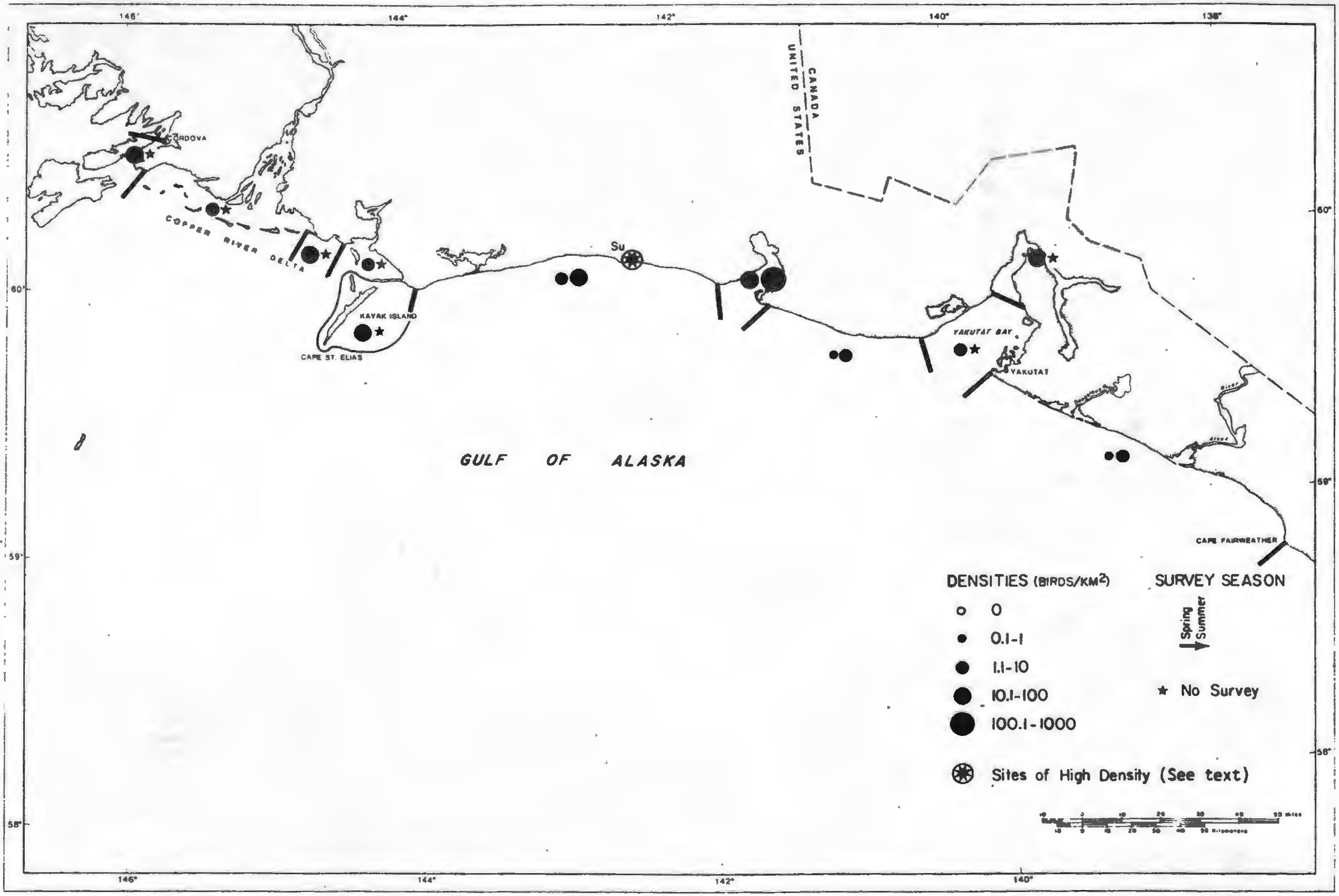


Fig. 18. Sea duck density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

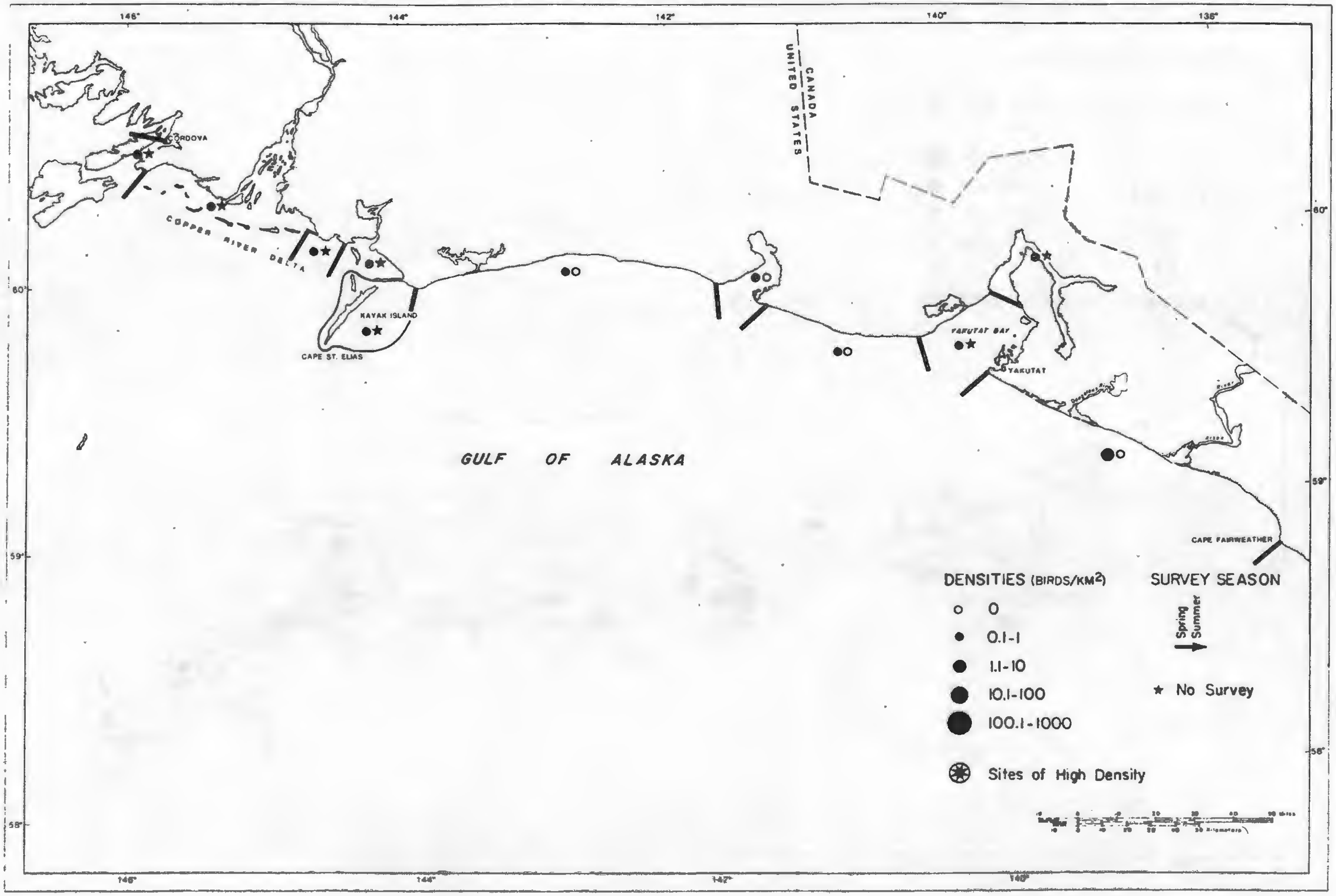


Fig. 19. Merganser density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

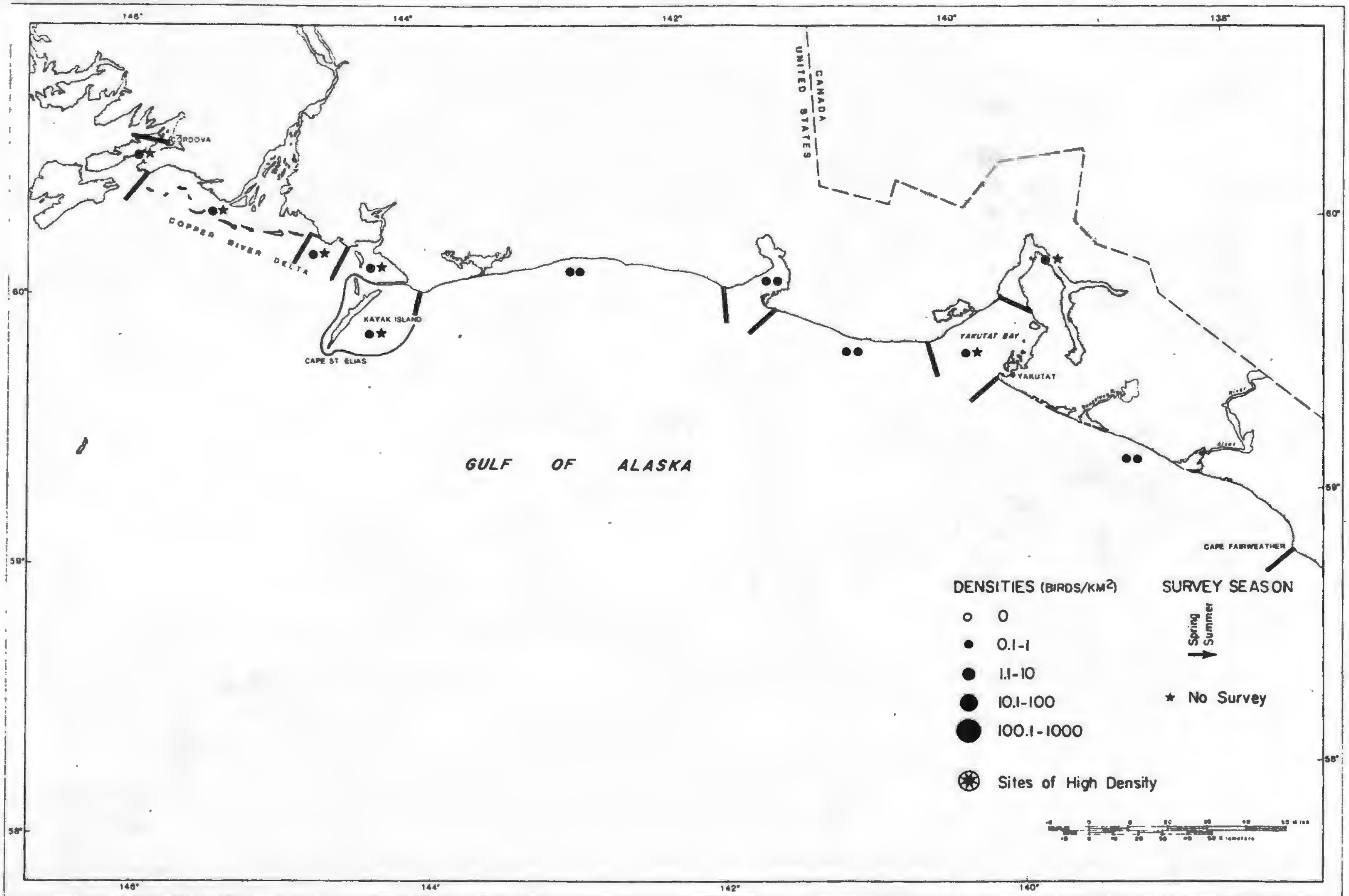


Fig. 20. Raptor density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

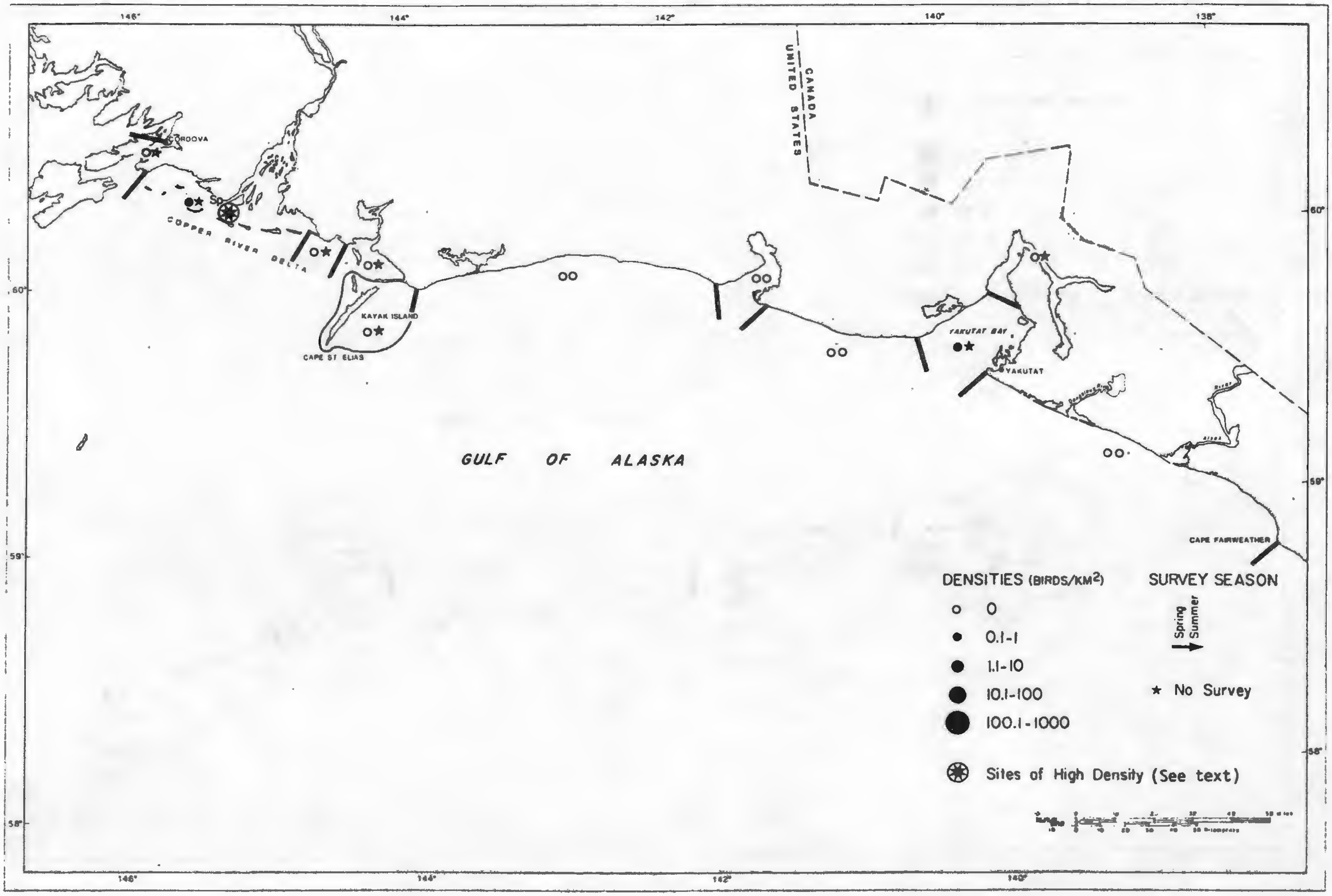


Fig. 21. Crane density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

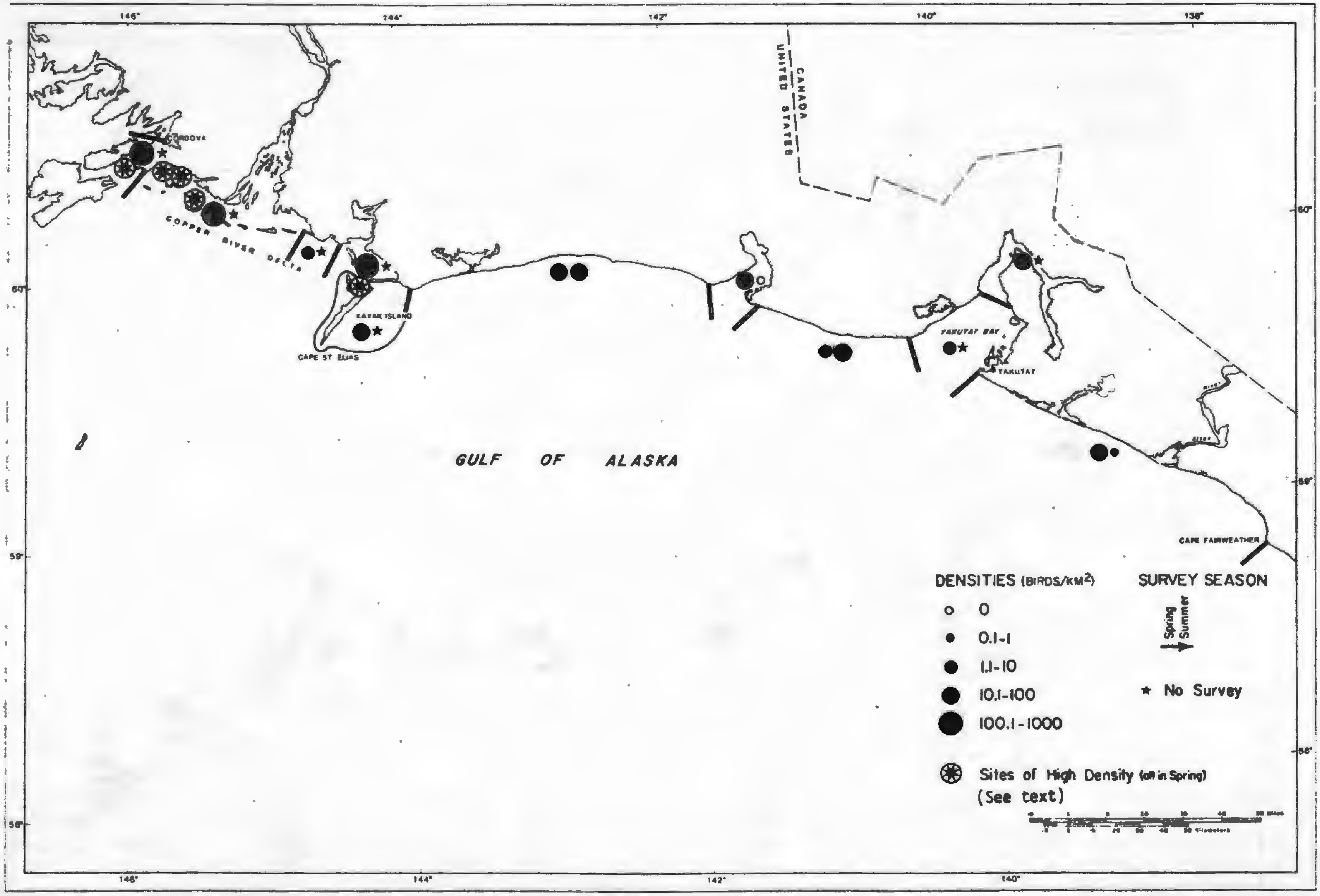


Fig. 22. Shorebird density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

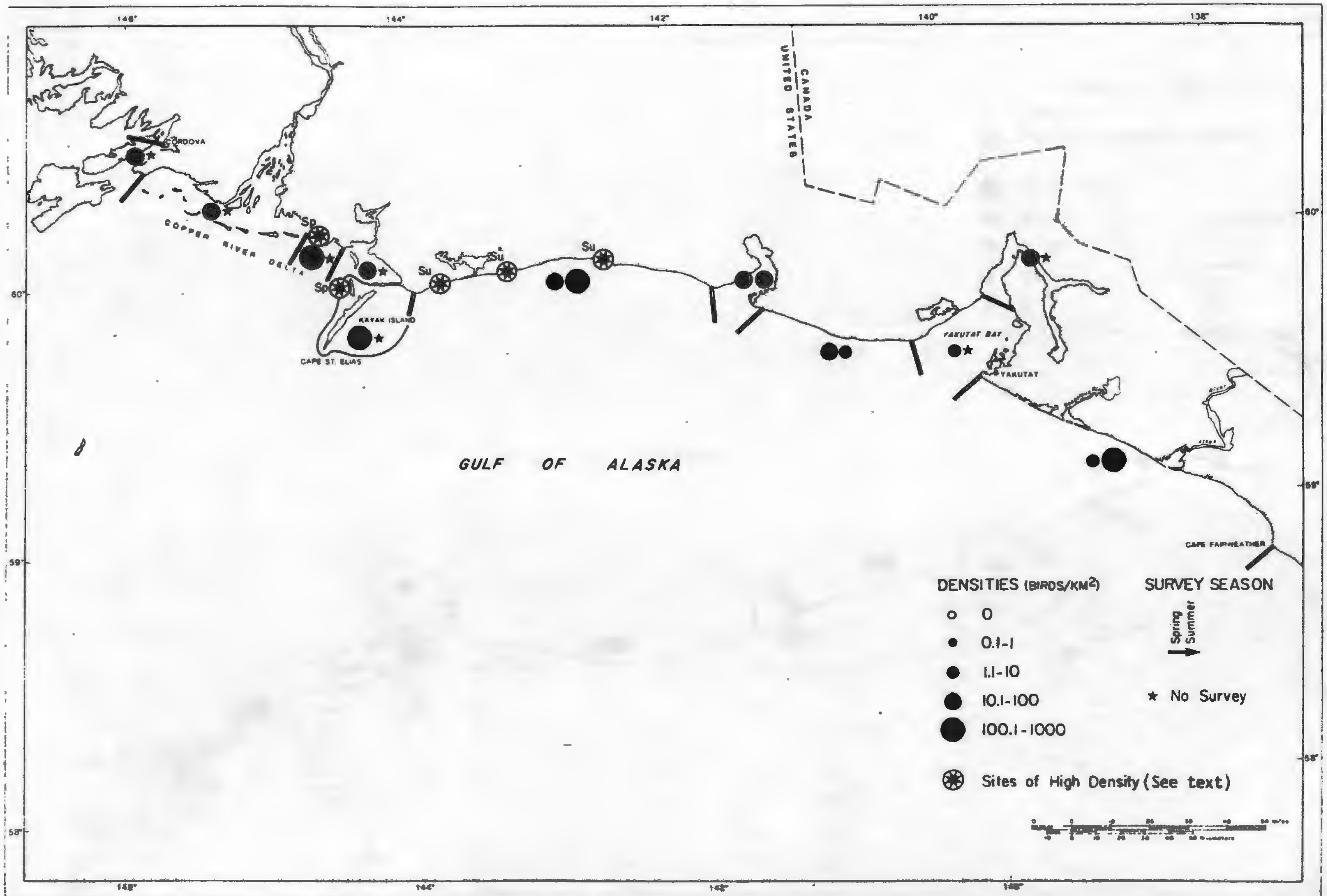


Fig. 23. Gull and jaeger density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

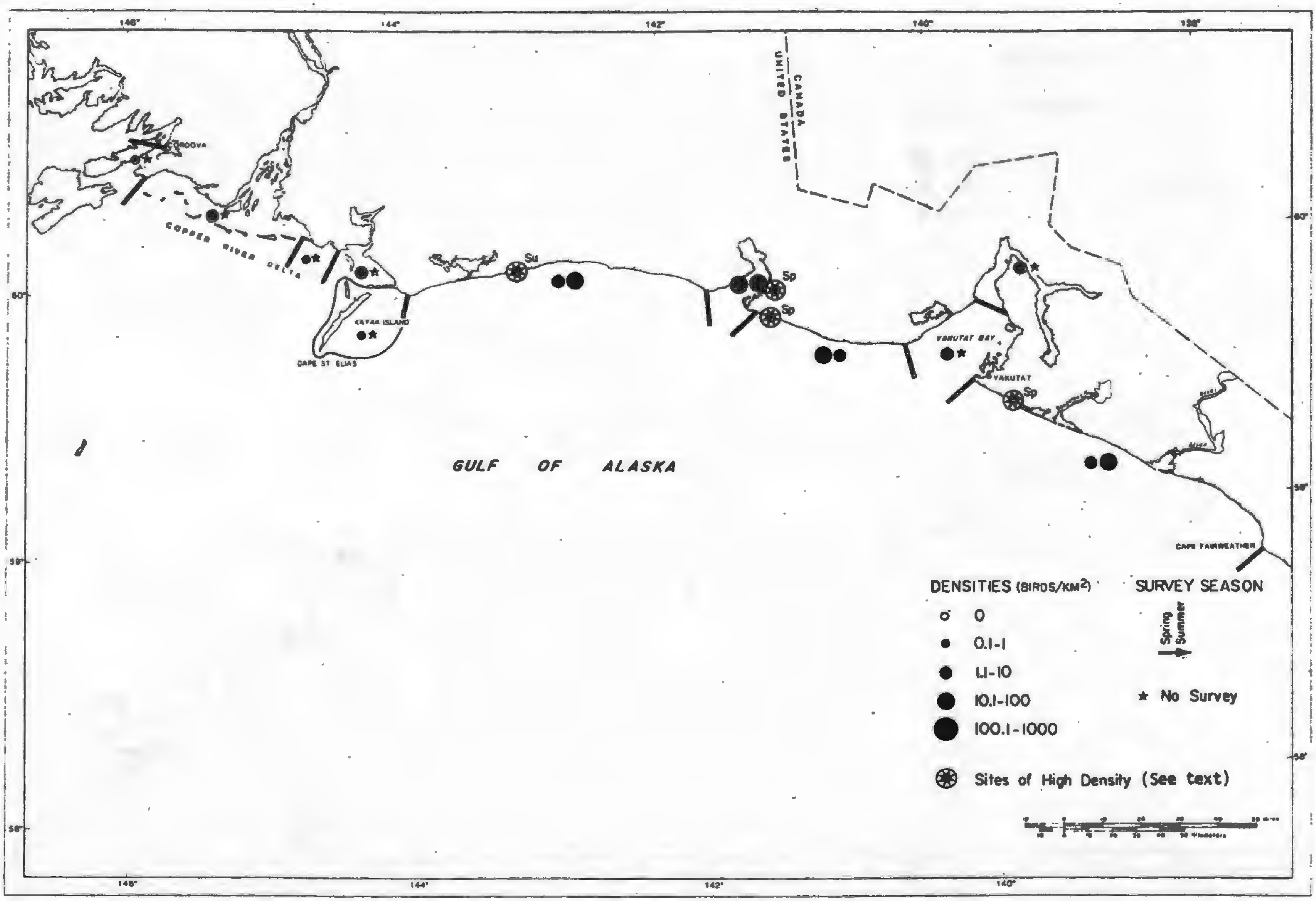


Fig. 24. Tern density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

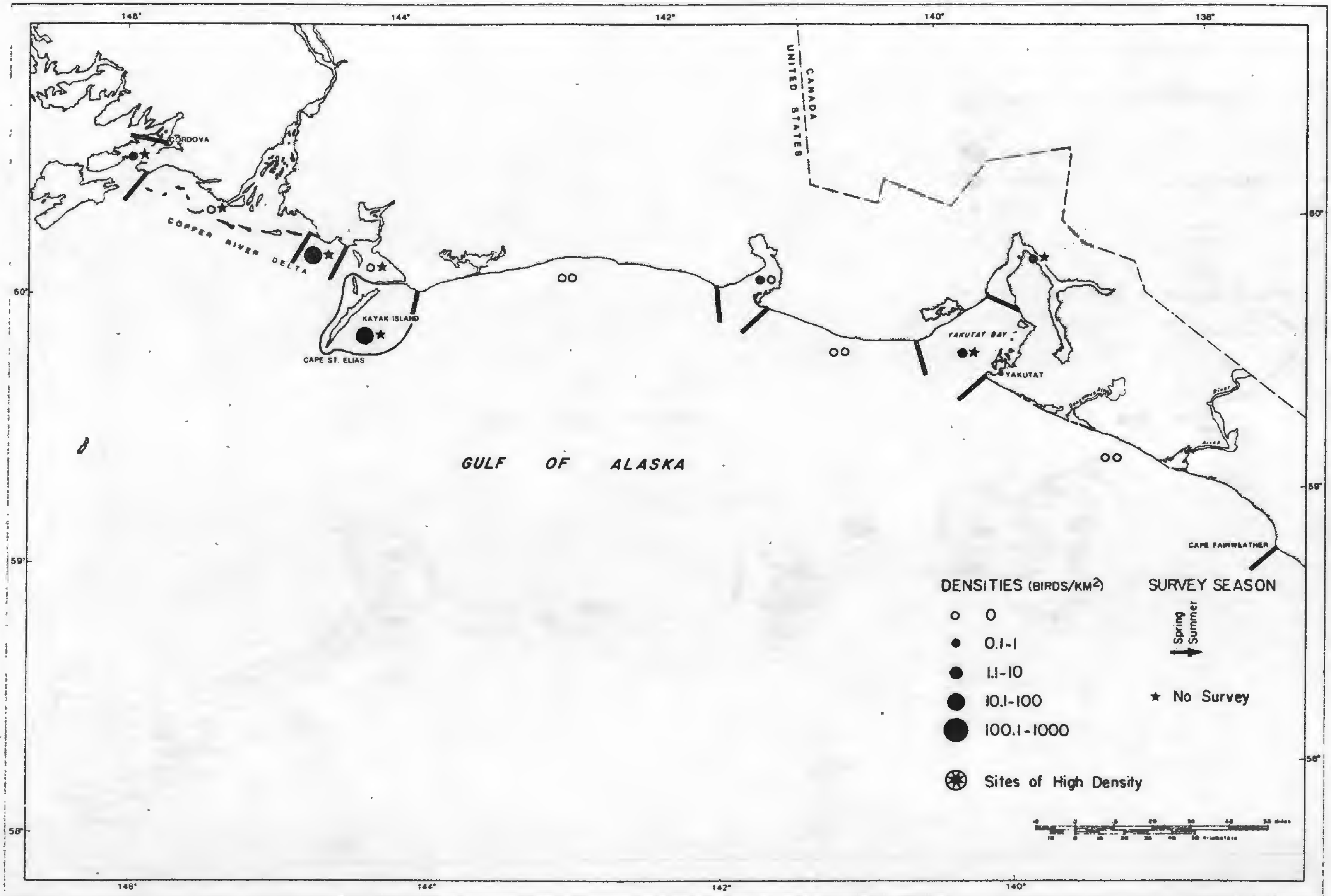


Fig. 25. Alcid density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

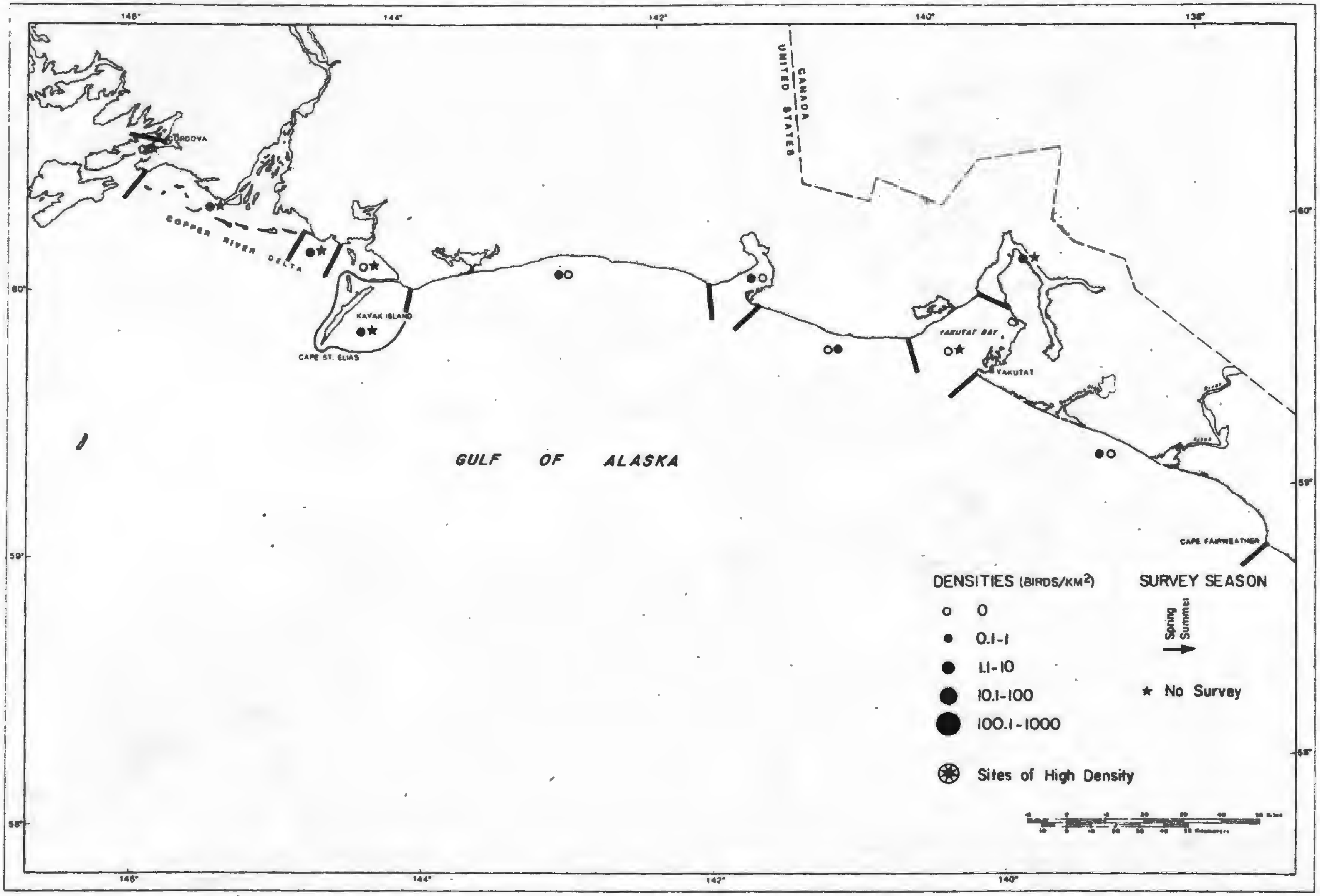


Fig. 26. Corvid density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

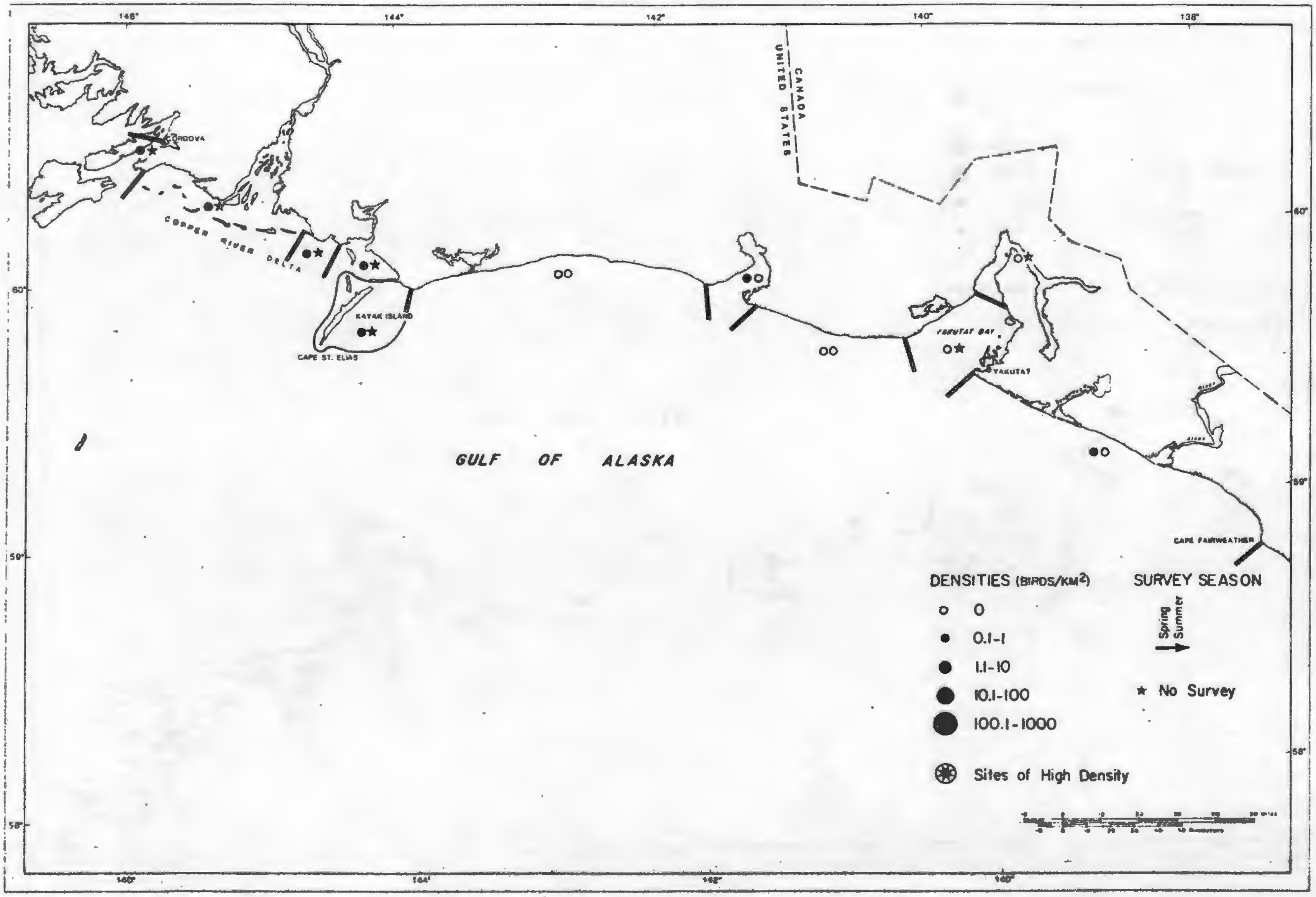


Fig. 27. Passerine (other than corvid) density by section in Northeast Gulf of Alaska during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

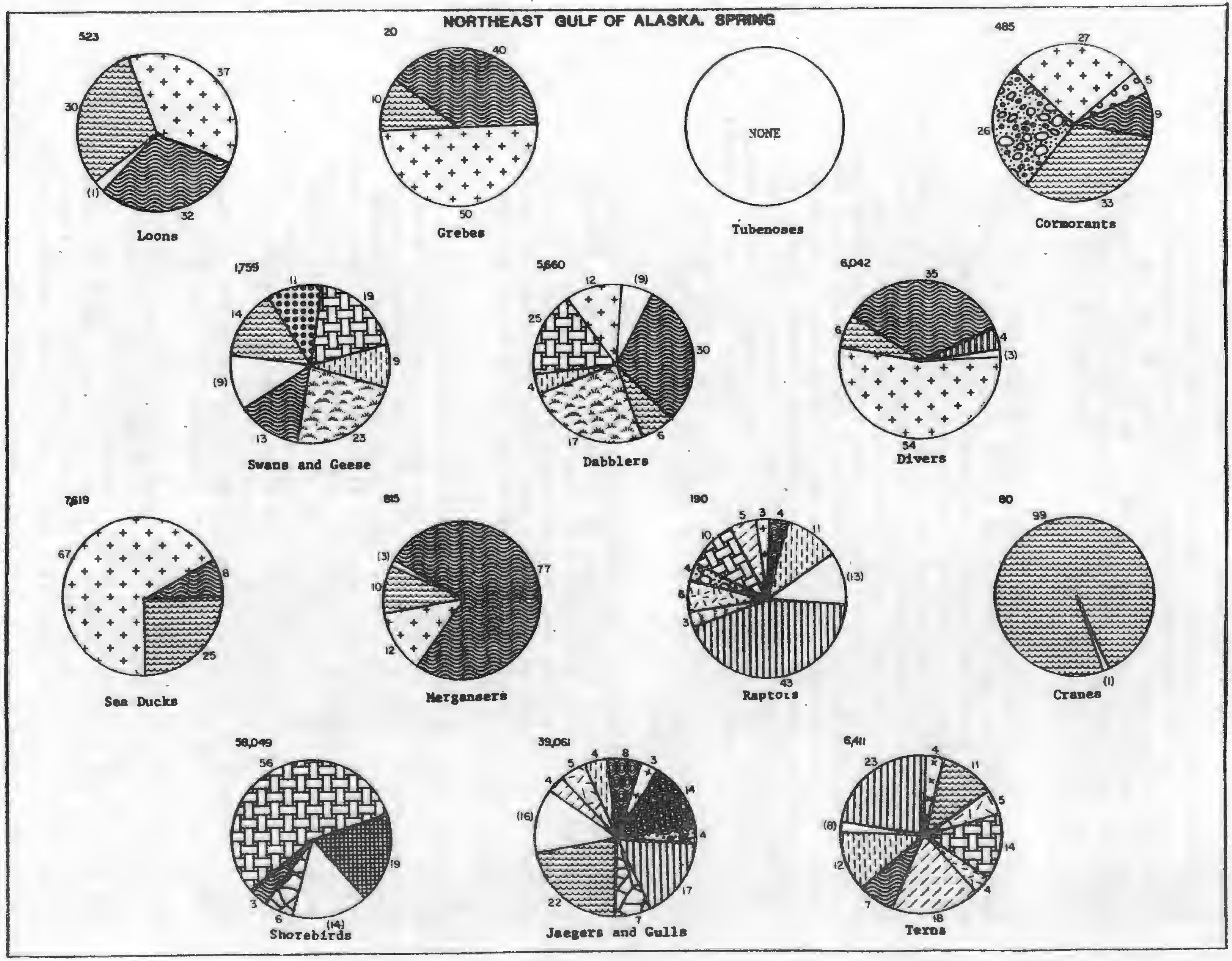
Spring migration of Arctic Terns (*Sterna paradisaea*) was near a peak in NEGOA at the time of the survey. Large flocks roosted at mouths of streams and on sandspits reaching highest densities in Icy Bay (34 birds/km^2) and on the coast from Yakutat Bay to Icy Bay (23 birds/km^2). Numbers of terns were also high (1751) from Cape Fairweather to Ocean Cape in Section 1 but the area searched was larger and, therefore, the density was less.

All other bird groups had densities less than 10 birds/km^2. The peak migration period for geese had already passed and those on the Copper River Delta had established breeding territories in fresh water areas above the supratidal survey region. Most geese were in estuaries of Section 1 (532 individuals) and on the Copper River Delta (457). Merganser populations, although never dense, were found most frequently in Section 1 where one-half of the total for NEGOA were found (403 of 815). Red-throated Loons (*Gavia stellata*) were the most common (72%) of identified loons. Loons were most abundant in Sections 2 and 10 with 150 and 164 individuals, respectively. Cormorants were abundant only in the Kayak Island vicinity where several small colonies were located. There were 7 birds/km^2 and 262 individuals in that section. Raptors [95% of which were Bald Eagles (*Haliaeetus leucocephalus*)] were found in every section, but were most numerous in Section 1 (49) and Section 6 (46). All sectional densities for raptors were 1 bird/km^2 or less. Few corvids [Common Ravens (*Corvus corax*) or Northwestern Crows (*C. caurinus*)] were observed in the entire region.

Habitat Usage - Because survey coverage included most NEGOA stations in spring, most littoral habitat types were searched for birds. However, no offshore transects were surveyed in this region and, therefore, offshore-dwelling species such as shearwaters and other tubenoses were not observed. Habitat preferences of each species group and observations of species groups on each habitat type for the spring survey are shown in Figures 28 and 29, respectively.

Loons were found in almost equal numbers in three water types, bay water, protected delta water and exposed inshore water. Cormorants shared nearshore water habitats with loons but were also frequently found on intertidal rocks where they dried their plumage. Geese and dabblers selected similar habitats and were most frequently seen at river mouths on floodplains, mudflats or on fluvial water. Over half of the diving ducks were on bay waters and most of the remainder on protected delta water. Only 6 percent were on exposed inshore waters. Sea ducks, the third most abundant species group, were found primarily on bay/fjord waters (67%) with lesser amounts on exposed inshore water (25%) and protected delta water (8%). Mergansers preferred the mouths of rivers and streams where over three-fourths of the mergansers were found.

Bald Eagles were uniformly dispersed along the entire coastline and were found in a variety of habitats. The predominant habitat for eagles was exposed sand beaches (43%) where they frequently roosted on drift logs and fed on carrion washed ashore. Most cranes overfly NEGOA in spring (Isleib and Kessel 1973) and those few we saw (80) were flying along exposed inshore waters. Shorebirds were by far the most abundant species


NORTHEAST GULF OF ALASKA. SPRING
523
37
30
(1)
32
Loons
20
40
10
50
Grebes
NONE
Tubenoses
485
27
5
9
26
33
Cormorants
1,759
11
19
14
9
(9)
13
23
Swans and Geese
5,660
12
(9)
25
30
4
17
6
Dabblers
6,042
35
6
4
(3)
54
Divers
7,619
67
8
25
Sea Ducks
815
(3)
77
10
12
Mergansers
190
5
3
4
10
11
4
(13)
6
3
43
Raptors
80
99
(1)
Cranes
58,049
56
19
3
6
(14)
Shorebirds
39,061
5
4
8
3
4
14
(16)
4
22
7
17
Jaegers and Gulls
6,411
23
4
11
5
(8)
14
12
7
18
4
Terns

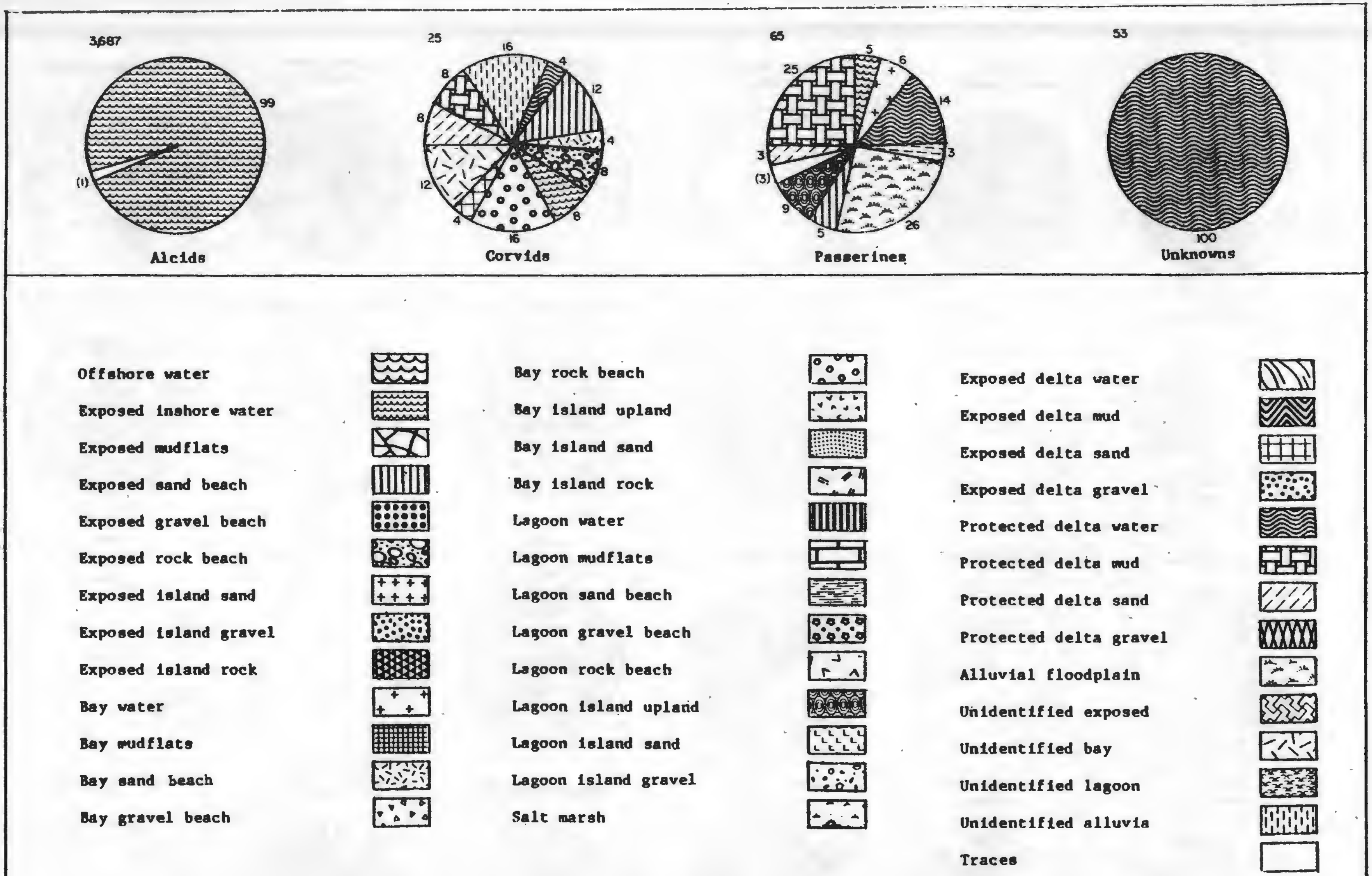
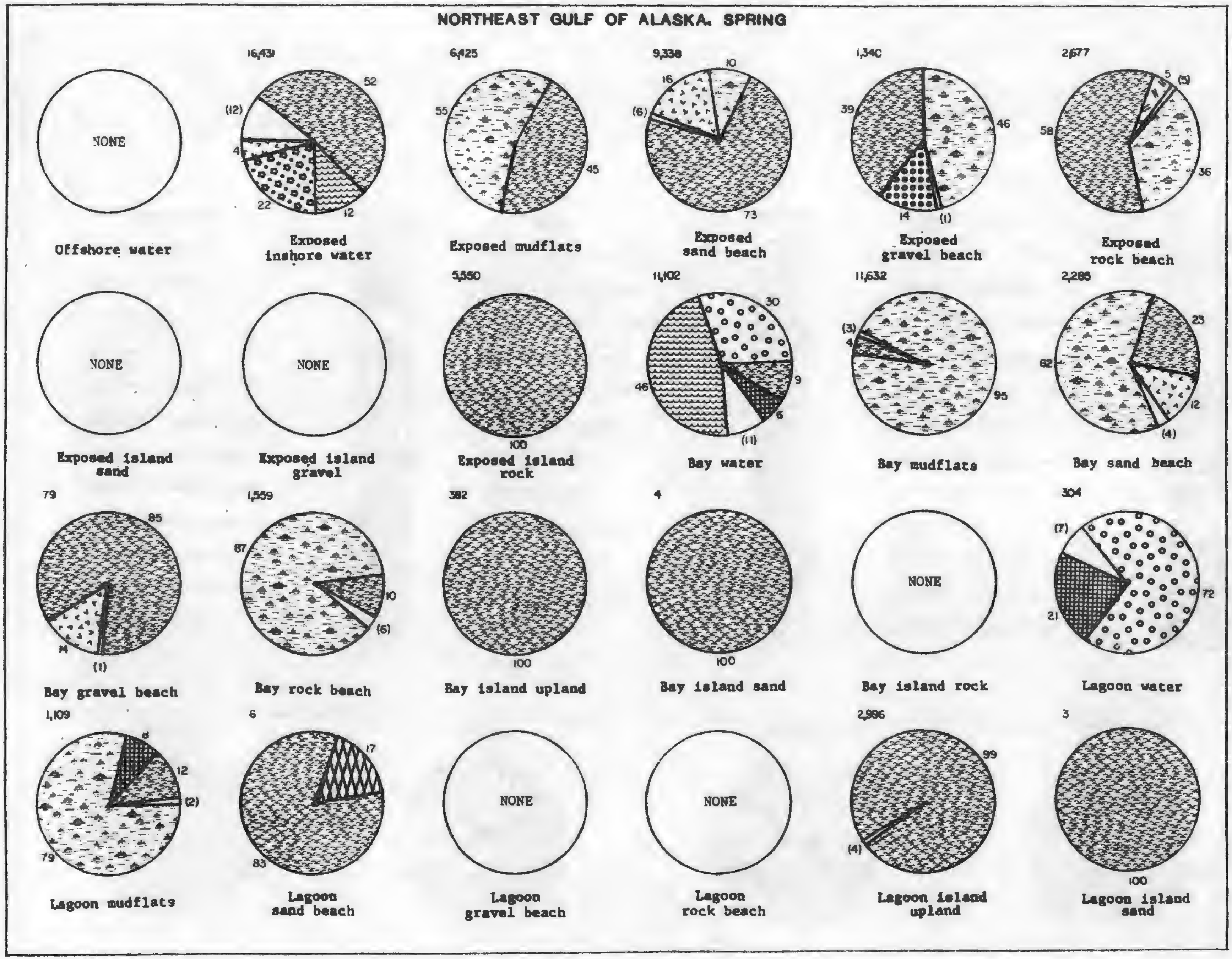


Fig. 28. Northeast Gulf of Alaska, Spring, 1976. Habitat preference of marine birds as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


NORTHEAST GULF OF ALASKA, SPRING
NONE
Offshore water
16,431
52
(12)
4
22
12
Exposed inshore water
6,425
55
45
Exposed mudflats
9,338
10
16
(6)
73
Exposed sand beach
1,340
39
46
14
(1)
Exposed gravel beach
2,677
5
(5)
58
36
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
5,550
100
Exposed island rock
11,102
30
46
9
6
(11)
Bay water
11,632
(3)
4
95
Bay mudflats
2,285
23
62
12
(4)
Bay sand beach
79
85
14
(1)
Bay gravel beach
1,559
87
10
(6)
Bay rock beach
382
100
Bay island upland
4
100
Bay island sand
NONE
Bay island rock
304
(7)
72
21
Lagoon water
1,109
8
12
(2)
79
Lagoon mudflats
6
17
83
Lagoon sand beach
NONE
Lagoon gravel beach
NONE
Lagoon rock beach
2,996
99
(4)
Lagoon island upland
3
100
Lagoon island sand

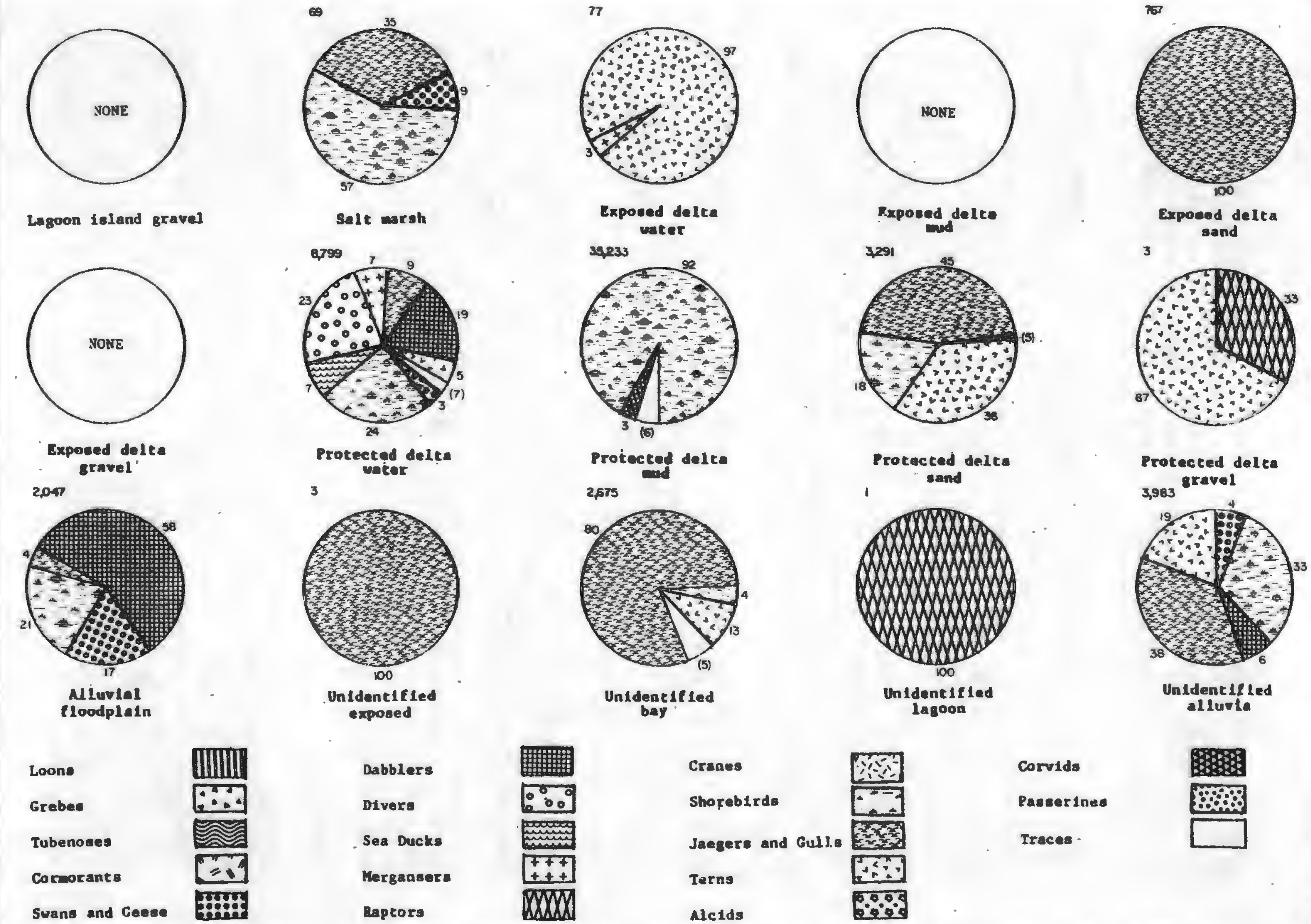


Fig. 29. Northeast Gulf of Alaska, Spring, 1976. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

group, and the importance of the mudflats of the Copper River Delta, Orca Inlet and Controller Bay was further substantiated. Shorebirds were found on a greater variety of habitat types (16 of 26) than was expected, but this was probably a result of the wide diversity of species observed. Each species had its own habitat requirements; some preferred brackish floodplains, some rock beaches and others mudflats.

Six species of gulls were found in all but 3 of the 26 different habitat types. They were most frequently seen along exposed inshore waters (22%), on exposed sand beaches (17%), or at colony sites on exposed island rock (14%). Densest concentrations of breeding gulls were on barrier islands of the Copper River Delta. A sandy substrate along exposed beaches and in protected deltas was selected by terns for roosting, and they were frequently seen flying along exposed beaches and over delta mudflats in migration and feeding. Receding glaciers have left deposits of sand or gravel moraine providing habitat for nesting Arctic and Aleutian Terns (*Sterna aleutica*). Few alcids except murres had returned to breeding sites at the time of the survey and 99 percent of the murres were rafted on exposed inshore waters near their colonies. Few corvids or other passerines were observed, and those that were used a variety of habitats.

Protected delta mud was the habitat type used by the largest number of birds (35,233) but 92 percent of these were shorebirds. The next most used habitat, exposed inshore water (16,431 birds), had all 16 bird groups present. Over half the birds found in this type were gulls (52%); 22 percent were alcids and 12 percent sea ducks. Other groups were present in small numbers.

Other habitats with high bird usage were bay mudflats (11,632) and bay water (11,102), but the same pattern of usage was found as in the two habitats mentioned above. Shorebirds comprised 95 percent of the birds on the mudflats, and a variety of species were found in bay water. Sea ducks were the most abundant species group in bay water (46%); diving ducks were second (30%), followed by gulls (9%). Protected delta water was another habitat used by most species groups (14 of 16). Shorebirds, diving ducks and dabbling ducks were the groups most frequently found in this habitat (24%, 23% and 19%, respectively).

SUMMER

Density - The abbreviated survey in NEGOA in late July provided data on summering populations of gulls and terns along the exposed beaches and of sea ducks in Riou Bay. Gulls were most common on the section of beach from Icy Cape to Cape Suckling where 677 gulls/km^2 and 14,343 individuals were recorded. The section south of Yakutat had 106 gulls/km^2 and 2608 individuals. Those sections also had the densest tern populations with 48 birds/km^2 in Section 6 and 33 birds/km^2 in Section 1. Sea ducks were found in all sections surveyed but were densest in Section 5. Over 1,000 scoters were found summering in Riou Bay. These may have been non-breeders that spent the entire summer in the area, or they could have been breeding males that had returned to saltwater to molt. Most of the 1867 scoters recorded in Section 6 were observed at Cape Yakataga. Sea ducks were frequently concentrated at promontories along exposed coasts. Substrates were usually mixed at these capes but included much rock. This and current patterns may have concentrated food organisms.

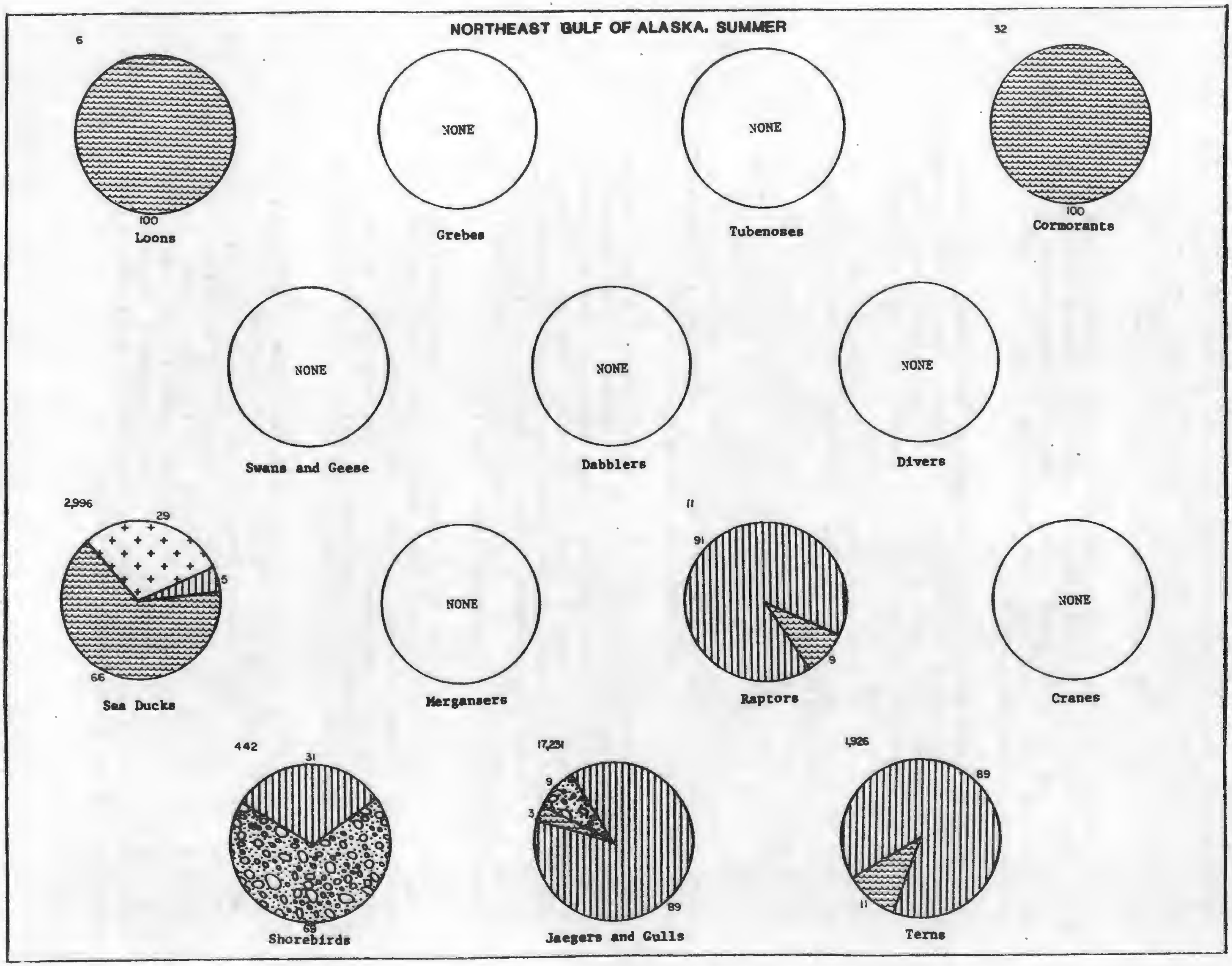
Shorebirds were the only other relatively abundant bird group seen on this short summer survey, and Sections 4 and 6 had highest densities with 13 and 14 birds/km^2, respectively. Only four other species groups were recorded (all in small or trace densities). These were loons, cormorants, raptors and corvids.

Habitat Usage - Because of limited coverage on this survey, little can be said for bird usage of NEGOA habitats in summer. The data are summarized in Figs. 30 and 31. We recorded birds on only six habitat types. Most birds (76%) were on exposed sand beaches; however, this was the habitat most searched for birds. Eighty-eight percent of the birds on this habitat were gulls and 10 percent were terns. Exposed inshore water was the next most used habitat (12% of the total birds) followed by exposed rock beaches (8%) and bay water (4%). This represents most of the habitats searched on the summer survey. Eighty-nine percent of both gulls and terns were observed flying over, or roosting on, exposed sand beaches. Nine percent of the gulls and 69 percent of the shorebirds were found on exposed rock beaches. On this survey, sea ducks were found on exposed inshore waters most frequently (66%) with the remainder on bay waters (29%) or roosting on exposed sand beaches (5%).

Spring Migration, Cape St. Elias - In spring 1977 and 1978, W. Cunningham and S. Stanford were placed at Cape St. Elias on Kayak Island to obtain marine mammal data. As time permitted, they also conducted sea watches for birds and recorded other information including first arrival dates, peak migration periods and migration directions. The 1977 information was briefly summarized by Arneson (1978). Following is a brief account of what occurred in 1978. It is hoped that a detailed report of the birds of Kayak Island will be published in the future.

Birds migrating past Cape St. Elias chose one of several flight paths (Fig. 32). Most flew around the Cape and back up the northwest side of Kayak Island or easterly towards the mainland. Others flew north, northwest, west or even southwest toward Middleton Island. Flocks of some species were observed crossing over Kayak Island and many proceeded directly up the coast bypassing Kayak Island.

Some birds stopped to rest and feed near the Cape; others migrated past low to the water, and some were migrating so high as to be visible only with binoculars. Certain species passed by the Cape only during a short time span in spring, others passed by the Cape on diurnal migrations to and from roosting and feeding areas, while still others nested at colonies on the Cape. Flocks of some species migrated directly past, or over, the Cape while others seldom came closer than a kilometer or more. Following is a brief account by species group of the spring migration status of various birds at Cape St. Elias.


NORTHEAST GULF OF ALASKA, SUMMER
6
100
Loons
NONE
Grebes
NONE
Tubenoses
32
100
Cormorants
NONE
Swans and Geese
NONE
Dabblers
NONE
Divers
2,996
29
5
66
Sea Ducks
NONE
Mergansers
11
91
9
Raptors
NONE
Cranes
442
31
69
Shorebirds
17,231
9
3
89
Jaegers and Gulls
1,926
89
11
Terns

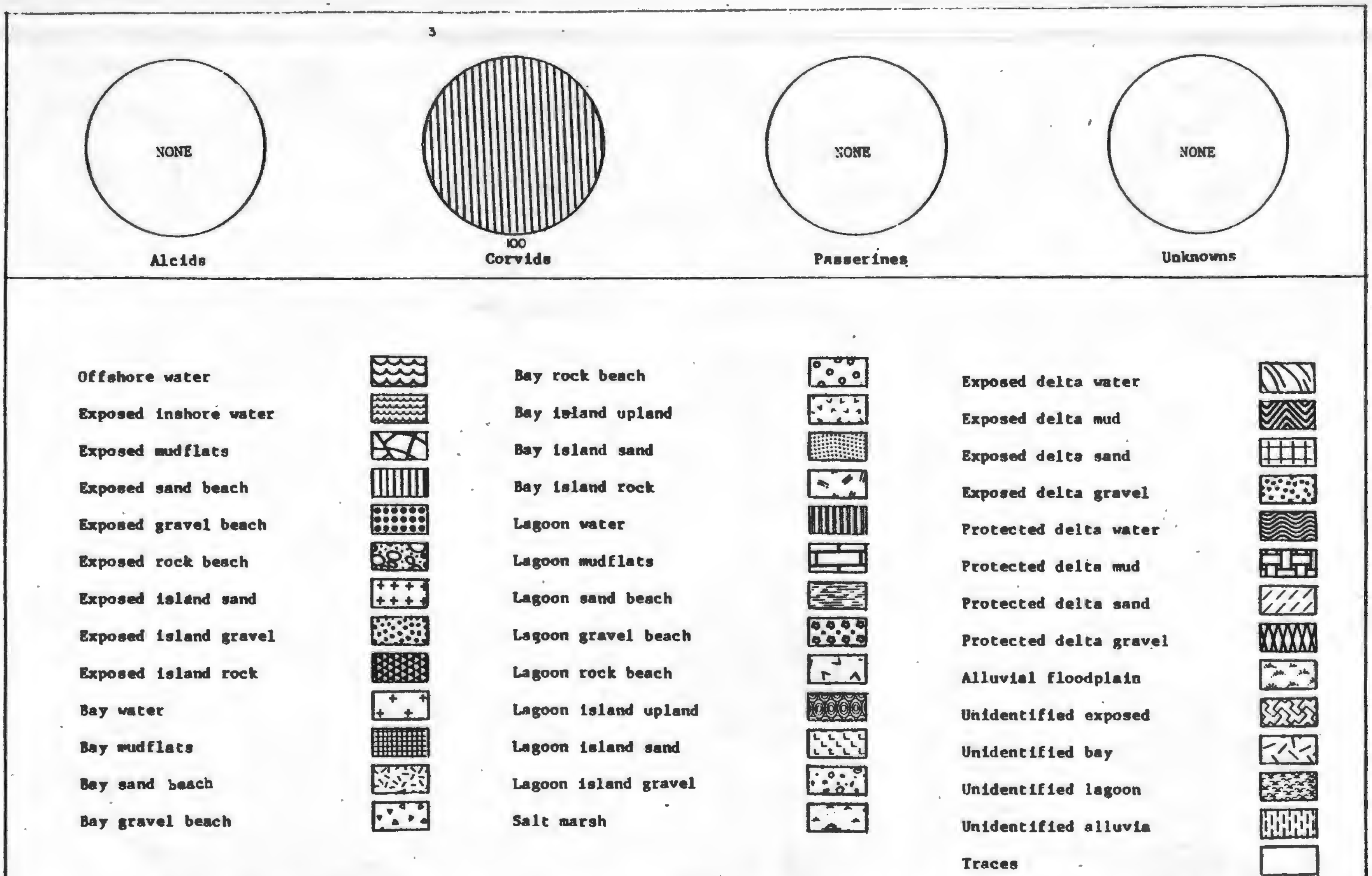
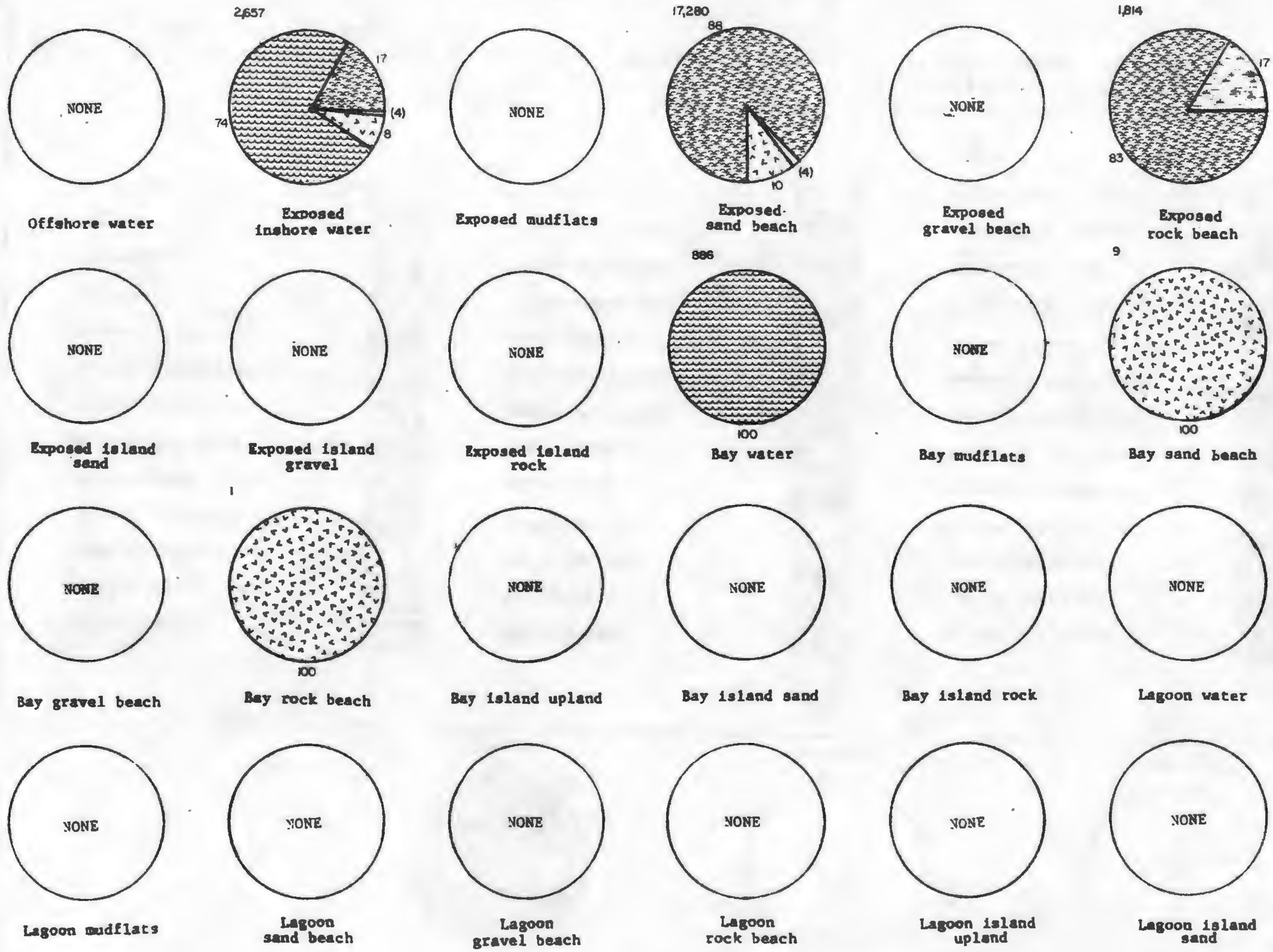


Fig. 30. Northeast Gulf of Alaska, Summer, 1976. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

NORTHEAST GULF OF ALASKA, SUMMER



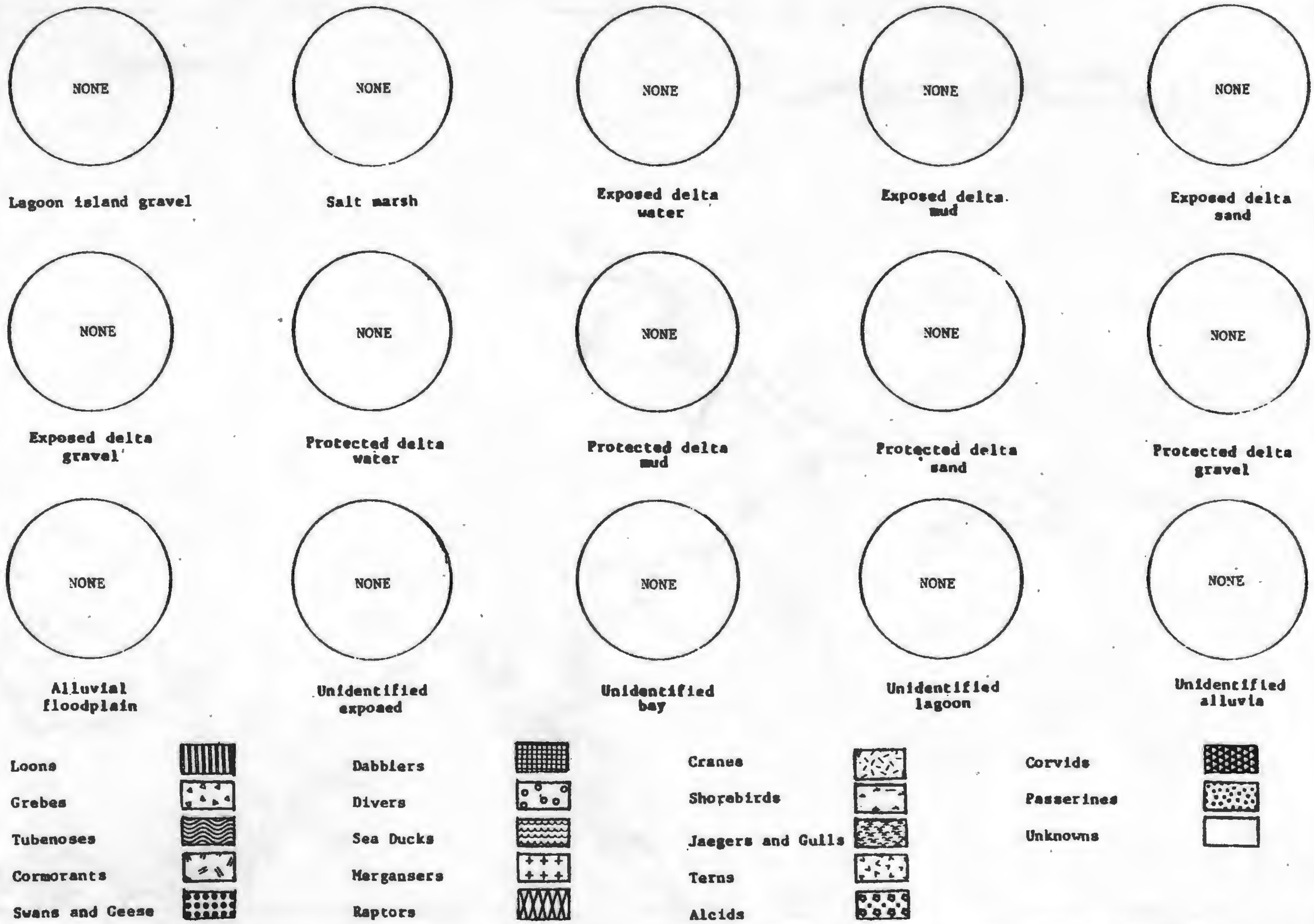


Fig. 31. Northeast Gulf of Alaska, Summer, 1976. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

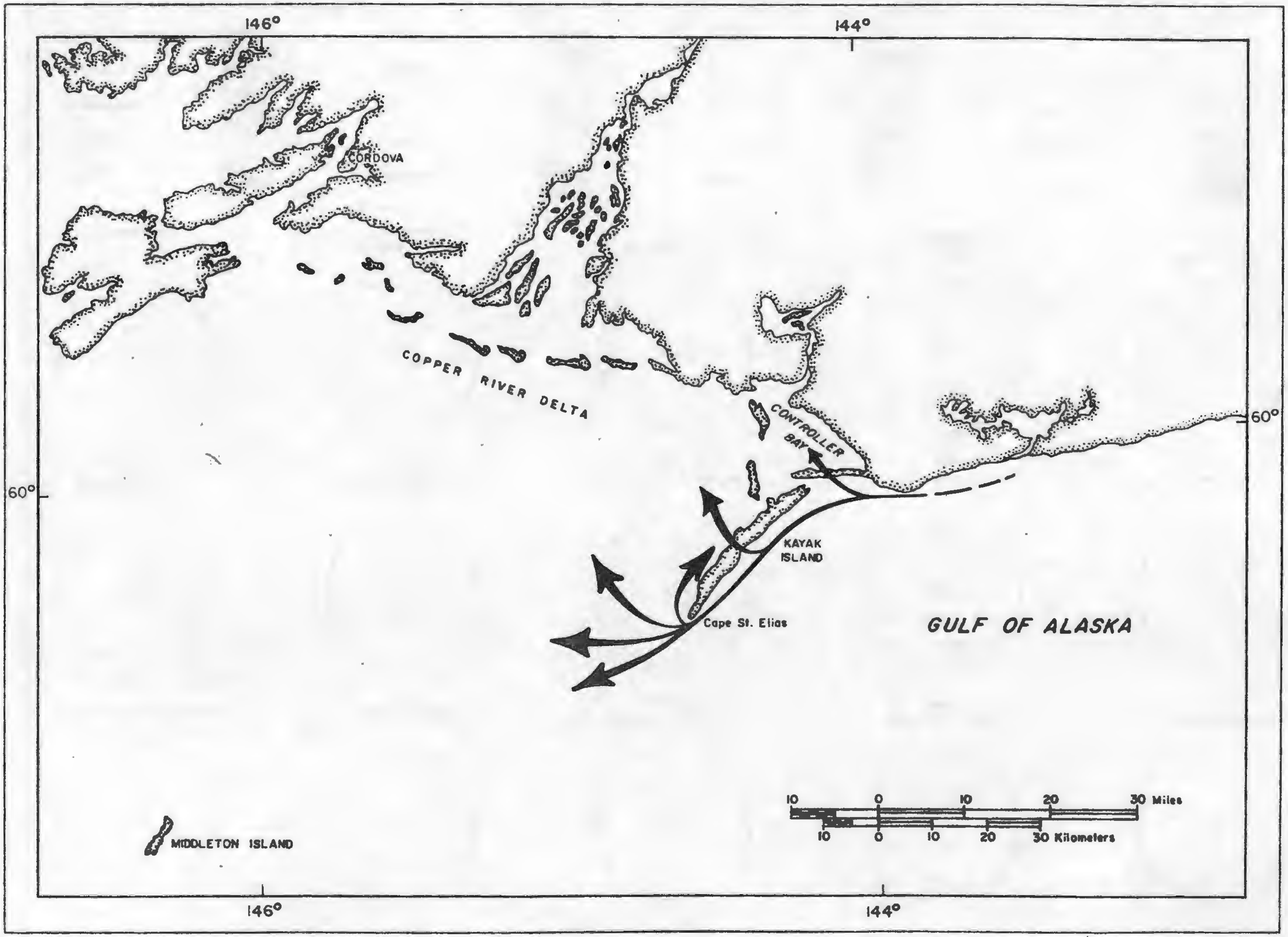


Fig. 32. Bird migration past Cape St. Elias, Kayak Island. Most migrants turned at the Cape and flew up the northeast coast of the island. Others flew north, northwest or west. A small percentage flew southwest toward Middleton Island or over Kayak Island. An unknown portion continued up the mainland coast past Controller Bay.

Loons - Common Loons (*G. immer*) were first observed on 29 March 1978 and were observed almost daily thereafter. Red-throated and Arctic Loons (*G. arctica*) were first recorded on 12 April and were seen almost daily afterward. From sea watch counts, as many as 10 loons per minute were migrating past the Cape from 8 May to 20 May with a peak of 20 loons per minute on 16 May. It was estimated that as many as 10,000 loons per day were migrating past during this peak period. Frequently they would stop to feed and rest in rafts numbering up to several hundred in a cove about 2 km southeast of the lighthouse. Others fed in a small area at the tip of a reef just west of the pinnacle at the Cape. On June 3, when seas were calm, loons were sighted "everywhere" out to 3 km. When migrating, their path beyond the Cape was usually back up the island's northwest coast but was occasionally due north or west. Their migrating flocks were frequently mixed with other species including cormorants, Brant (*Branta bernicla*), dabblers, scoters and murres. Migration was reduced from thousands of birds per day to hundreds per day after the first week of June. At that time almost all loons observed were Arctic Loons.

Grebes - Horned Grebes (*Podiceps auritus*) passed the Cape in small numbers from 18 April to 12 May and at times stopped in nearshore waters. Only one Red-necked Grebe (*Podiceps grisegena*) was sighted, on 22 May. Grebes normally migrate at night and would pass unnoticed at Cape St. Elias.

Tubenoses - Individual shearwaters (*Puffinus* spp.) were observed on 10 and 21 April; on 2 May several thousand appeared and remained until the end of the observation period at the end of June. On 21 May, although seas were calm and visibility excellent for observation, no shearwaters were sighted. Generally, flock size varied from a few hundred to several thousands. They fed in scattered clusters in an arc from southeast of the Cape to due north, seldom getting closer than 2 km from shore. Occasionally they fed near the reef west of the pinnacle. Occasionally dead shearwaters washed ashore (some were oiled), but beaches were not conducive to systematic beached bird surveys. Only one storm-petrel (*Oceanodroma* spp.) was observed on 20 June.

Cormorants - Pelagic (*Phalacrocorax pelagicus*) and Red-faced Cormorants (*P. urile*) were resident in the area and were seen on the arrival date of the observers, 22 March, and daily thereafter. Double-crested Cormorants (*P. auritus*) were first seen on 12 April. However, cormorants that wintered farther south did migrate past the Cape. Migration occurred from mid-April until about 5 May. After that, local movements of resident breeders past the Cape obscured migratory patterns. Three-to six-hundred per day were counted during the peak of migration. Their paths were generally close to the pinnacle and then up the northwest coast of Kayak Island. Others crossed the Gulf in a westerly or northwesterly direction.

<u>Geese and Swans</u> - Brant were the only common species to migrate past the Cape. Their migration began 3 April and continued until 15 June. Migration occurred daily throughout the month of May. Their flight pattern was generally well offshore (up to 5 km) south of the Cape and continued in a west or northwest direction. Brant occasionally stopped and rested on the cove southeast of the Cape, and some returned easterly when fog or inclement weather prevented migration to the west. Flocks of swans and Canada Geese (*Branta canadensis*) were observed only 4 and 8 times, respectively: swans from 13-22 April and Canadas from 23 March to 23 April. The earliest flock of swans was 5 km south of the pinnacle and headed west southwest across the Gulf. Swans and Canada Geese both flew northwest from the pinnacle or up the northwest coast of the Island. White-fronted Geese (*Anser albifrons*) were seen only once on 22 April and no Snow Geese (*Chen caerulescens*) were recorded. It was assumed that most of these birds continued straight up the coast to the Copper River Delta bypassing Kayak Island.

<u>Dabblers</u> - Mallards and Pintails first appeared on 6 April but 14 April was the date when heavy migration began. On that day Mallards, Pintails, Green-winged Teal, Northern Shovelers and American Wigeon rounded the Cape and flew back up the northwest side of Kayak Island. The peak of pintail migration was 25 April when 8,543 were observed passing the Cape. In 1977 this occurred on 26 April. The 1978 peak decreased on 28 April, but migrants of most dabbler species passed daily until 22 May. Late migrants were seen on several days after that. Most migrating dabblers at the Cape flew in a westerly or northwesterly direction over the Gulf, thereby bypassing the Copper River Delta. Others flew up the northwest coast of Kayak Island and back toward the mainland. Dabblers seldom stopped near the Cape; however, they did utilize brackish ponds on the uplifted southern shore of the island. Migrating flocks were frequently consisted of mixed dabbler species or even other species of birds.

<u>Divers</u> - Only two diving duck species groups were observed in the 1978 migration. A total of 17 Goldeneyes was observed on three days in March and one subsequent to that. Scaup appeared on 14 April, 5 May, almost daily from 8 to 21 May and sporadically in June. The largest number was 186 on 8 May and most migrants continued up the northwest coast of the Island. Because divers are normally nocturnal migrants, they did not show up in many counts. They appeared to be a minor constituent of the Cape St. Elias avifauna.

<u>Sea ducks</u> - Six species of sea duck were observed at Cape St. Elias. Oldsquaws and King Eider were observed only once. Oldsquaws are nocturnal migrants (Bellrose 1976), and probably fly overland toward the interior from southeast Alaska wintering grounds (Palmer 1975). They probably would not be expected in large numbers. King Eiders were rare winter visitants in the area and would also not be expected. Harlequin Ducks were resident in small numbers throughout

the observation period and apparent.y did not migrate past the Cape. Three scoter species were the most abundant sea duck migrants. Black Scoters wintered at the Cape and frequently fed in shallow water on both sides of the pinnacle. White-winged Scoters, first observed on 28 March, were present in small numbers until migration began and their numbers increased. Surf Scoters were less commonly observed as winter residents in 1978 but were the most abundant migrant. On 14 April flocks of scoters began flying past the Cape and continued until 1 July. The first peak for migrating Surf Scoters was from 14 to 26 May. A maximum count of 1245 individuals occurred on 20 May. A second minor peak occurred from 2 to 10 June and a third larger peak from 19 to 28 June. White-winged Scoters were second in abundance with 25 to 100 observed migrating daily from 14 April to 16 May, with a second peak from 2 to 10 June as with Surf Scoters, and the largest number observed on 19, 20, 23 and 24 June. When resident Black Scoters left by 4 April, a second migration period occurred. Scattered individuals flew past the Cape from 16 April to 16 May. The most seen was 284 on 5 May and none were seen after 16 May. Flocks of mixed scoter species were frequently seen, and other species, commonly Green-winged Teal, were also observed migrating with scoters. Their flight path was most often around the Cape and up the northwest coast of Kayak Island, but occasionally scoters would travel northwest across the Gulf.

Mergansers - Small numbers of Red-breasted Mergansers wintered at the Cape and were present when observation began. They were observed feeding on both sides of the Cape and pinnacle on sculpins (Cottidae) and an abundant supply of blennies (Stichaeidae). Migrants appeared on 14 May when 85 passed the Cape and continued up the northwest coast of Kayak Island. Small numbers of individuals (5 to 50) were seen in early June, after which none were seen. Common Mergansers were observed only in late April. Some stopped to feed nearshore and others migrated up the northwest coast in the same flight pattern as Red-breasted Mergansers.

Raptors - Cape St. Elias was not a part of the migration corridors for raptors. Two Peregrine Falcons (*Falco peregrinus*) were observed: one on 20 April and another on 12 May. It is unknown whether these were the endangered subspecies *F. p. anatum* or more common *F. p. pealei*. A Merlin (*F. columbarius*) was seen on 26 April and a Marsh Hawk (*Circus cyaneus*) on 8 May. No other migrating raptors were recorded. Bald Eagles were resident in the area (3 active nests were found), and 5 to 12 were seen almost daily at the pinnacle scavenging on dead sea lion pups and other carrion or, occasionally, taking a bird that nested at the pinnacle colonies. A large part of the total population were non-breeding, immature birds.

Cranes - No Sandhill Cranes (*Grus canadensis*) migrated past Cape St. Elias in 1978 (only one in 1977). It appears, therefore, that this species must have followed along the coast to Controller Bay and continued to the Copper River Delta.

Shorebirds - Although 13 species of shorebirds were identified, only two were observed regularly at the Cape, Black Oystercatchers (*Haematopus bachmani*) and Rock Sandpipers (*Calidris ptilocnemis*). Suitable habitat for other species was not prevalent at the Cape. Black Oystercatchers were resident on Kayak Island in small numbers (about 8 at the Cape). This species also migrated past the Cape in relatively large numbers (20-65 per day) in April. Rock Sandpipers were present on the first day of observation, 22 March, and migrating flocks of up to 100 individuals stopped occasionally at the Cape to feed in intertidal rock habitat. None were seen after May 20. Other species like Whimbrels (*Numenius phaeopus*), Wandering Tattlers (*Heteroscelus incanus*), Surfbirds (*Aphriza virgata*) and several sandpiper species, infrequently stopped to feed. After a severe storm that piled kelp and other algae in thick windrows on the beach, shorebirds of several species were observed feeding on amphipods (Talitridae) that were abundant in the algae. Semipalmated Plovers (*Charadrius semipalmatus*) and least Sandpipers (*Calidris minutilla*) nested along the beach on both sides of the island. Northern Phalaropes (*Phalaropus lobatus*) were recorded on only 5 days, but on 15 May several thousand were observed well offshore alternately feeding and migrating in a westerly direction. On 20 May 850 phalaropes migrated past the Cape, and only small numbers were seen subsequently.

Jaegers and Gulls - Although all three jaeger species were observed migrating past the Cape, Parasitic Jaegers (*Stercorarius parasiticus*) were the most common. The first was sighted 21 April and the most (11) on 29 May. Almost all rounded the Cape and headed up the northwest coast. Glaucous-winged Gulls (*Larus glaucescens*) were resident on the Island. An estimated 1-500 were seen in March soon after arrival of the observers. Migration began the second week in April and continued into the first week of May. Local movements past the Cape by resident gulls obscured migration patterns after that. Up to 25 Herring Gulls (*L. argentatus*) were observed migrating past or feeding and roosting in the area. Only two Bonaparte's (*L. philadelphia*) and no Mew Gulls (*L. canus*) were sighted. One would assume they must follow the mainland coast or travel well offshore in their migration. Migration patterns of Black-legged Kittiwakes were obscured by a large diurnal movement past the Cape of birds nesting near Cape St. Elias. In the morning and early afternoon Kittiwakes flew around the Cape and up the northwest coast toward colonies at Wingham and Martin Islands. After 17:00 most reversed the direction and flew up the southeast side of Kayak Island toward the mainland. This diurnal movement involved 10-15,000 birds. As many as 436 Black-legged Kittiwakes per minute were recorded in sea watches. This mass movement ended about 22 May. Subsequently, only a few hundred passed the Cape each day. Occasionally kittiwakes stopped to rest on the water at Cape St. Elias in rafts of 1,000 or more. They also frequently joined feeding rafts of loons, murres and puffins in the vicinity of the Cape.

<u>Terns</u> - Although thousands of terns migrate up the coast of NEGOA in spring, none were seen at Cape St. Elias in 1977 or 1978. They must have followed the mainland coast past Kayak Island or migrated far offshore.

<u>Alcids</u> - The normal migration pattern for most alcids are from offshore wintering areas to coastal breeding areas. Therefore, migration of alcids past Cape St. Elias would not be expected. Most movements were to feeding and roost areas by birds nesting in the vicinity. Murres (*Uria* spp.) had already arrived at the Cape when observations began on 22 March. By March 26,500 murres were rafted on nearshore waters. These birds flew back and forth past the Cape, roosted and fed in the vicinity but did not come ashore until 7 April. At times there were due north diurnal movements past the pinnacle in the morning, with returns in a southeasterly direction in the evening. This pattern was followed by a minimum of 10,000 murres on 15 April. Whether this represented a migration or diurnal movements of birds from colonies at Wingham and Martin Islands was uncertain. The murres could possibly have been feeding in the gyre northwest of Kayak Island. Frequently in the evening during the last 3 weeks of April, a raft of several hundred to over 1,000 murres congregated 1 to 3 km west of the lighthouse at the Cape. Several hundred Tufted Puffins (*Lunda cirrhata*) often joined this raft of birds. Tufted Puffins arrived at Cape St. Elias on 15 April and the population subsequently increased to several hundred birds. ubsequently. Although there was much movement by puffins back and forth past the Cape, no specific migration pattern was noted. There were far fewer (less than 1,000 vs. 6,000) Tufted Puffins nesting at the pinnacle than reported by Isleib and Haddock in Sowls et al. (1978). Horned Puffins (*Fratercula corniculata*) were reported as being "found largely at colonies from Cape St. Elias westward" by Isleib and Kessel (1973) but Horned Puffins were not observed in 1977 or 1978 at Cape St. Elias. Marbled Murrelets (*Brachyramphus marmoratus*) were the next most commonly observed alcid, and this bird may nest on the island. They were observed occasionally in April and early May, but after 29 May they were seen regularly, feeding near the Cape or flying past in both directions. As many as 60 to 70 were observed on some days. Ancient Murrelets (*Synthliboramphus antiquus*) and Cassin's Auklets (*Ptychoramphus aleuticus*) were sporadically observed but never abundant. An estimated 150 Cassin's Auklets per hour flew easterly past the Cape most of the day on 18 May. At that time mating was observed so it appeared that this auklet may nest near Cape St. Elias. Pigeon Guillemots (*Cepphus columba*) were observed on only 10 days; the most observed was three.

<u>Corvids</u> - Common Ravens were the only corvid regularly observed at the Cape. A family group exploited the nesting murres, gulls and cormorants and scavenged on the beach. Northwestern Crows were seldom seen and no more than three individuals were present at one time.

Other Passerines - Although many were recorded on the island, few directly used marine habitats. However on 14 May Steller's Jays (*Cyanocitta stelleri*), American Robins (*Turdus migratorius*) Varied Trushes (*Ixoreus naevius*), Savannah Sparrows (*Passerculus sandwichensis*) and Fox Sparrows (*Passerella iliaca*) fed with shorebirds on amphipods and insects that were in the windrows of algae on the beach.

KODIAK

Only one coastal bird survey was conducted by this research unit in the Kodiak lease area. A stratified-random survey design was used in winter 1976 (Arneson 1976). Eight strata were preselected in the stratification: exposed waters-forested, protected waters-forested, heads of bays-forested, exposed waters-tundra/alder, protected waters-tundra/alder, heads of bays-tundra/alder, estuaries-lagoons and embayments and low tundra/ sand beach. Count units were randomly selected within each stratum (Fig. 33). Because of the stratification, all coastal habitats found on Kodiak may not have been searched.

Two observers recorded all birds within a section of bay or along an exposed coast rather than along an entire coast as in other surveys. This increased the observational area for birds beyond 400 meters from the tideline but decreased it for those birds near the tideline. All major islands of the archipelago were surveyed.

For analysis, the survey area was divided into five sections (Fig. 34) which were based partially on habitats and exposure: Section 1 - Afognak/Shuyak is almost entirely forested, Section 2 - North side is only partially forested and protected by Chiniak and Kizhuyak Bays, Section 3 - West side has a tundra/alder shore but is exposed to Shelikof Strait, Section 4 - East side is exposed to Gulf of Alaska and has a tundra/alder shore, and Section 5 - South side has several low, sand/gravel beaches.

WINTER

Density - In the 1976 Kodiak winter survey, we found an average bird density of 39 birds/km^2 (Table 6). Over half of the birds were sea ducks (20 birds/km^2). Diving and dabbling ducks were a distant second and third with densities of 5 and 4 birds/km^2, respectively. Alcid densities were slightly higher than densities of gulls and shorebirds (3 vs. 2 birds/km^2). On a percentage basis, the relative abundance was seabirds 51 percent, divers 13 percent, dabblers 10 percent, alcids 9 percent, gulls 5 percent and shorebirds 4 percent.

Bird densities by section are depicted in Figs. 35-52. Most sea ducks were in the Chiniak/Kizhuyak section of Kodiak Island (44 birds/km^2) and the Gulf of Alaska side (23 birds/km^2). Of identified sea ducks, 40 percent were scoters, 28 percent Oldsquaws, 22 percent eiders and 11 percent Harlequin Ducks. Sixty-three percent of the identified scoters were Black, 20 percent Surf and 18 percent White-winged. Steller's Eiders comprised 69 percent of the identified eiders, 22 percent were King Eiders and 9 percent Common Eiders.

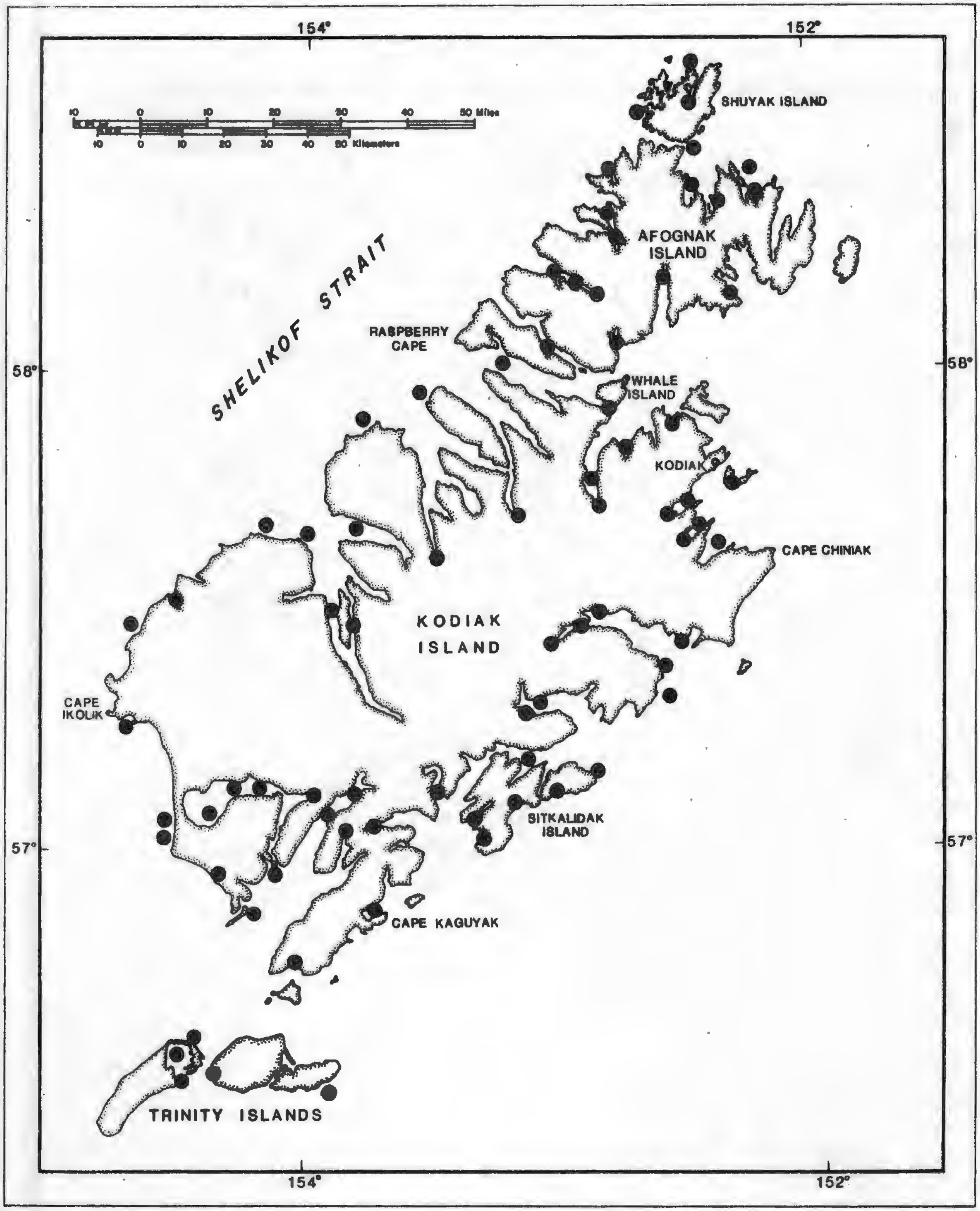


Fig. 33. Count areas sampled during aerial bird survey along Kodiak archipelago, Winter 1976. A stratified random design was used. This was survey number 7603 conducted from 22 February to 3 March, and 21-24 March; total time of survey was 9 hours, 51 minutes.

Fig. 34. Physiographic subdivision of Kodiak archipelago for bird density analysis. Each numbered section contains many count areas.

Table 6. Bird density by section of coastline in Kodiak Archipelago, winter, 1976. See Figure 34 for section boundaries. (T=trace).

	Winter Density (birds/km^2)					
	Section of Coastline					
Bird Group	1	2	3	4	5	Total
Loon	T	T	T	T	T	T
Grebe	T			T	T	T
Tubenose						0
Cormorant	2	2	T	1	T	1
Goose and Swan				T	T	T
Dabbler	3	2	8	4	1	4
Diver	14	9	2	4	2	5
Sea Duck	13	44	12	23	12	20
Merganser	T	T	T	T	T	T
Raptor	T	T	T	T	T	T
Crane						0
Shorebird	2	2	T	2	1	2
Gull and Jaeger	1	4	1	1	3	2
Tern						0
Alcid	1	2	3	9	T	3
Corvid	2	T	T	1	T	1
Other Passerine	T				T	T
Other Bird	T		T	T	T	T
TOTAL	40	67	28	48	20	39

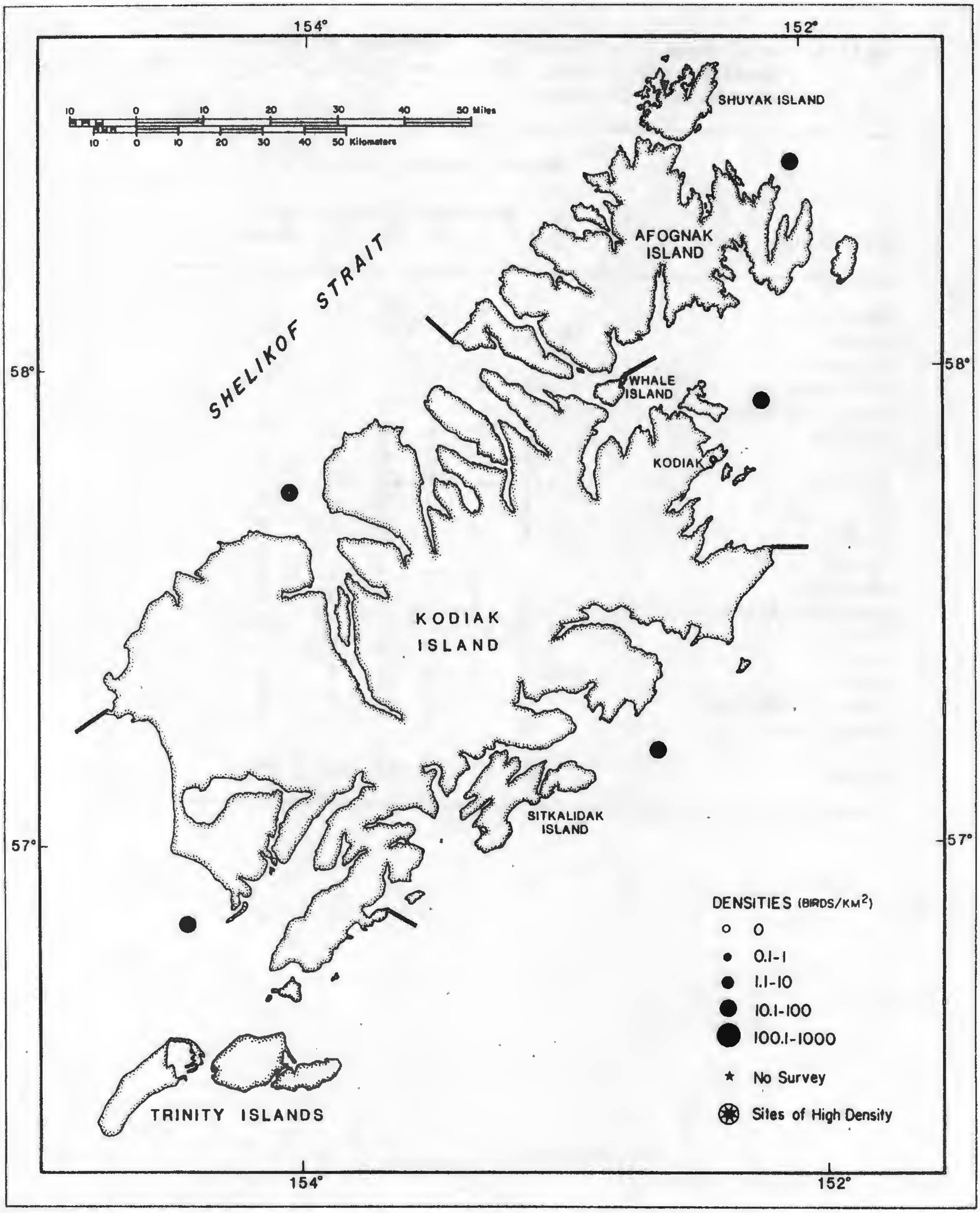


Fig. 35. Total bird density by section in Kodiak archipelago during winter as determined by aerial survey.

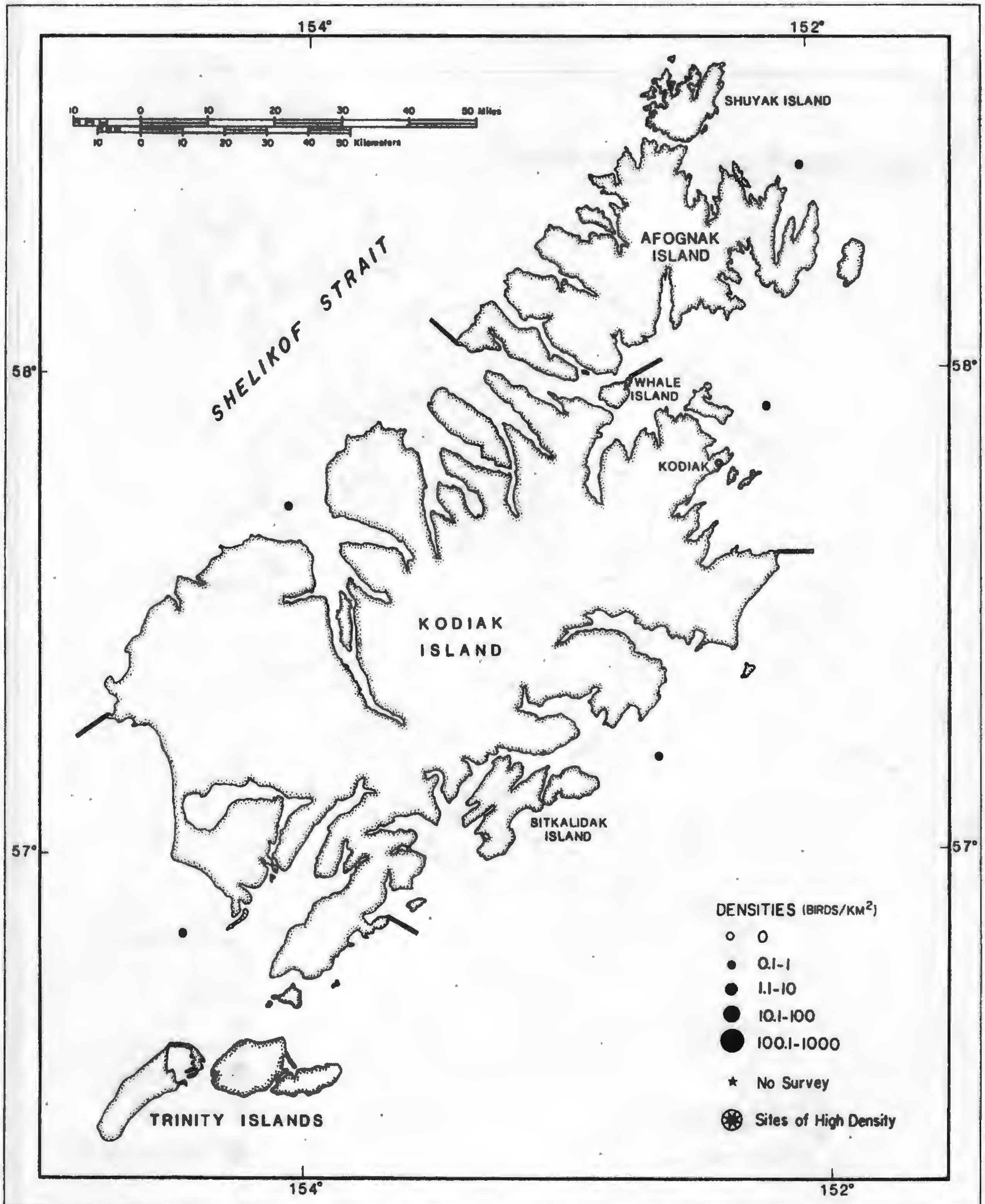


Fig. 36. Loon density by section in Kodiak archipelago during winter as determined by aerial survey.

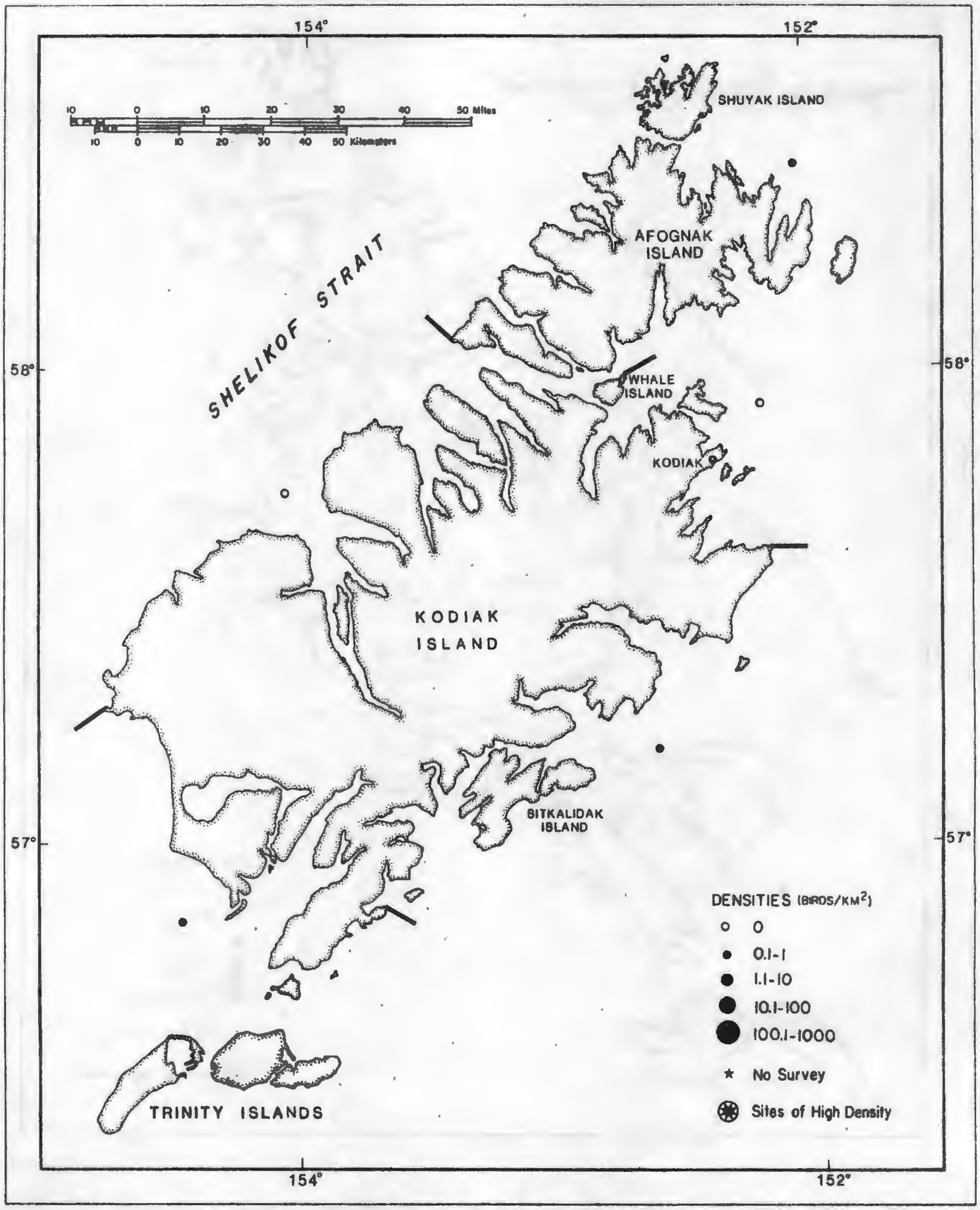


Fig. 37. Grebe density by section in Kodiak archipelago during winter as determined by aerial survey.

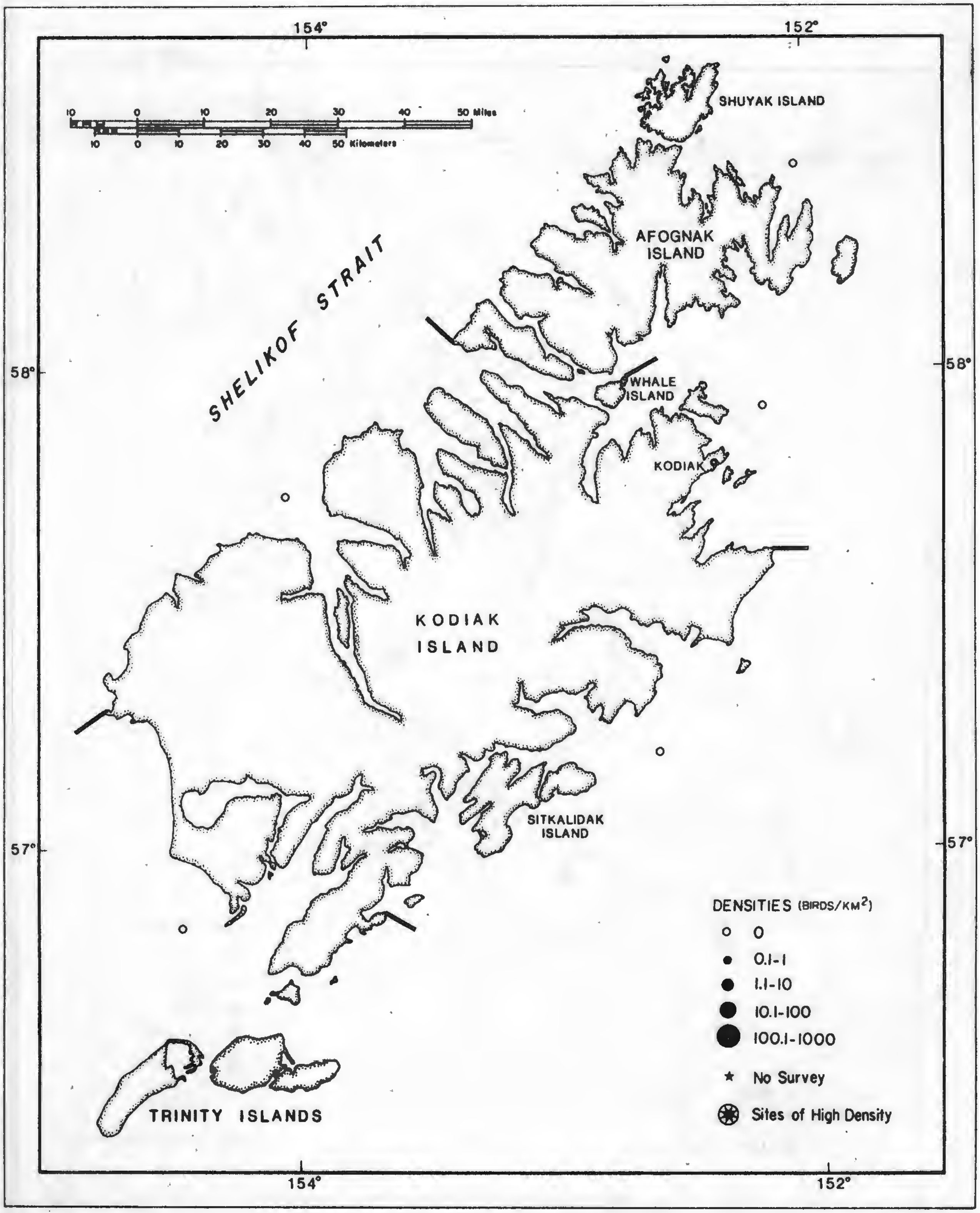


Fig. 38. Tubenose density by section in Kodiak archipelago during winter as determined by aerial survey. No tubenoses were sighted.

Fig. 39. Cormorant density by section in Kodiak archipelago during winter as determined by aerial survey.

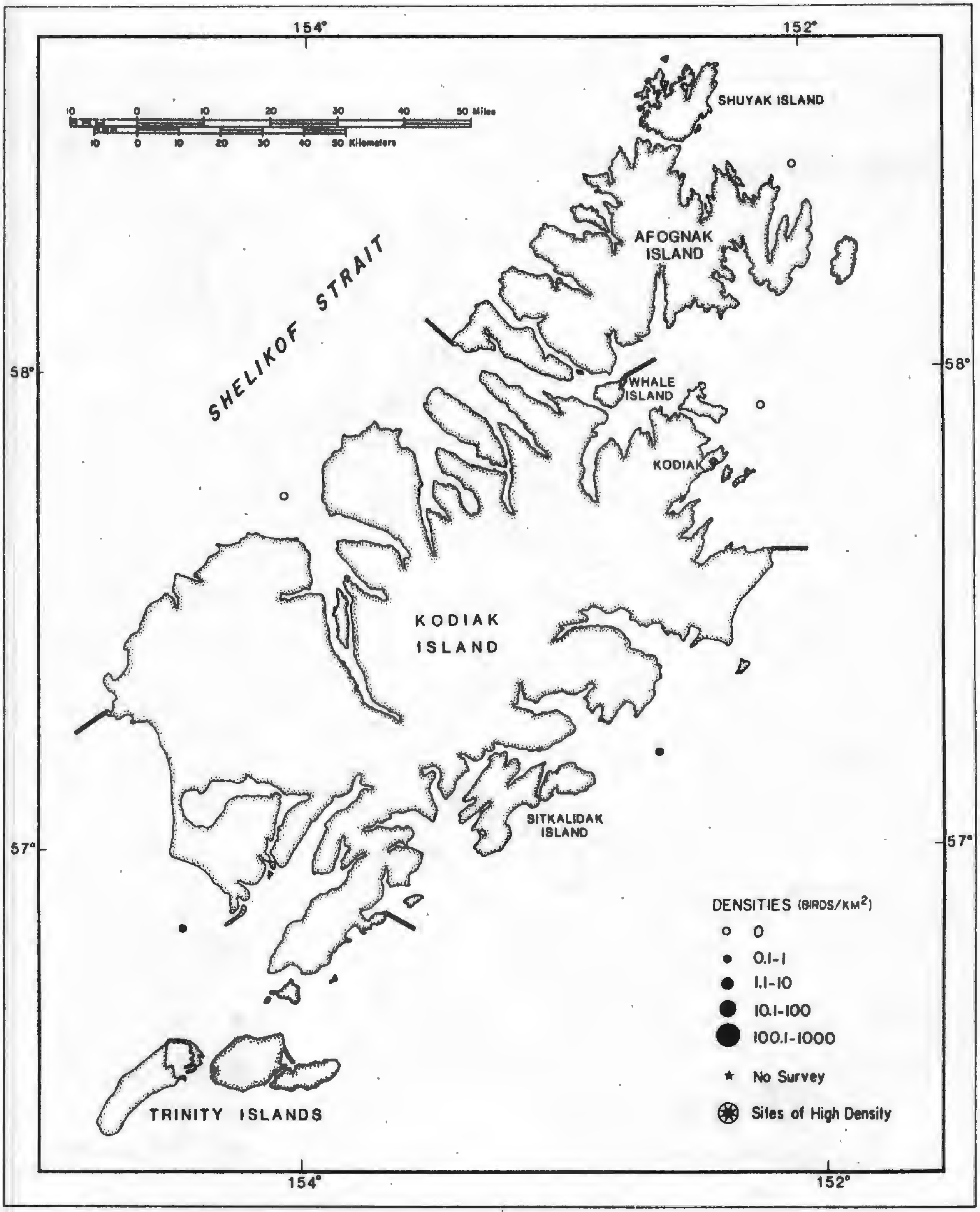


Fig. 40. Goose and swan density by section in Kodiak archipelago during winter as determined by aerial survey.

Fig. 41. Dabbling duck density by section in Kodiak archipelago during winter as determined by aerial survey.

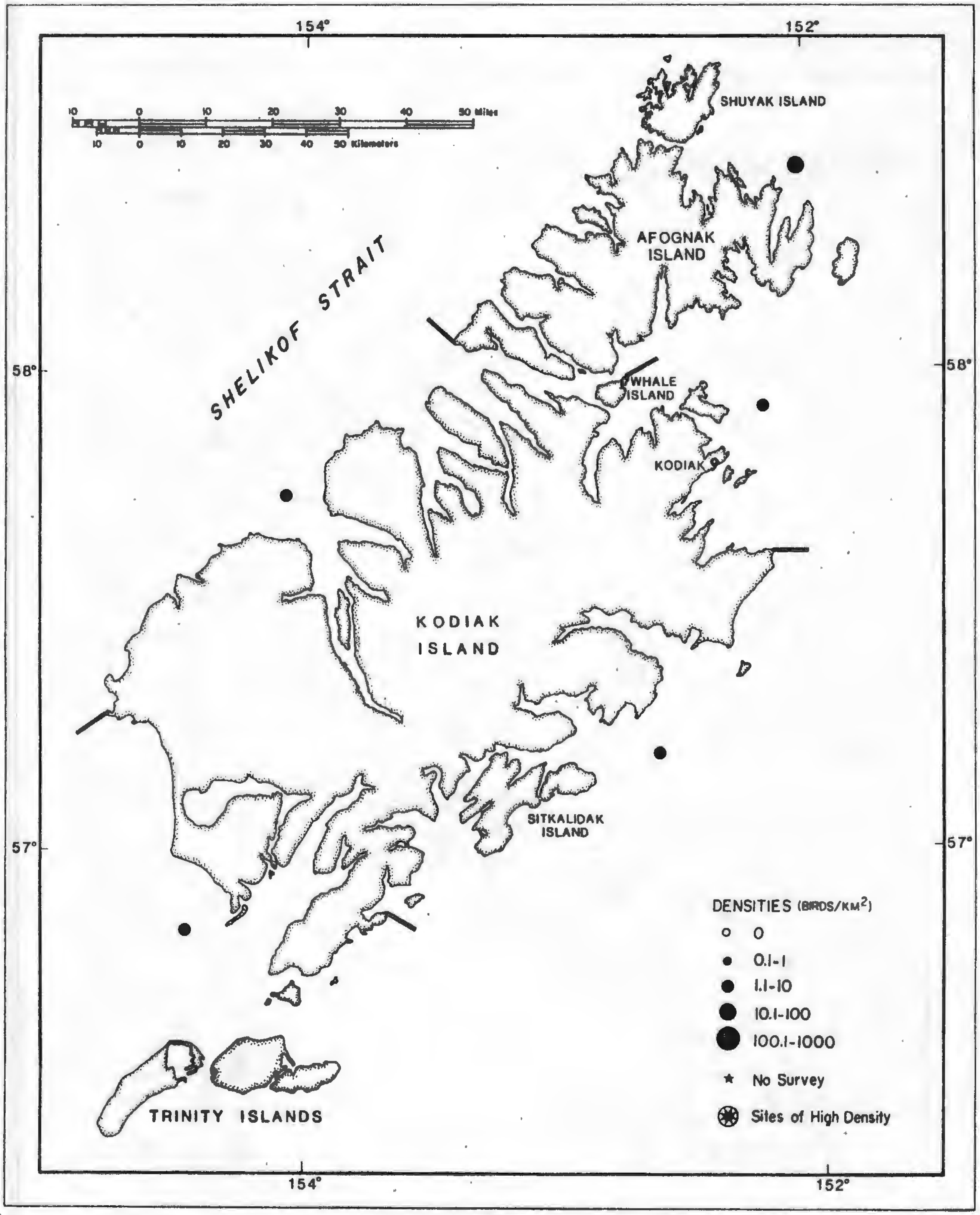


Fig. 42. Diving duck density by section in Kodiak archipelago during winter as determined by aerial survey.

Fig. 43. Sea duck density by section in Kodiak archipelago during winter as determined by aerial survey.

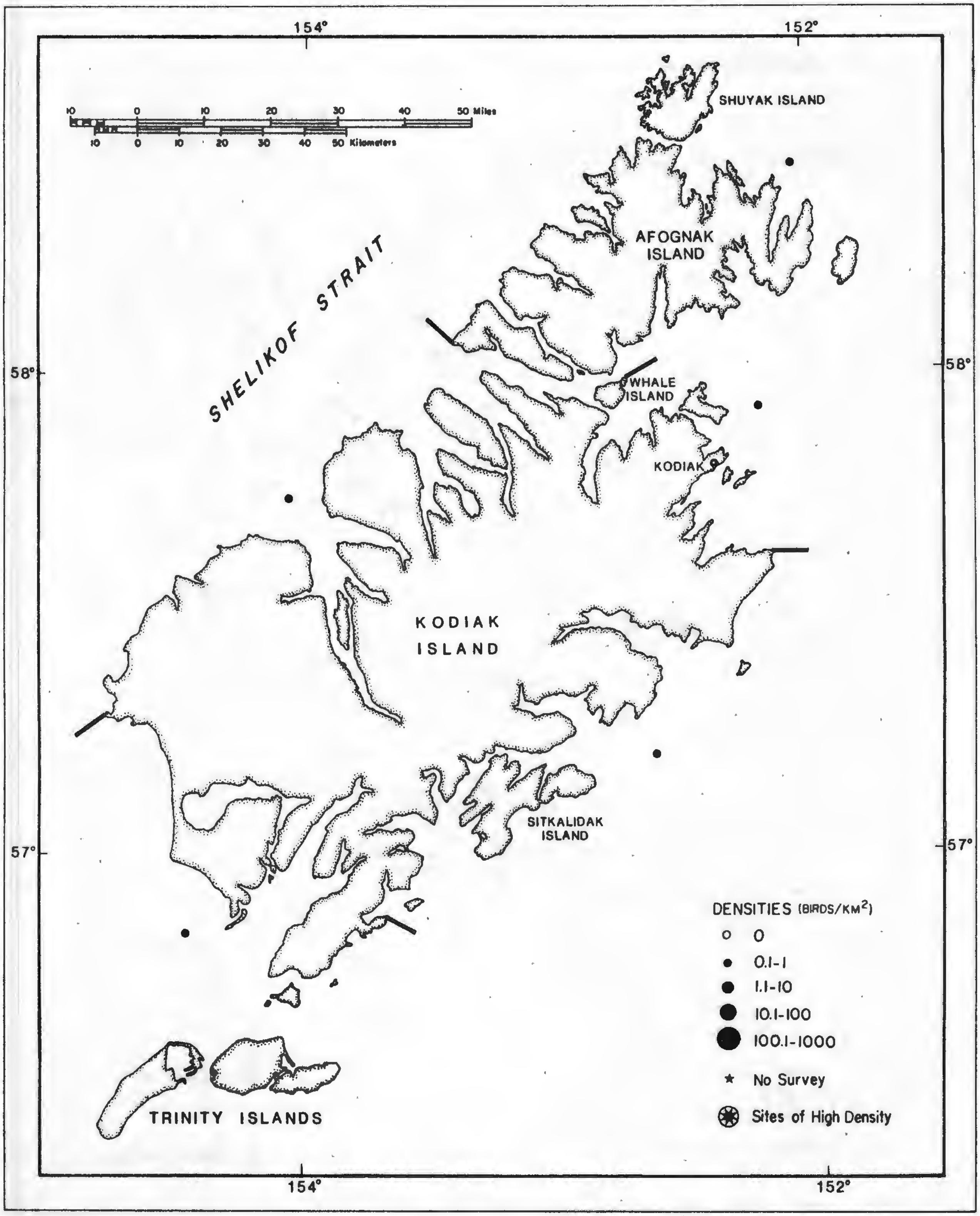


Fig. 44. Merganser density by section in Kodiak archipelago during winter as determined by aerial survey.

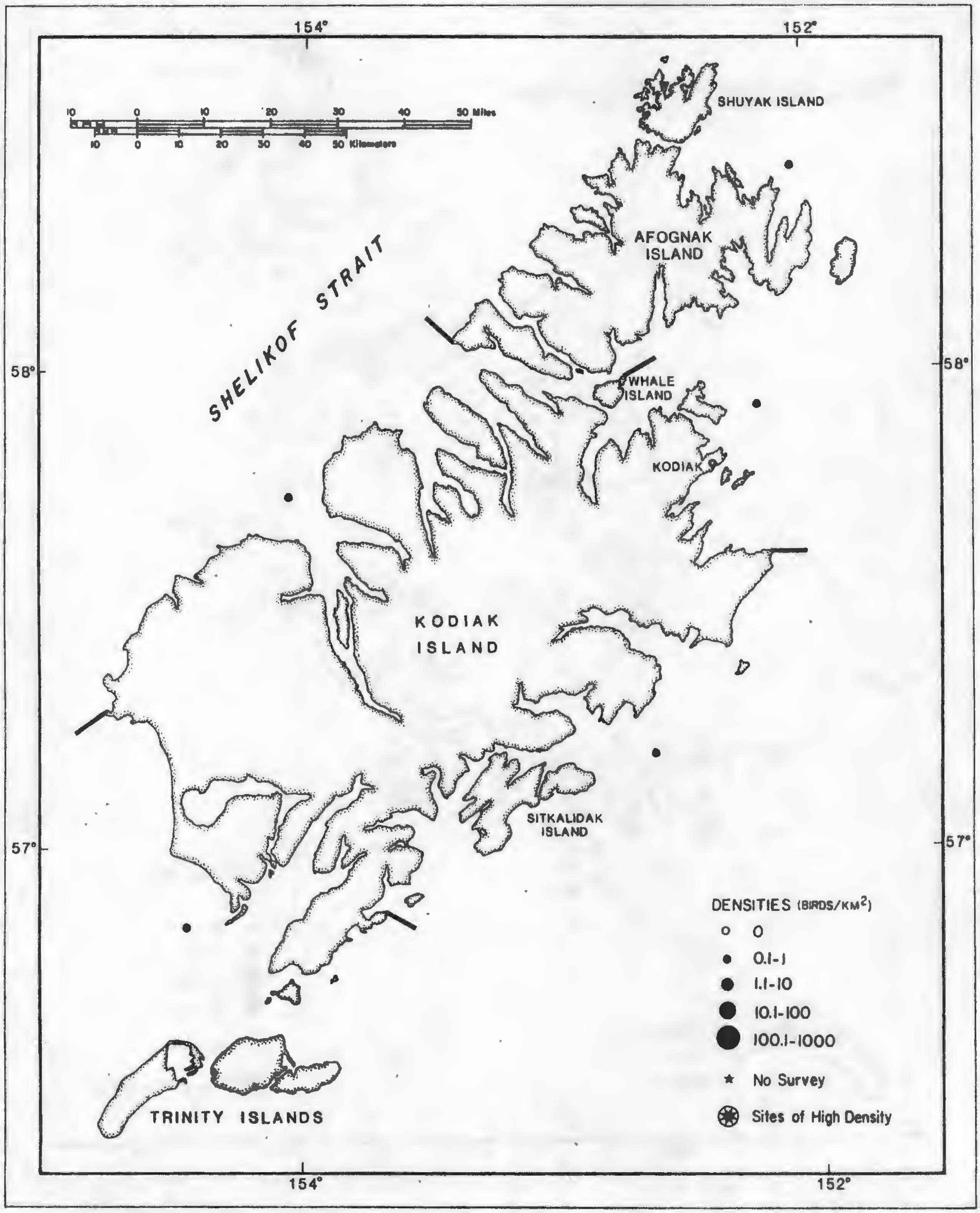


Fig. 45. Raptor density by section in Kodiak archipelago during winter as determined by aerial survey.

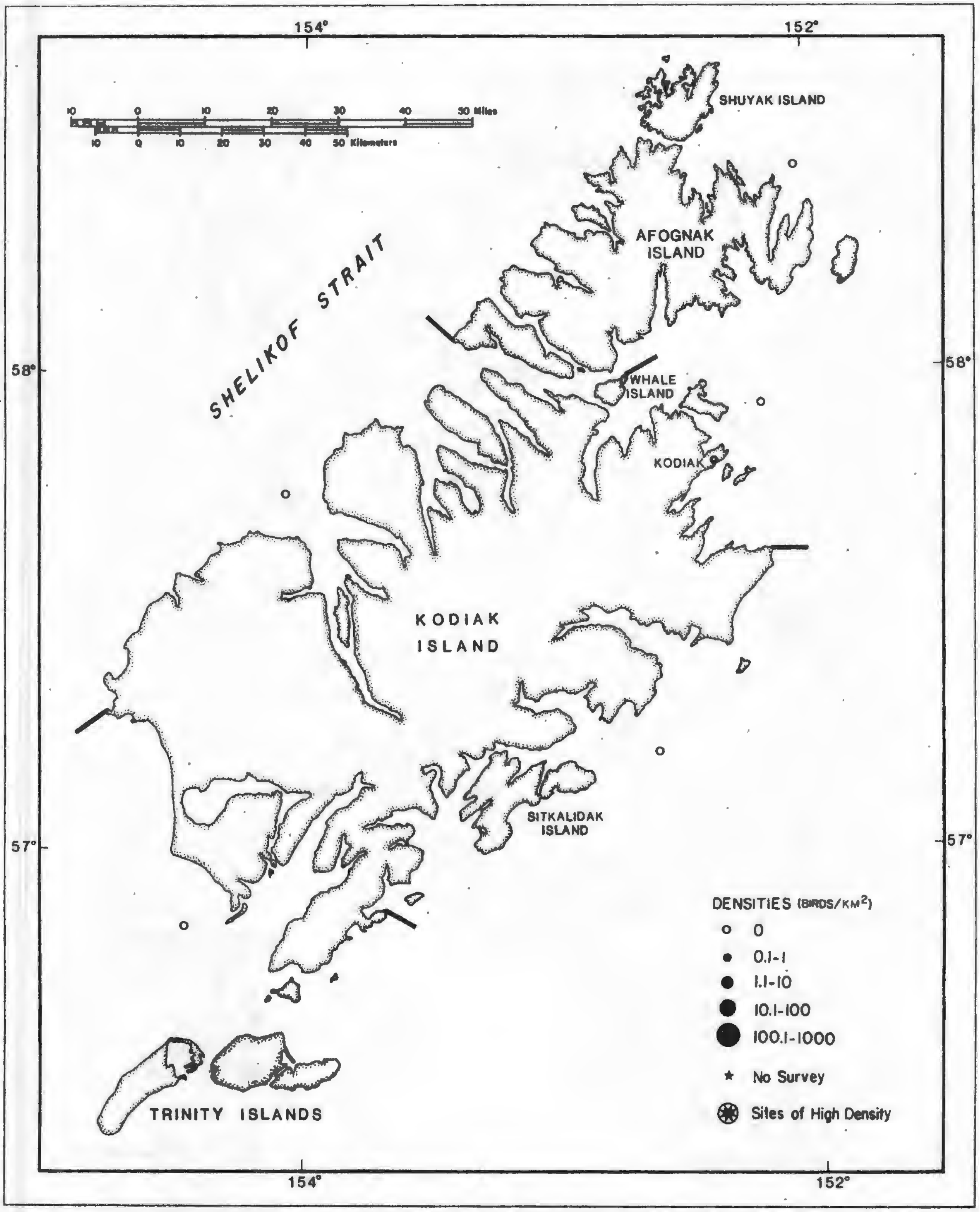


Fig. 46. Crane density by section in Kodiak archipelago during winter as determined by aerial survey. No cranes were sighted.

Fig. 47. Shorebird density by section in Kodiak archipelago during winter as determined by aerial survey.

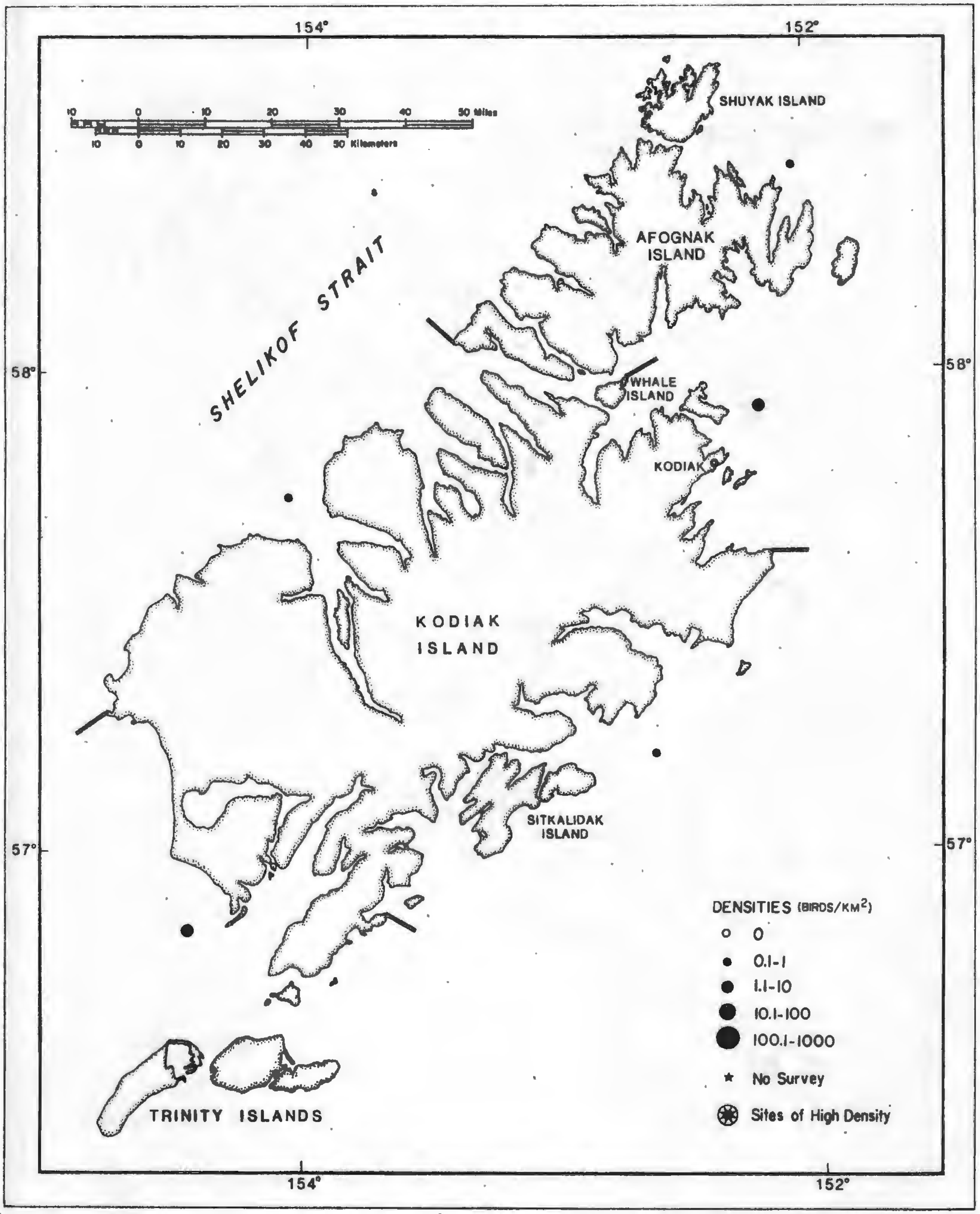


Fig. 48. Gull and jaeger density by section in Kodiak archipelago during winter as determined by aerial survey.

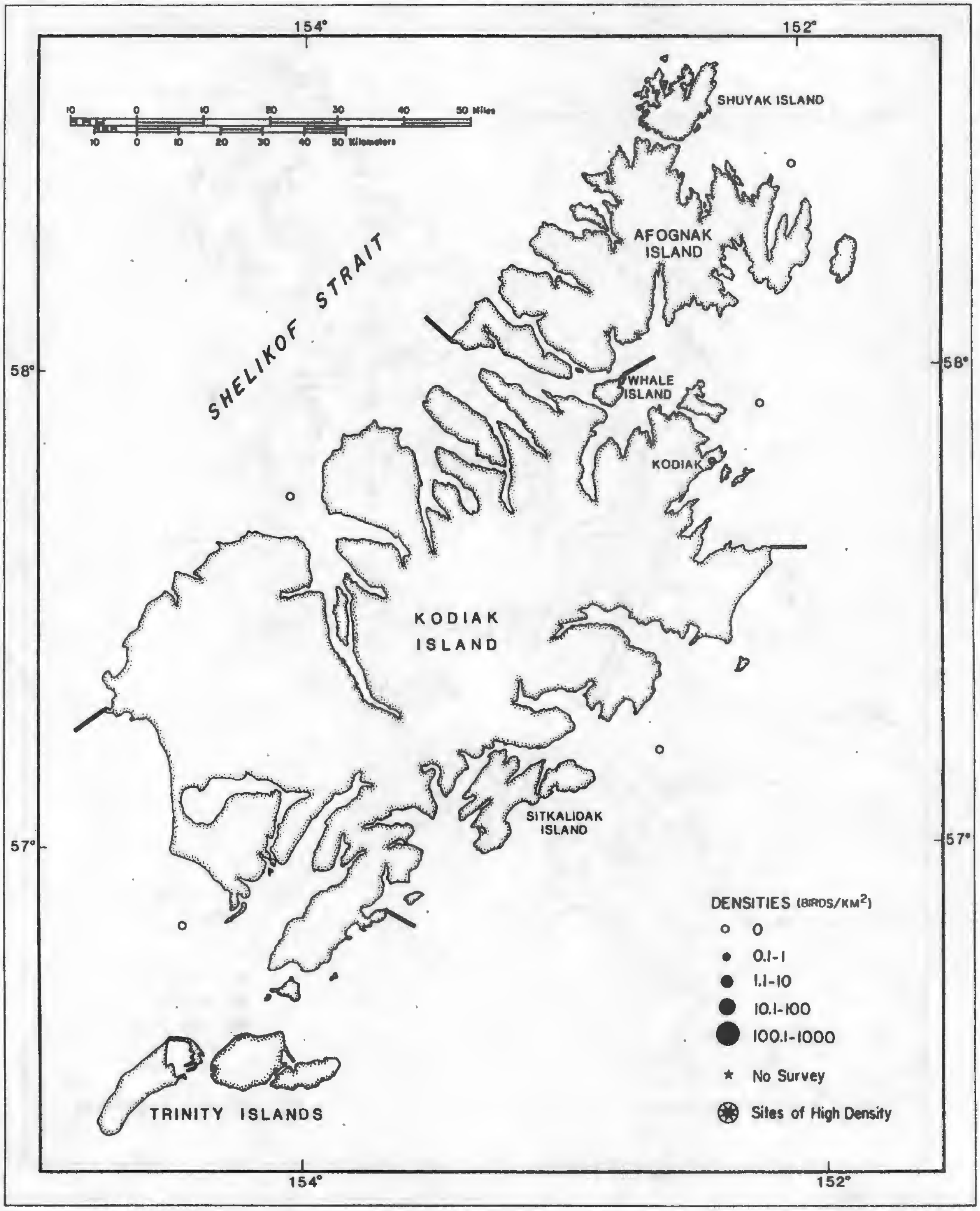


Fig. 49. Tern density by section in Kodiak archipelago during winter as determined by aerial survey. No terns were sighted.

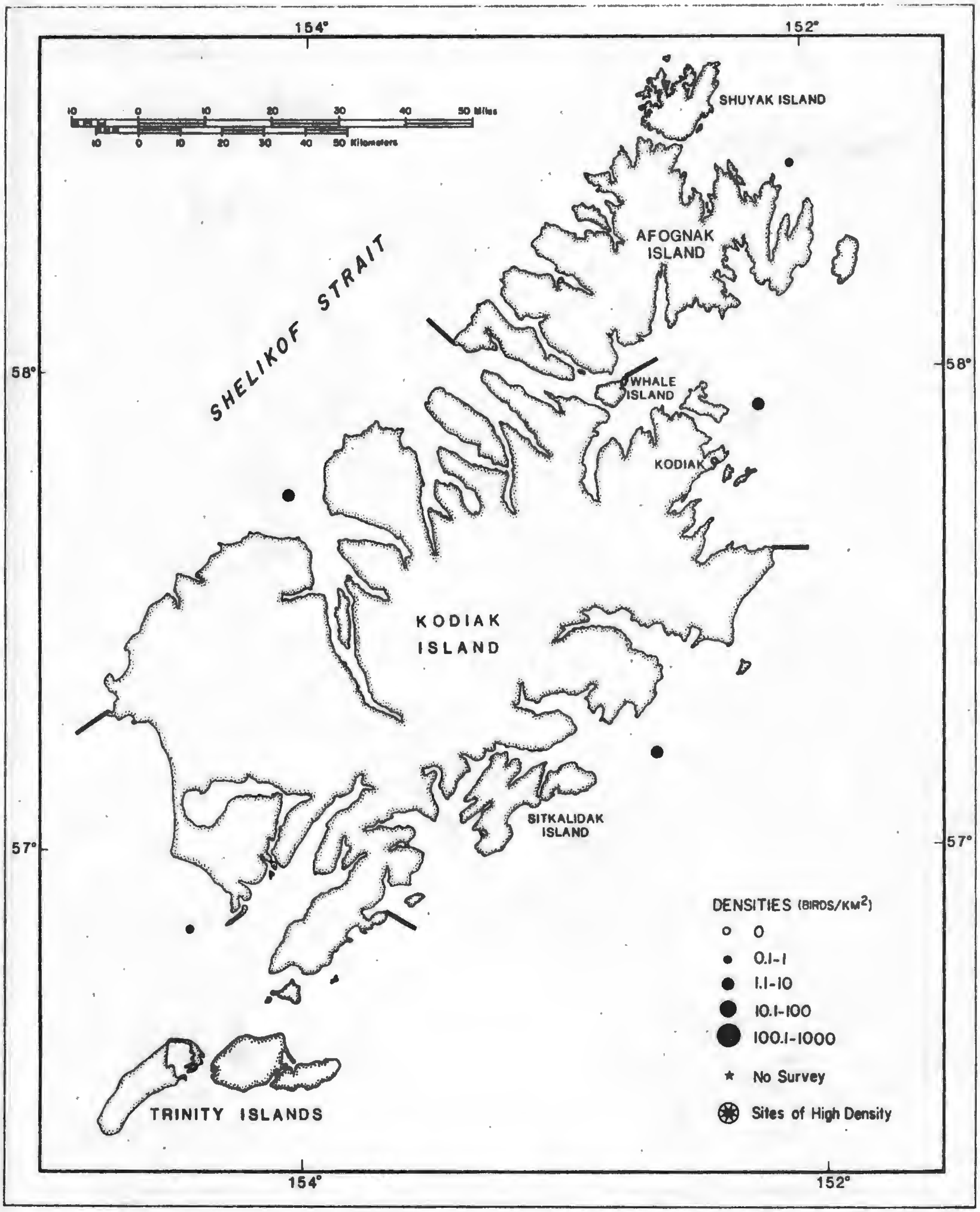


Fig. 50. Alcid density by section in Kodiak archipelago during winter as determined by aerial survey.

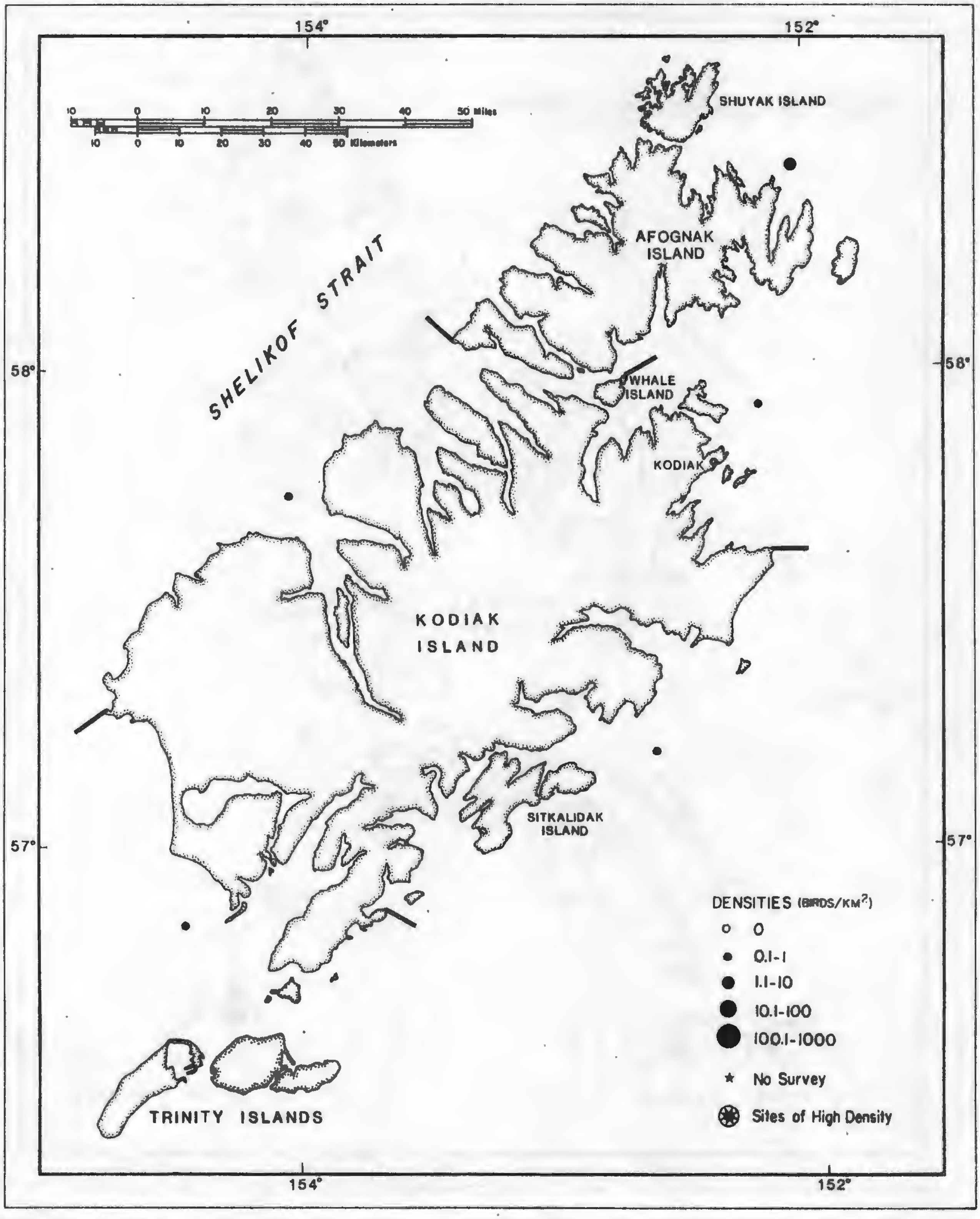


Fig. 51. Corvid density by section in Kodiak archipelago during winter as determined by aerial survey.

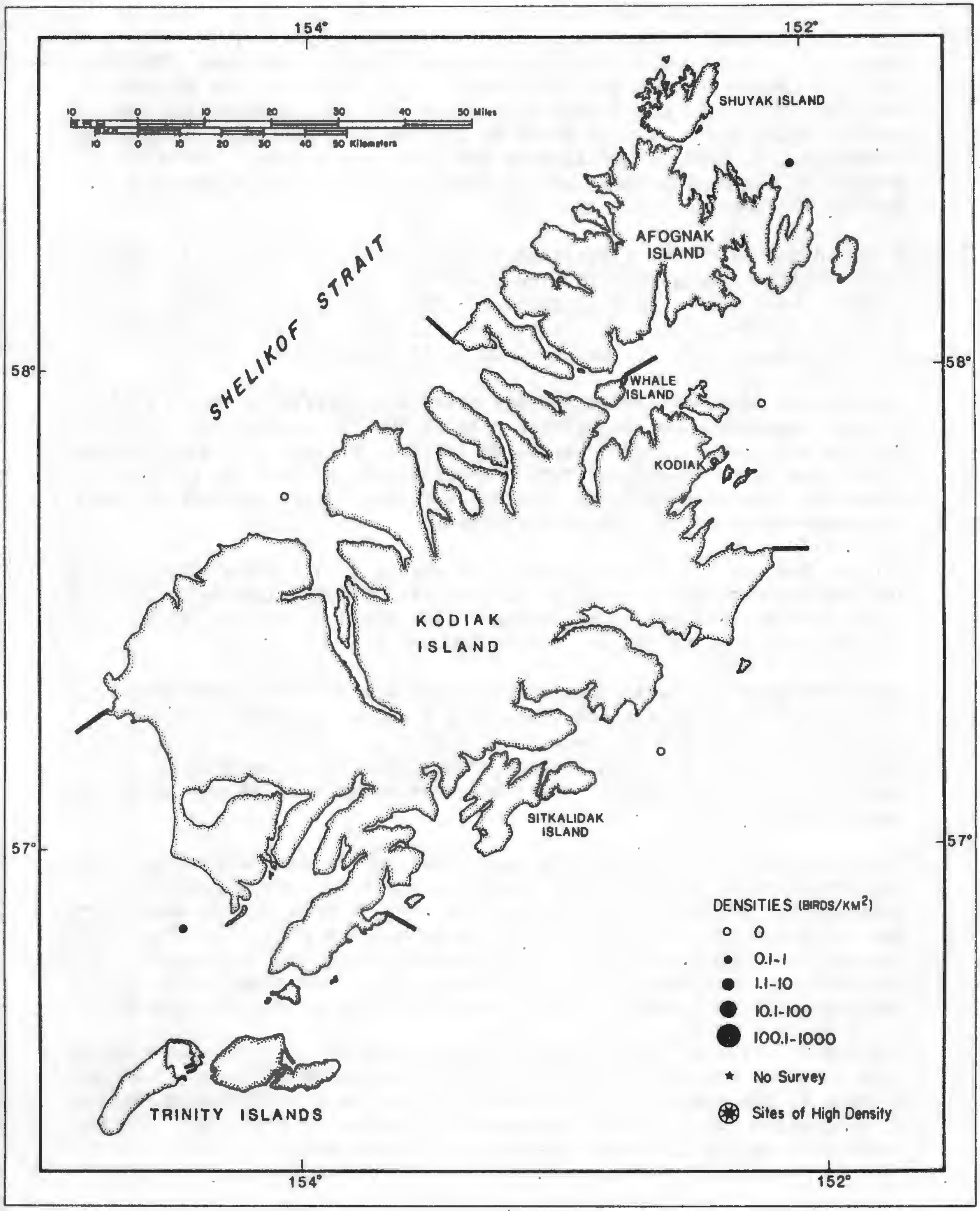


Fig. 52. Passerine (other than corvid) density by section in Kodiak archipelago during winter as determined by aerial survey.

Highest densities of diving ducks were recorded in the Afognak/Shuyak section (14 birds/km^2 and divers were least abundant in the Shelikof and southern sections (both 2 birds/km^2). Over 90 percent of the divers in the Afognak, Shelikof and southern sections were goldeneyes. The remainder in those three sections were Bufflehead. In Section 2, the Chiniak area, 50 percent of the divers were scaup, 47 percent goldeneye and 3 percent Bufflehead. Diving ducks in Section 4 consisted of 60 percent goldeneyes, 35 percent Buffleheads and 5 percent scaups. Overall, 76 percent of the diving ducks were goldeneyes, 13 percent scaups and 11 percent Buffleheads.

Ninety-nine percent of identified dabbling ducks were mallards. Dabblers reached highest densities (8 birds/km^2) in Section 3 on stream deltas at heads of bays and in coastal lagoons. They were least abundant on the southern portion of Kodiak. Gadwalls, Pintails and American Wigeons were all identified, but occurred in small numbers.

Alcids, the next most dense species group (3 birds/km^2), were found in greatest abundance on the eastern side of Kodiak, particularly in Kiliuda and Ugak Bays. There, large rafts of murres were observed both in and out of count units. Murres comprised 83 percent of all alcids observed. One alcid/km^2 was recorded for the Afognak section and only a trace was recorded for the southern end.

Chiniak Bay was the area of densest wintering gull populations (4 birds/km^2), and the southern end of Kodiak was next with three gulls/km^2. The three other sections had only one bird/km^2. Of identified gulls, 76 percent were Glaucous-winged and 24 percent Mew Gulls.

Shorebird densities were consistantly moderate (1 or 2 birds/km^2) in all but the southern section where only a trace was found. Twenty percent of the shorebirds were Black Oystercatchers, and the remainder were unidentified small and medium shorebirds. Rock Sandpipers were identified in small numbers and likely comprised most of the unidentified shorebirds.

Cormorants and corvids were the only other groups with a density greater than one bird/km^2) and Section 1 had the greatest corvid densities (2 birds/km^2). Ninety-five percent of the corvids were Northwestern Crows, and the remainder were Black-billed Magpies (*Pica pica*) (3%) and Common Ravens (1%). Loons, mergansers and raptors were observed in all sections but in only trace amounts. Emperor Geese (*Philacte canagica*) were recorded only in Sections 4 and 5, and only five grebes were observed.

Section 2, Chiniak/Kizhuyak Bays, had the highest bird densities of the five sections with 67 birds/km^2. Forty-eight birds/km^2 were found in Section 4, the eastern side, and 40 birds/km^2 were observed in Section 1, Afognak/Shuyak Islands. The western side had 28 birds/km^2, and the southern side had the lowest density - 20 birds/km^2.

Habitat Usage - As mentioned previously, the sampling techniques required more searching for birds in open waters of bays/fjords thereby increasing numbers found in that habitat type. Habitat preferences of each species group and what species groups were found on each habitat type are shown in Figs. 53 and 54, respectively. All species groupings observed with the exception of "Other Passerines" were recorded in bay/fjord water, and 78 percent of all birds were in that habitat type. Fifty-nine percent of birds in bay water were sea ducks, 16 percent diving ducks, 11 percent alcids and 7 percent dabbling ducks. All grebes, almost all alcids, 91 percent of the mergansers and diving ducks, 89 percent of the sea ducks and loons and 80 percent of the cormorants were found on bay water.

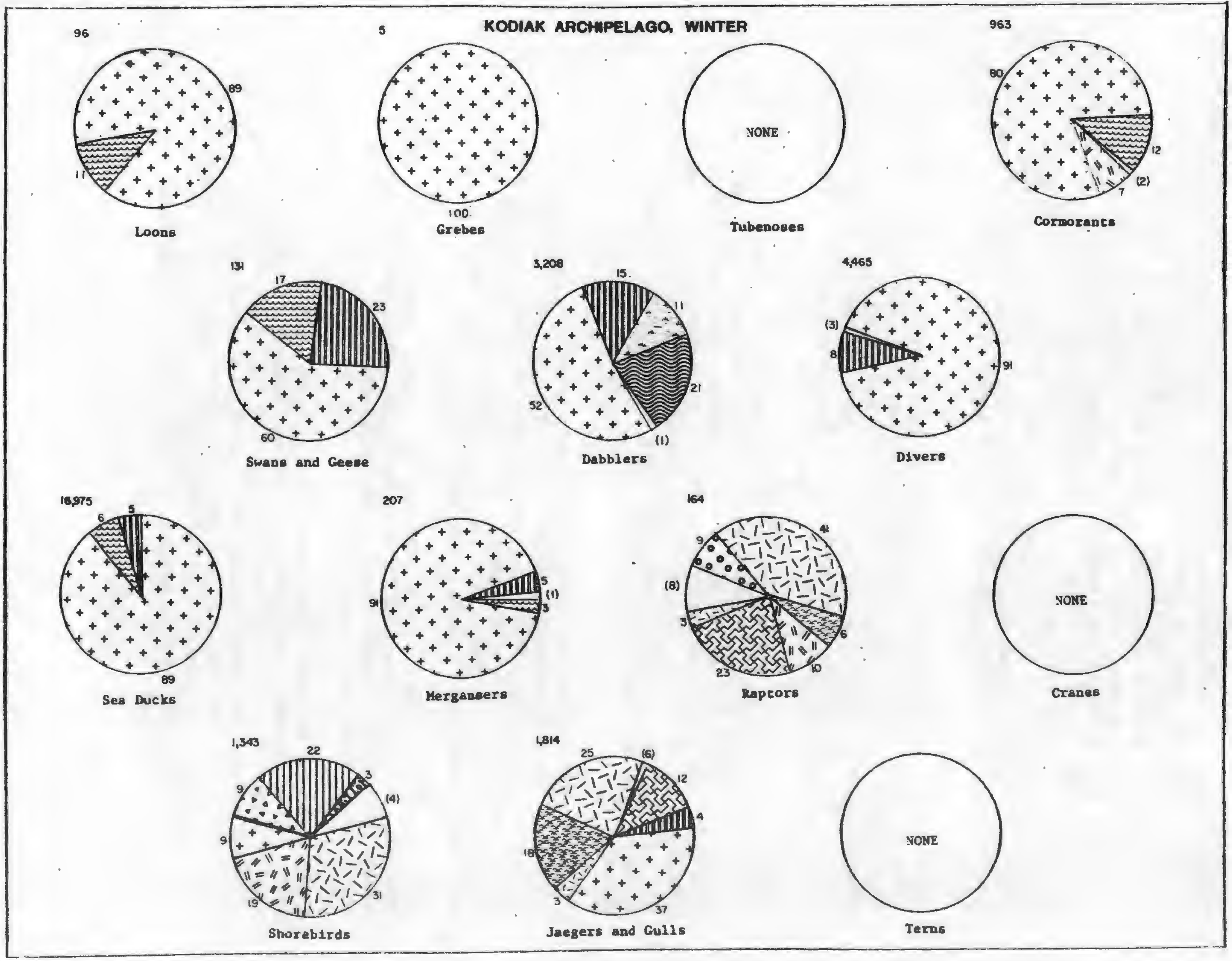
Lagoon/embayment waters were a distant second in habitats used by wintering birds on the Kodiak survey. Five percent of all birds were found in that habitat. Almost 94 percent of the birds in lagoon waters were waterfowl. Most (44%) were sea ducks, 28 percent were dabblers and 20 percent divers. However, only 5 percent of all sea ducks selected that habitat, plus 15 percent of the dabblers and 7 percent of the divers.

Exposed inshore water was the third most used habitat, but only about 4 percent of the birds were found there. Sea ducks and cormorants were the most abundant species groups in exposed inshore water with 85 and 9 percent of the total, respectively. The species group with the largest percentage of its total in exposed inshore water was geese. All were Emperor Geese and 17 percent were found over exposed waters. They frequently flushed from beach habitats and were flying over water when observed.

The only other habitat type on which 2 percent or more of the total birds were found was protected delta water. This habitat was frequently found at heads of bays. Ninety-one percent of the birds on protected delta water were dabblers, however, only 21 percent of the dabblers were found on the habitat. Most (52%) dabblers used bay water, 15 percent used lagoon water and 11 percent used saltmarshes.

Raptors (all were assumed to be Bald Eagles) used the widest variety of habitats. They were found on 10 identified types. Most heavily used were rocky islands or pinnacles and rocky beaches in bays. Over one-fourth were on exposed habitats.

Shorebirds were the most prevalent species group on exposed habitats. Twenty-seven percent of the shorebirds were on exposed sand, gravel or rock beaches. Black Oystercathers comprised 20 percent of all shorebirds and the remainder were unidentified small and medium shorebirds except for a few Rock Sandpipers. It was likely that many of the birds were Rock Sandpipers. Shorebirds also frequently chose rocky beaches of islands in bays (19%), gravel beaches in bays (9%) and were observed flying over bay water (9%).


KODIAK ARCHIPELAGO, WINTER
96
89
11
Loons
5
100
Grebes
NONE
Tubenoses
963
80
12
(2)
7
Cormorants
131
17
23
60
Swans and Geese
3,208
15
11
21
(1)
52
Dabblers
4,465
(3)
8
91
Divers
16,975
6
5
89
Sea Ducks
207
5
(1)
3
91
Mergansers
164
9
41
(8)
3
6
23
10
Raptors
NONE
Cranes
1,343
22
3
(4)
9
9
19
31
Shorebirds
1,814
25
(6)
12
4
18
3
37
Jaegers and Gulls
NONE
Terns

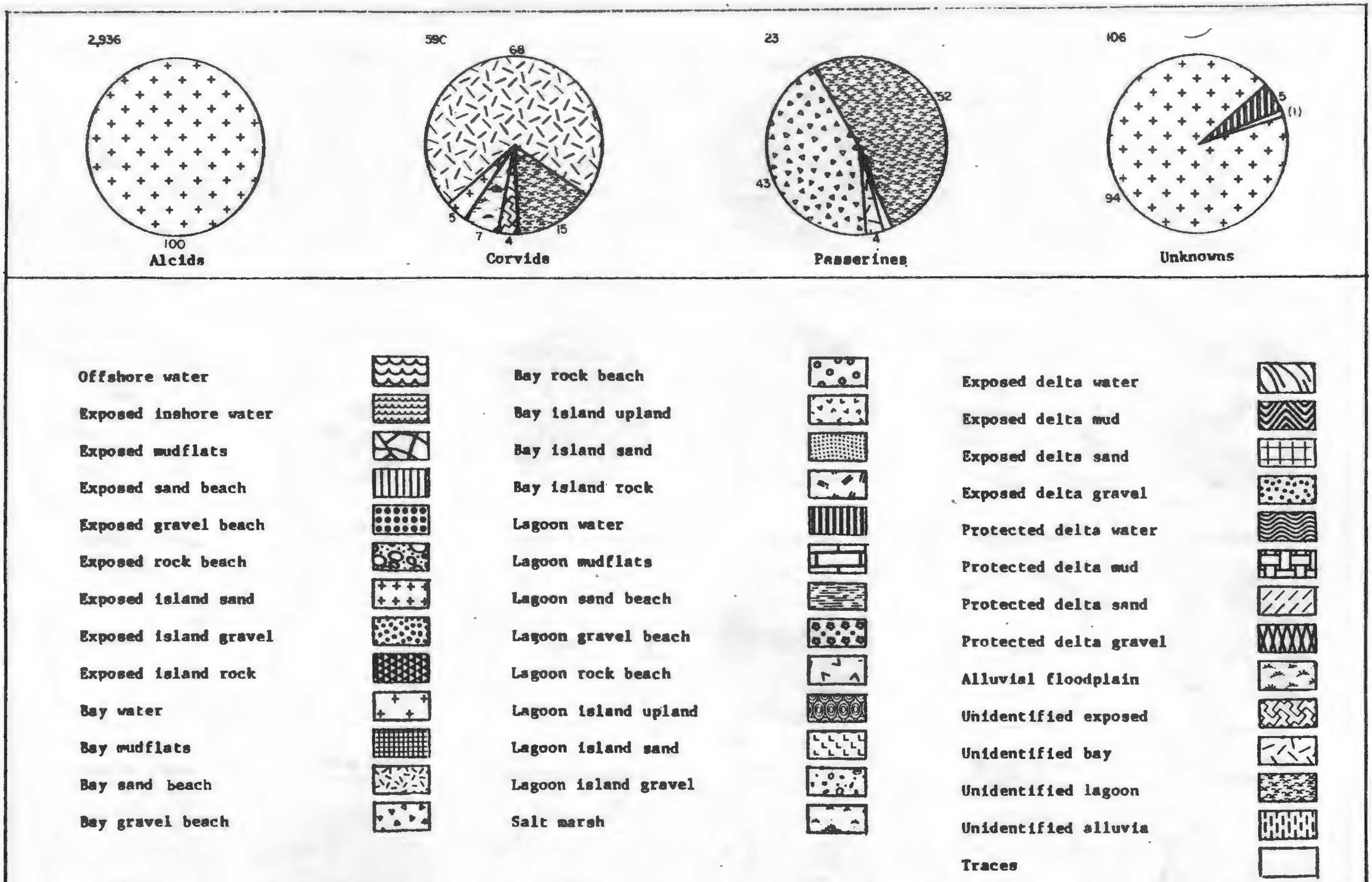
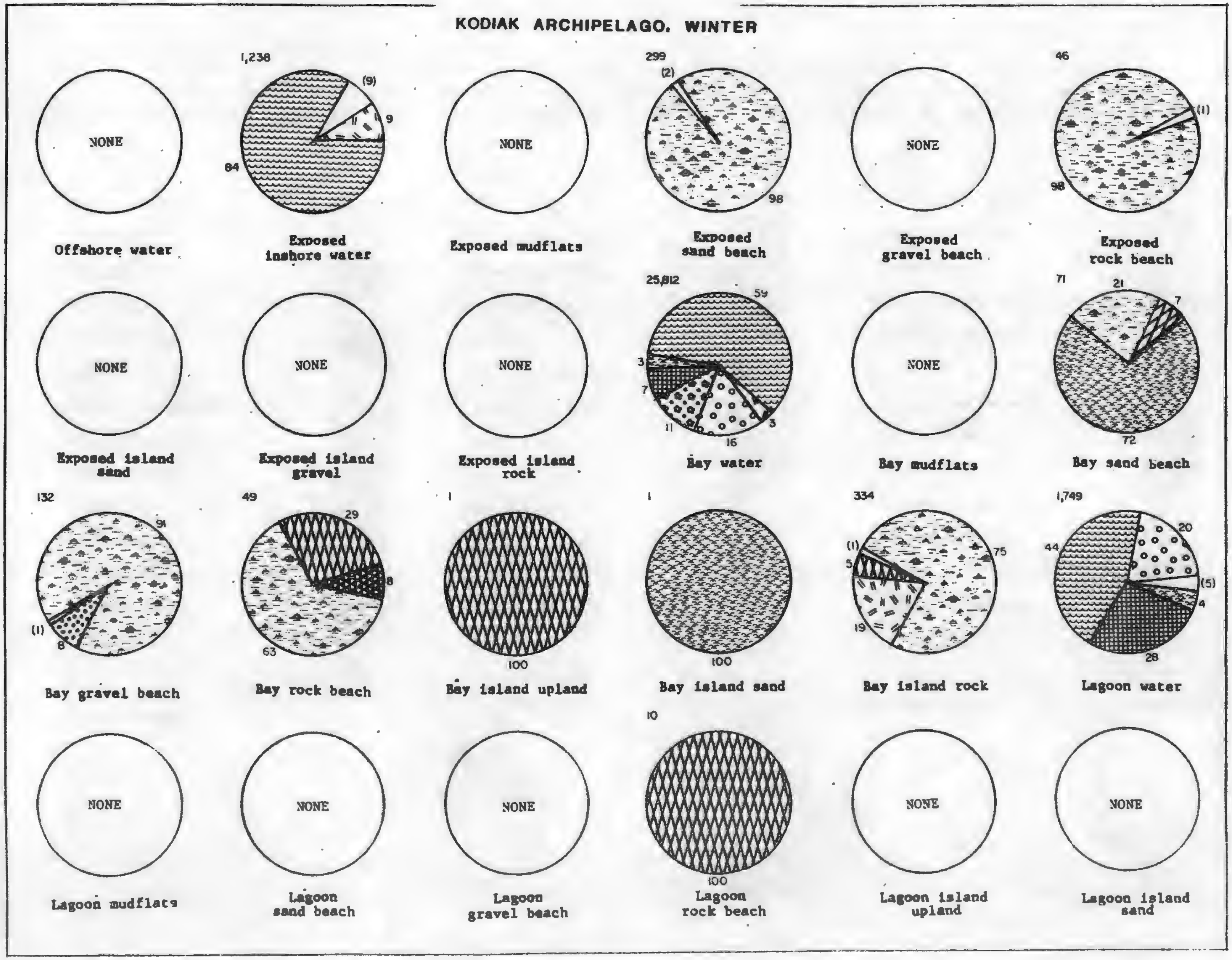


Fig. 53. Kodiak archipelago, Winter 1976. Habitat preference of marine birds as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.



KODIAK ARCHIPELAGO, WINTER
NONE
Offshore water
1,238
(9)
9
84
Exposed inshore water
NONE
Exposed mudflats
299
(2)
98
Exposed sand beach
NONE
Exposed gravel beach
46
(1)
98
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
25,812
59
3
7
11
16
3
Bay water
NONE
Bay mudflats
71
21
7
72
Bay sand beach
132
91
(1)
8
Bay gravel beach
49
29
8
63
Bay rock beach
1
100
Bay island upland
1
100
Bay island sand
334
(1)
5
75
19
Bay island rock
1,749
44
20
(5)
4
28
Lagoon water
NONE
Lagoon mudflats
NONE
Lagoon sand beach
NONE
Lagoon gravel beach
10
100
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

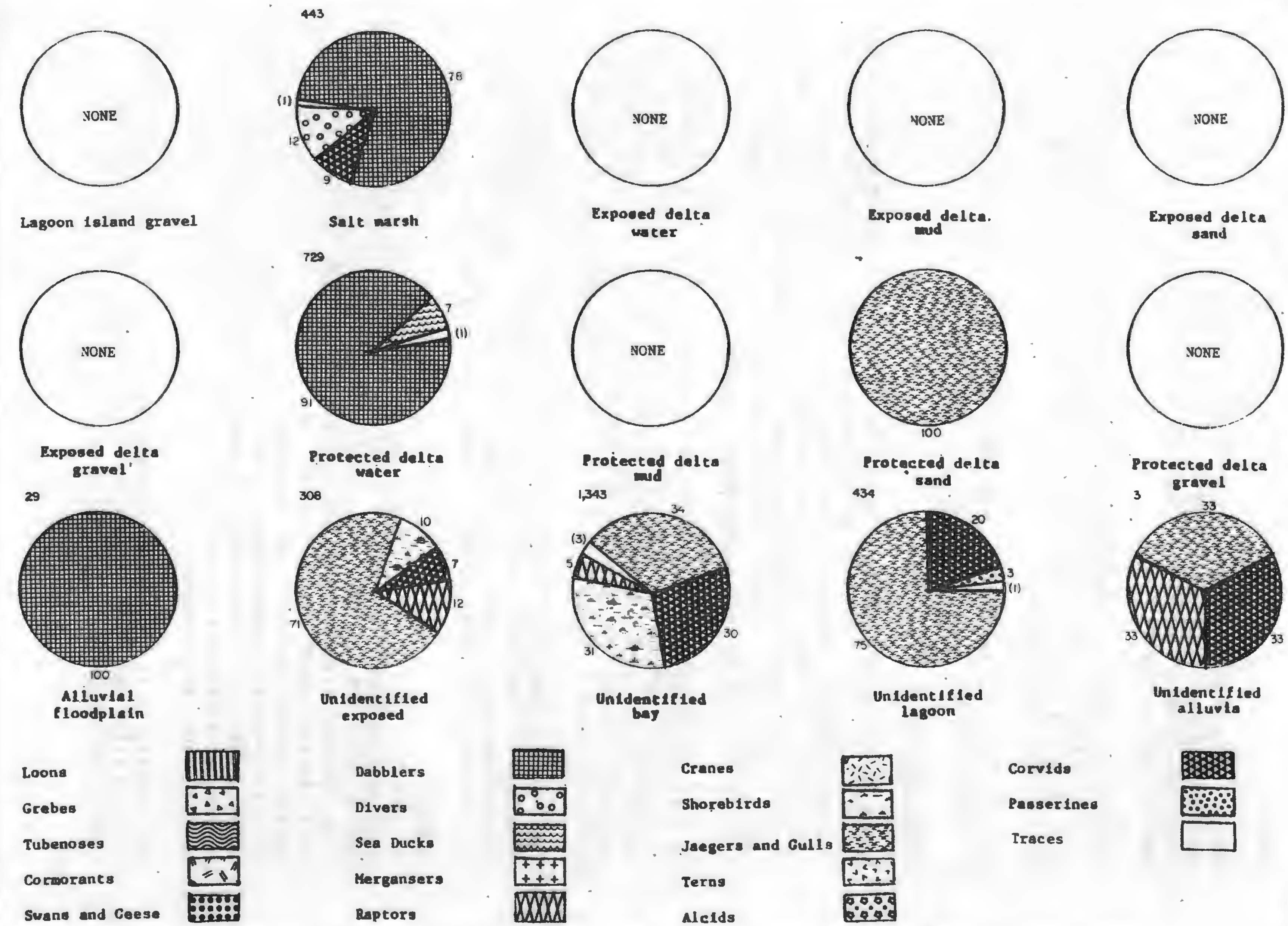


Fig. 54. Kodiak archipelago, Winter 1976. Marine bird usage of habitats as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Sixty-two percent of the gulls were recorded in protected bays and fjords either on water or on various coastal substrates. Another 22 percent were found on lagoon or embayment habitats. Only 13 percent used exposed coastal areas. Many gulls flock to the city of Kodiak in winter when crab processing is underway, but in this survey the Kodiak area was not surveyed.

Because corvids were frequently flying when observed, habitat types were often not recorded for them. Almost three-fourths of the corvids were associated with bay/fjord habitats, 15 percent with lagoons and 7 percent with salt marshes.

For the entire Kodiak survey, a minimum of 37 bird species were found on 16 habitat types.

LOWER COOK INLET

Survey data are more complete for Lower Cook Inlet than for other regions in the study area. In 1976, in conjunction with the Marine and Coastal Habitat Management Section, Alaska Department of Fish and Game, we conducted bird surveys in all four seasons. We flew the entire coastline in each survey and also conducted eight pelagic transects (Fig. 55). In addition, we flew a pelagic survey of Kamishak and outer Kachemak Bays in conjunction with an ADFG marine mammal survey team.

In 1978, field studies were confined to the Lower Cook Inlet region and we completed four spring coastal, one summer coastal, one fall coastal/pelagic and two winter coastal/pelagic surveys (Figs. 56 and 57). These surveys, combined with past information, provide a suitable data base for predicting potential impacts to birds by oil or other development in the region.

The coastline was subdivided into 17 physiographic sections for logical depiction of bird densities (Fig. 58). To summarize bird densities in offshore waters, we used five regions which were termed "natural regions" in the Lower Cook Inlet OCSEAP Synthesis Report (Fig. 58).

SPRING

Shoreline Density - Bird densities by shoreline section for total birds and for each species group are depicted in Figs. 59-76. Lower Cook Inlet had the highest overall bird density in spring when 192 birds/km^2 were recorded along the coast (Table 7). Over 50 percent of the birds were shorebirds and gulls at densities of 53 and 52 birds/km^2, respectively. The five waterfowl groups made up most of the remainder: 38 sea ducks/km^2, 23 divers/km^2, 15 dabblers/km^2, 7 geese/km^2, and 1 merganser/km^2. Except for alcids with 1 bird/km^2, no other bird groups were found in anything but trace amounts.

Section 15, on the south side of Kamishak Bay, had the highest combined density (417 birds/km^2) in spring. This section also contained the highest densities of shorebirds (216 birds/km^2) and sea ducks (117

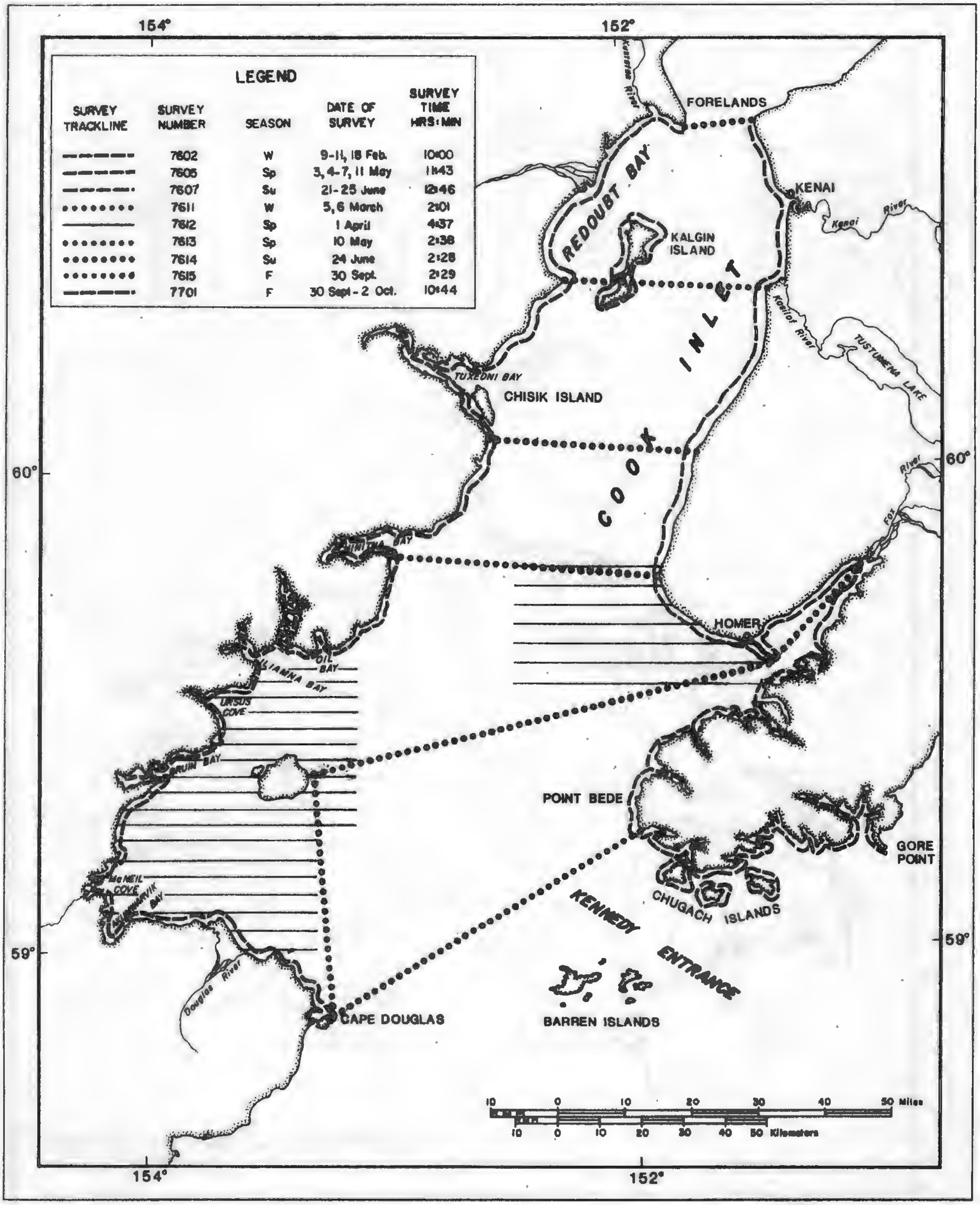


Fig. 55. Tracklines of aerial bird surveys in Lower Cook Inlet, 1976.

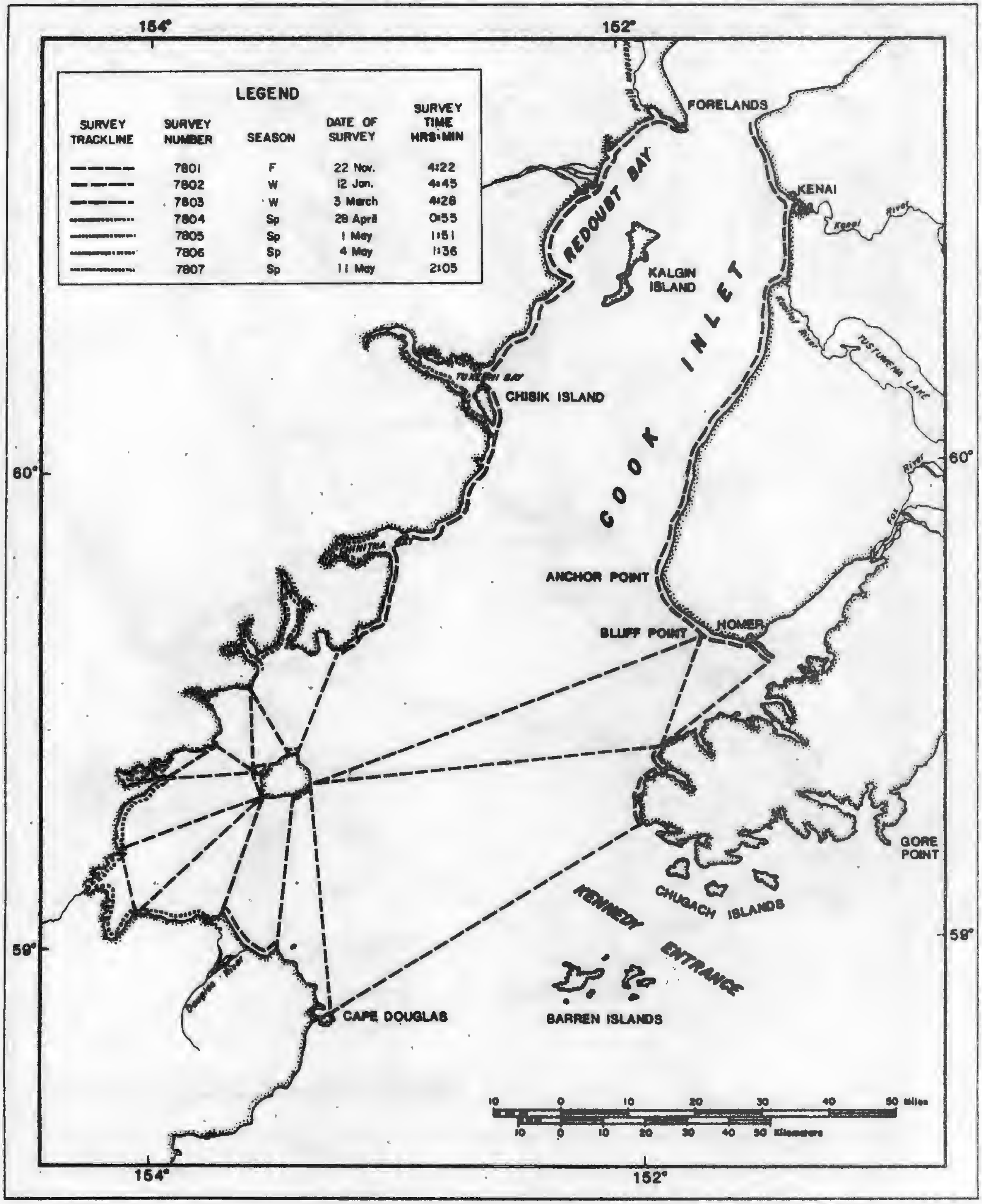


Fig. 56. Tracklines of aerial bird surveys in Lower Cook Inlet, 1977-1978.

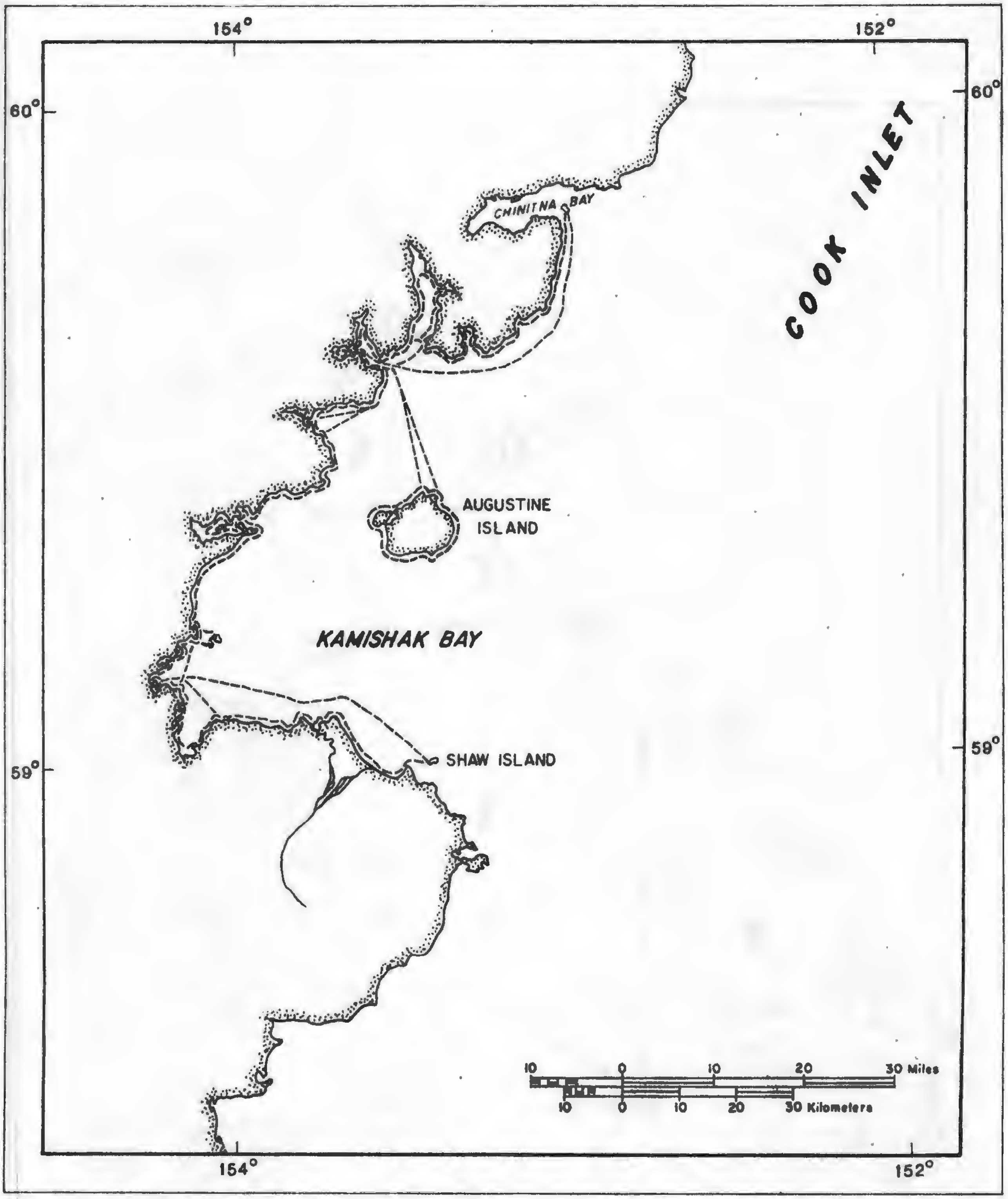


Fig. 57. Trackline of boat survey for birds in Kamishak Bay, Summer 1978. This was survey number 7808 conducted from 7 June to 16 August; total time of survey was 69 hours, 46 minutes.

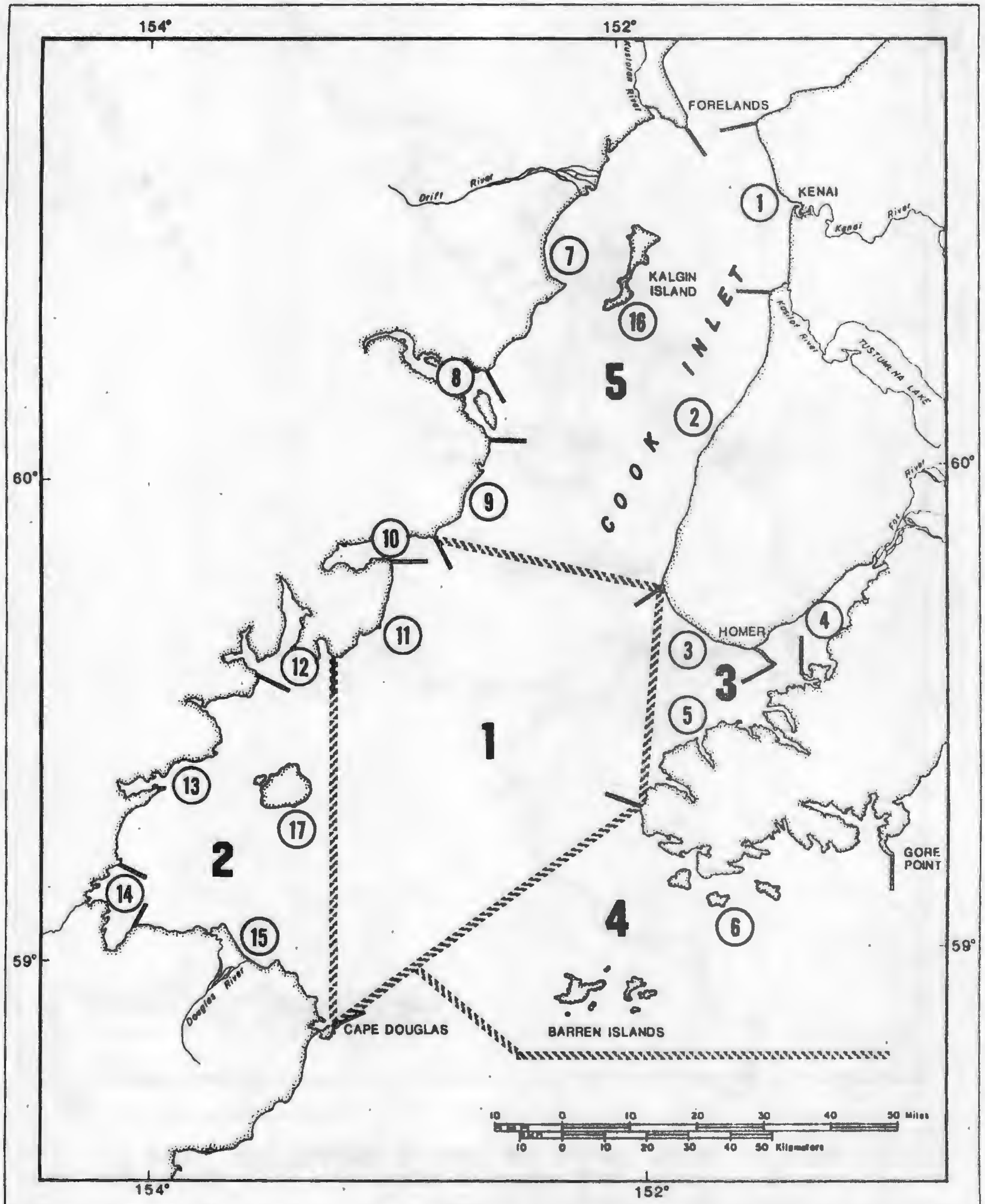


Fig. 58. Physiographic subdivision of Lower Cook Inlet for bird density analysis. Circled numbers 1-17 designate coastal survey sections, each containing several stations. Pelagic surveys were analysed within regions designated by bold numbers 1-5 and bounded by stippled lines.

Table 7. Bird density by section of coastline in Lower Cook Inlet, spring 1976, 1978. See Figure 58 for section boundaries. (T=trace).

	Spring Densities (birds/km^2)																	
	Section of Coastline																	
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Loon	T	T	1	T	T	T	T	T	T	T		T	T	T	T			T
Grebe	T	T	T	T	T	T		T		T			T	T	T	T		T
Tubenose																		0
Cormorant	T	T	1	T	2	5	T	1	T	T	1	T	3	1	1		4	T
Goose and Swan	54	1		14		T	58	T	1	1		T	2	1	12	40		7
Dabbler	39			9	1	3	40	18	3	24		9	17	13	12	84		15
Diver	3	1		49	4	4	6	50		25		36	24	27	17	4		23
Sea Duck	T	101	33	76	40	5	2	22	3	8	21	29	54	53	117	6	16	38
Merganser	T	T	T	5	2	1	T	T		2	T	T	1	1	1			1
Raptor	T			T	T	T	T	T	T	T		T	T	T	T			T
Crane	6	T										T			T	2		T
Shorebird	4			71	5	1	91	39		76		111	10	17	216	1		53
Gull and Jaeger	49	12	12	33	19	18	14	201	42	19	1	19	55	59	37	16	2	52
Tern							T											T
Alcid		1	4	1	2		T	T				T	T	T	3			1
Corvid				1	T	T		T		T		T	T	T	T			T
Other Passerine												T	T					T
Other Bird	1	4		3	1	2	2	1		T		T	T		T	T		1
TOTAL	156	120	51	262	78	39	210	332	50	155	24	206	166	173	417	151	21	192

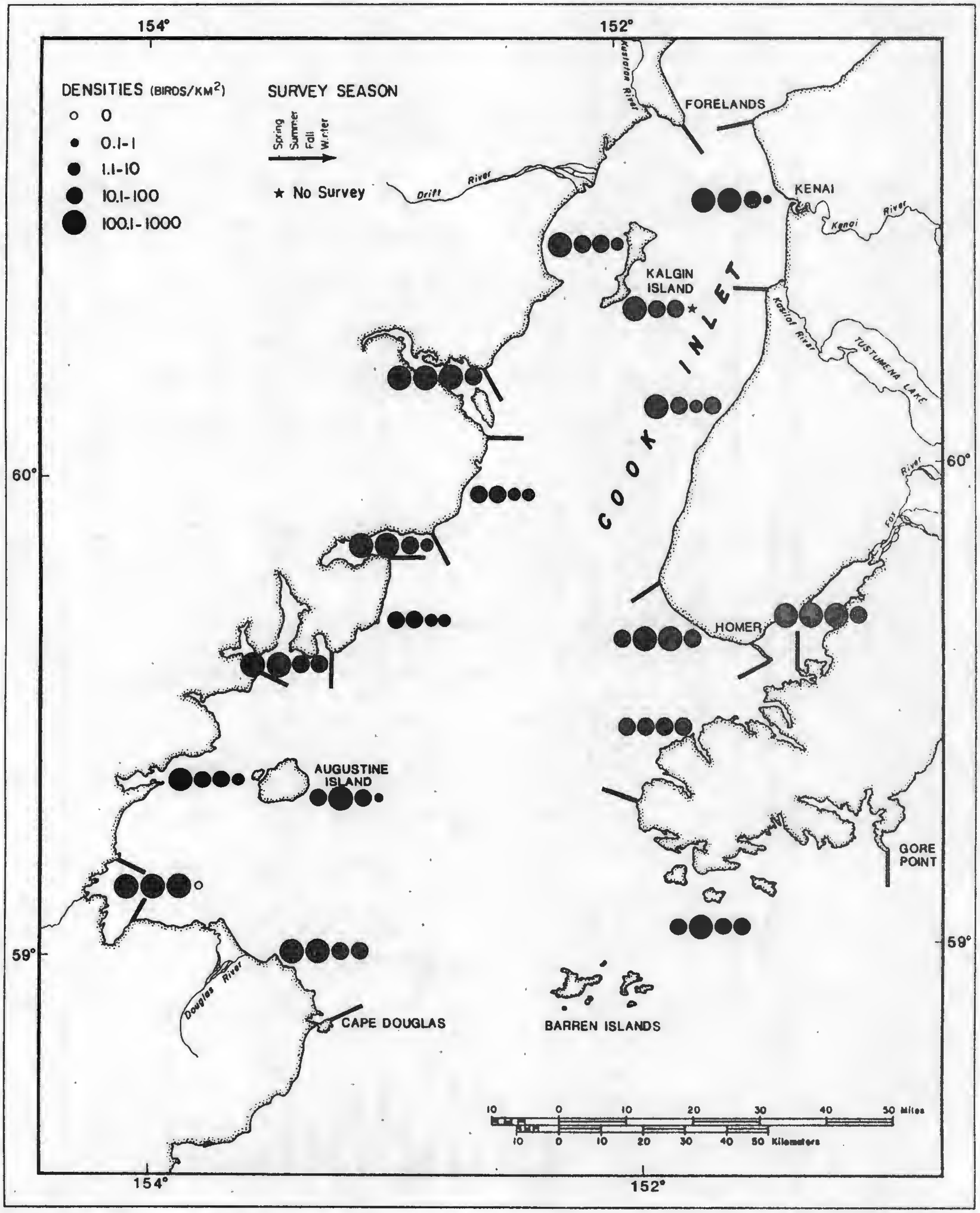


Fig. 59. Total bird density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

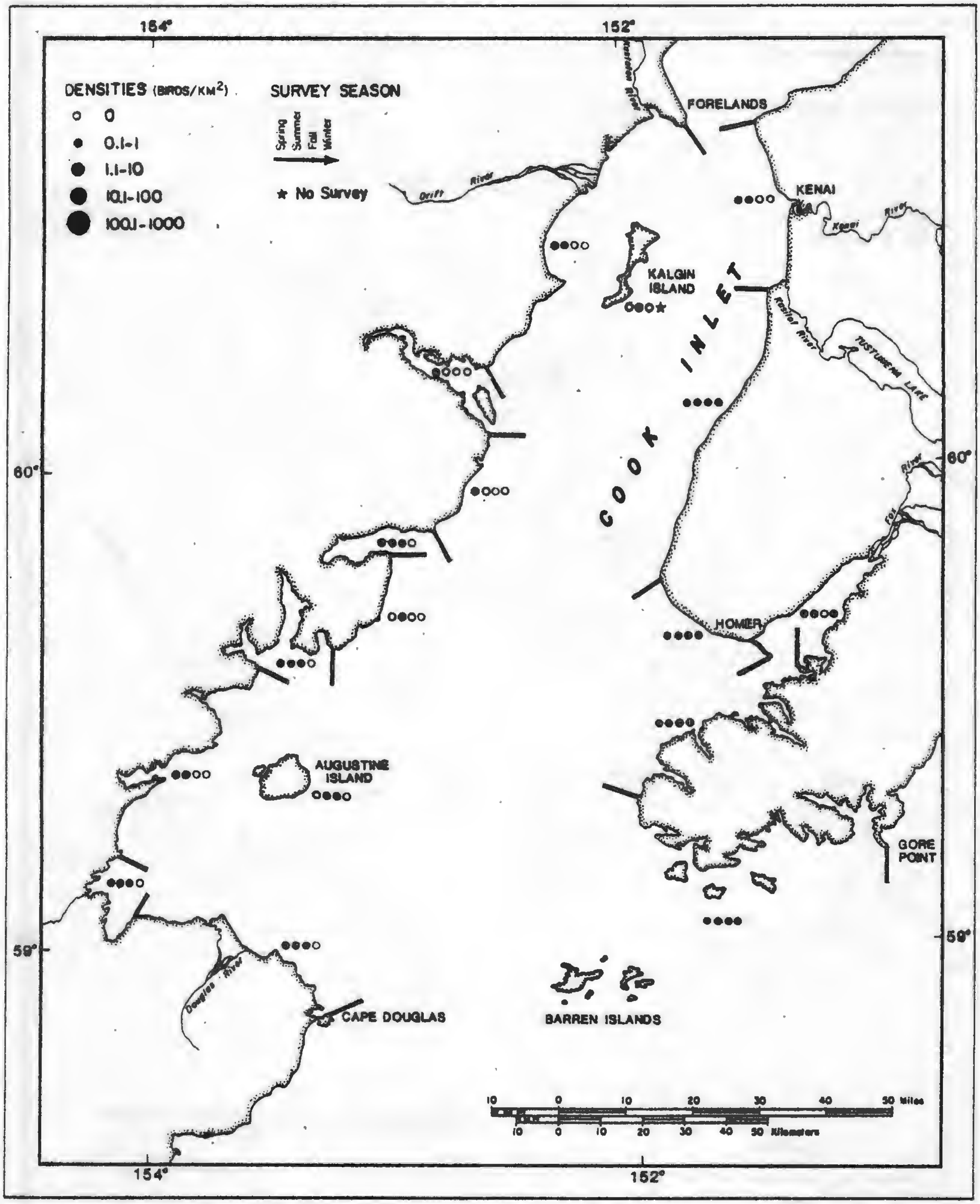


Fig. 60. Loon density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

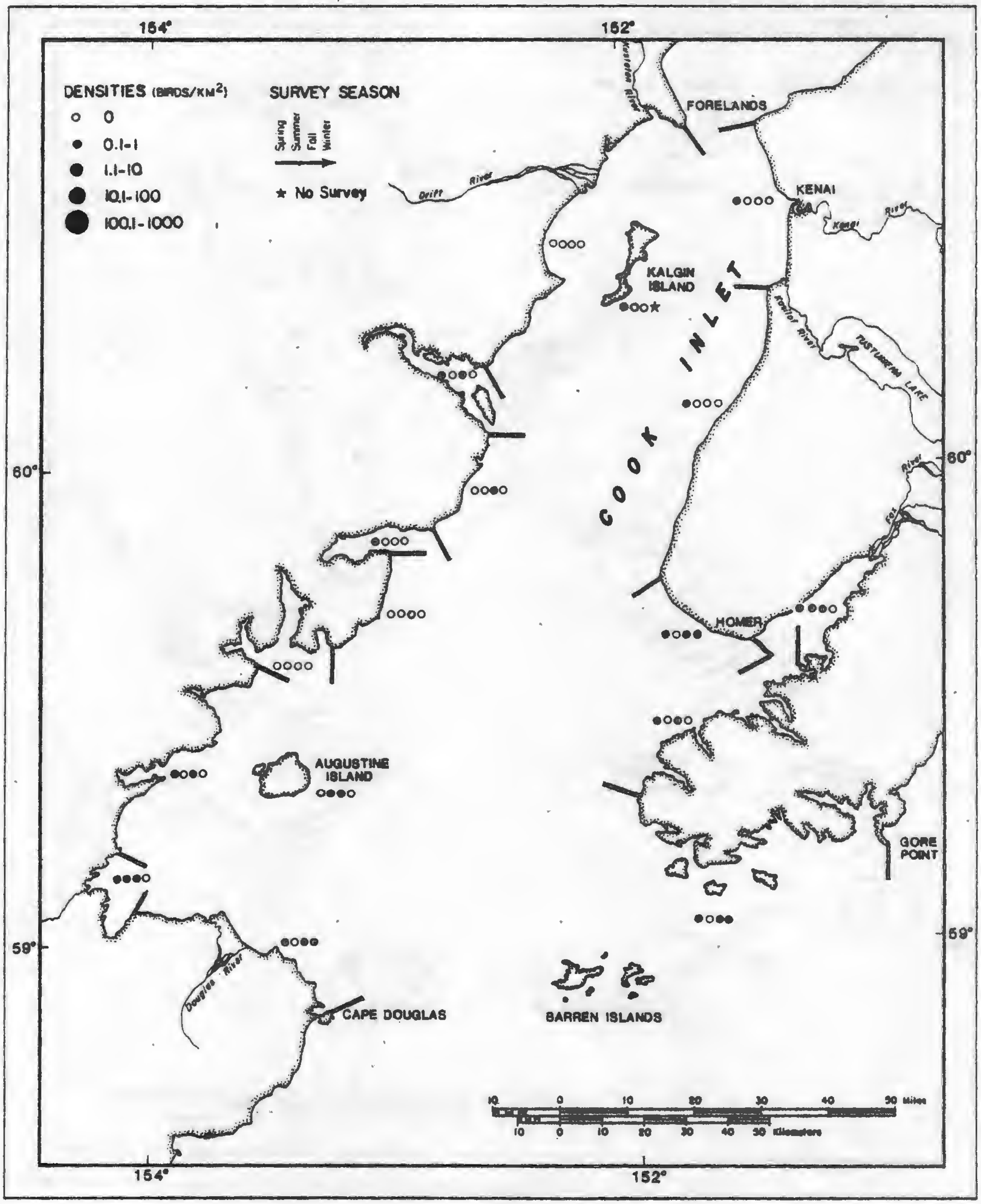


Fig. 61. Grebe density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

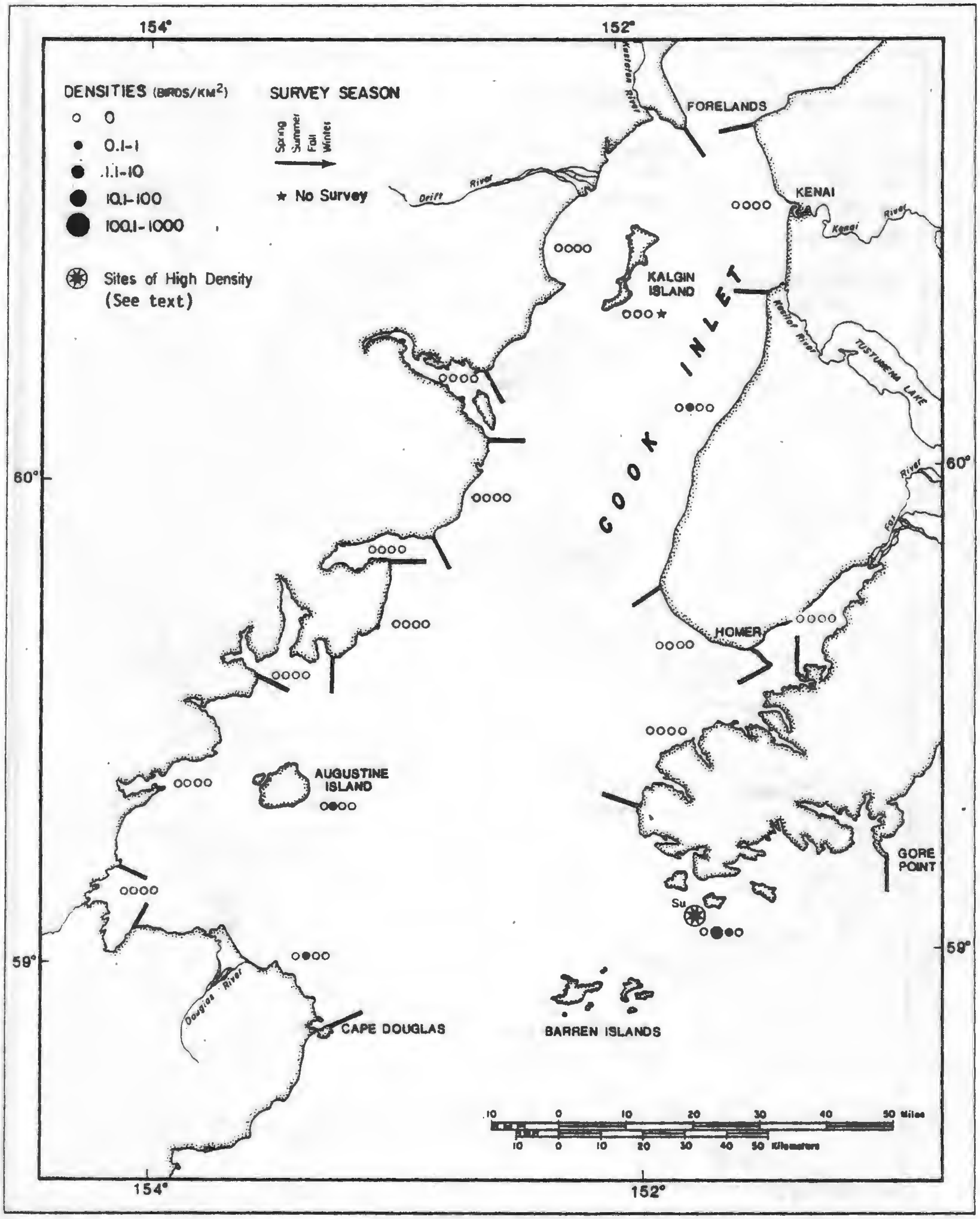


Fig. 62. Tubenose density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

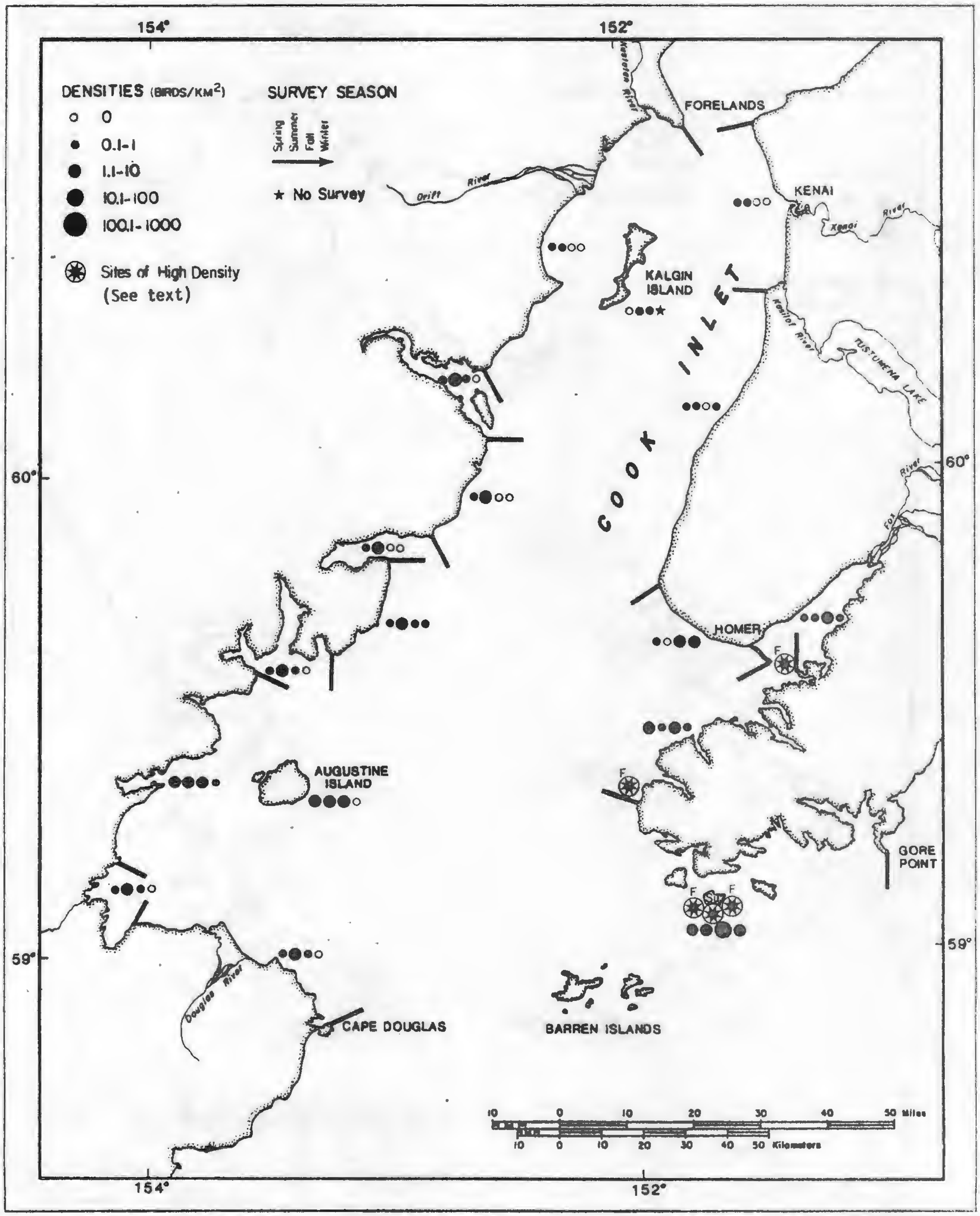


Fig. 63. Cormorant density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

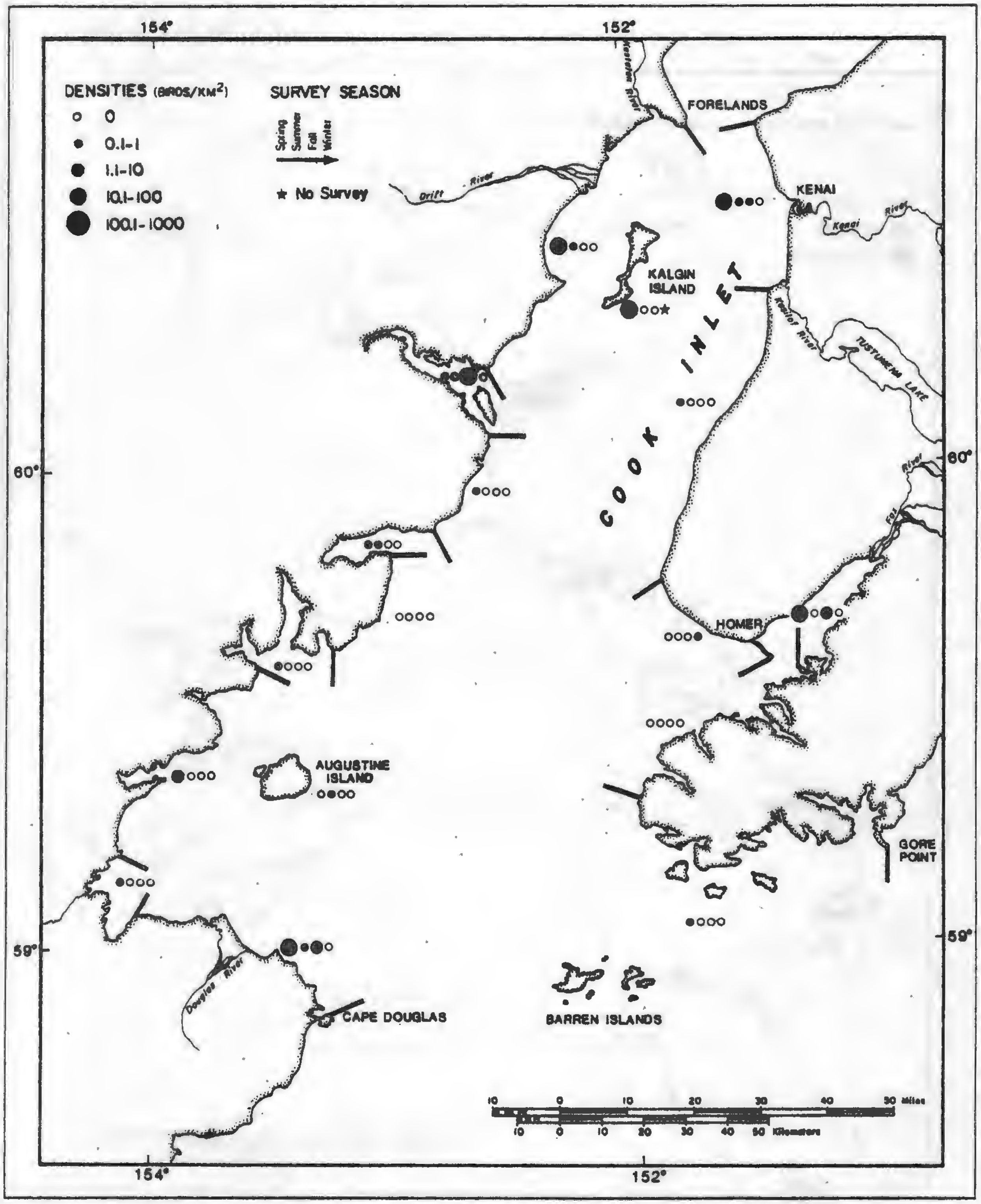


Fig. 64. Goose and swan density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

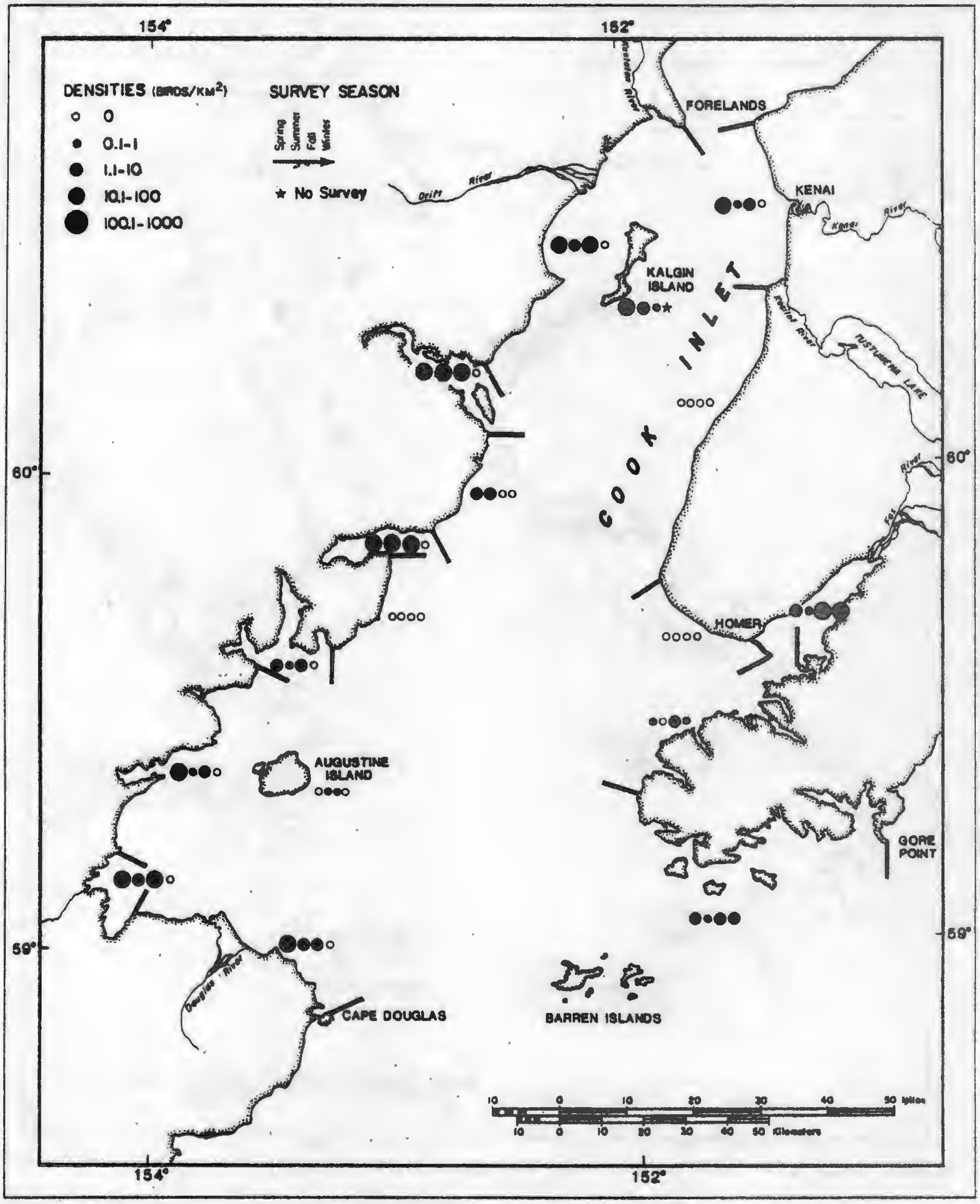


Fig. 65. Dabbling duck density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

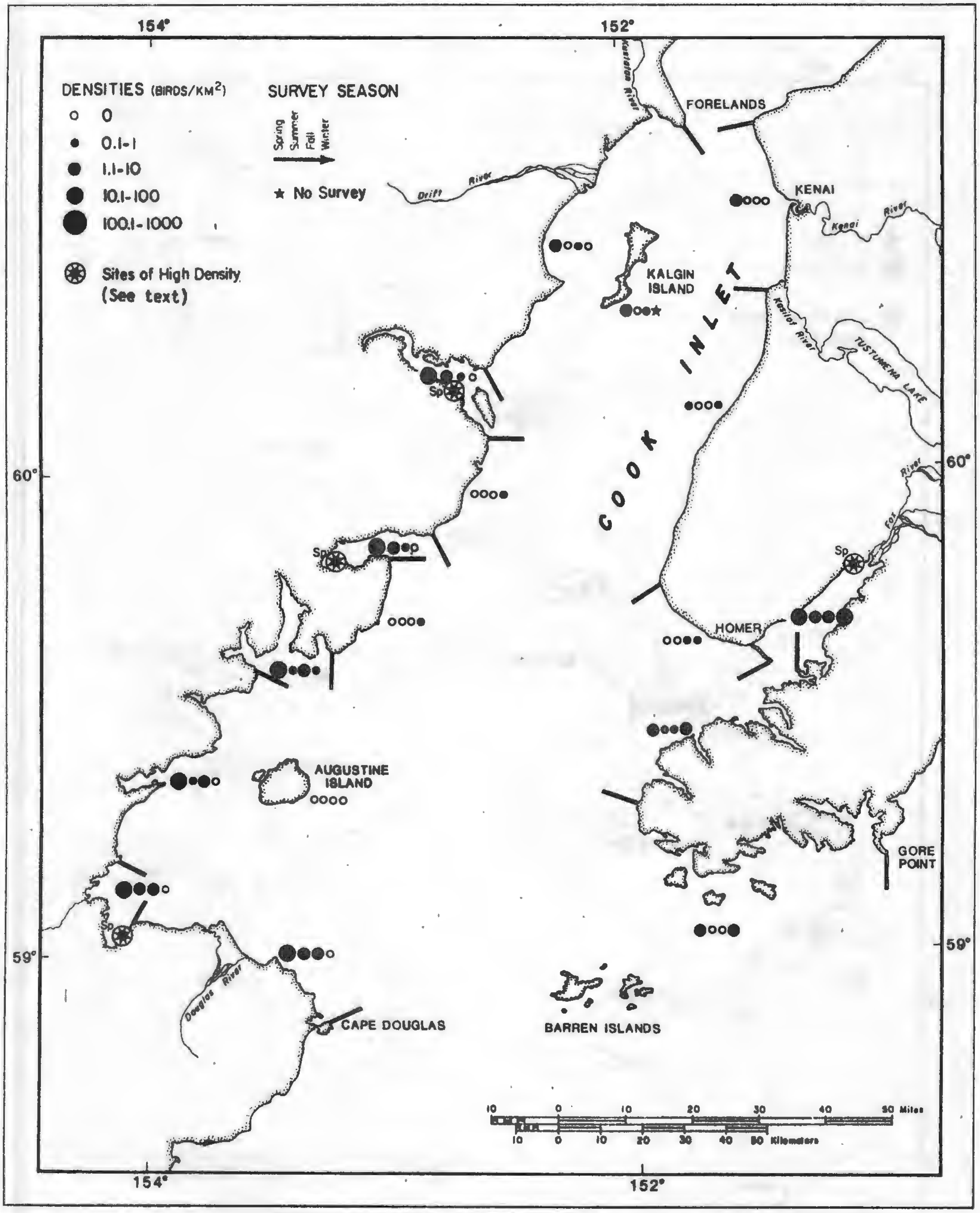


Fig. 66. Diving duck density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

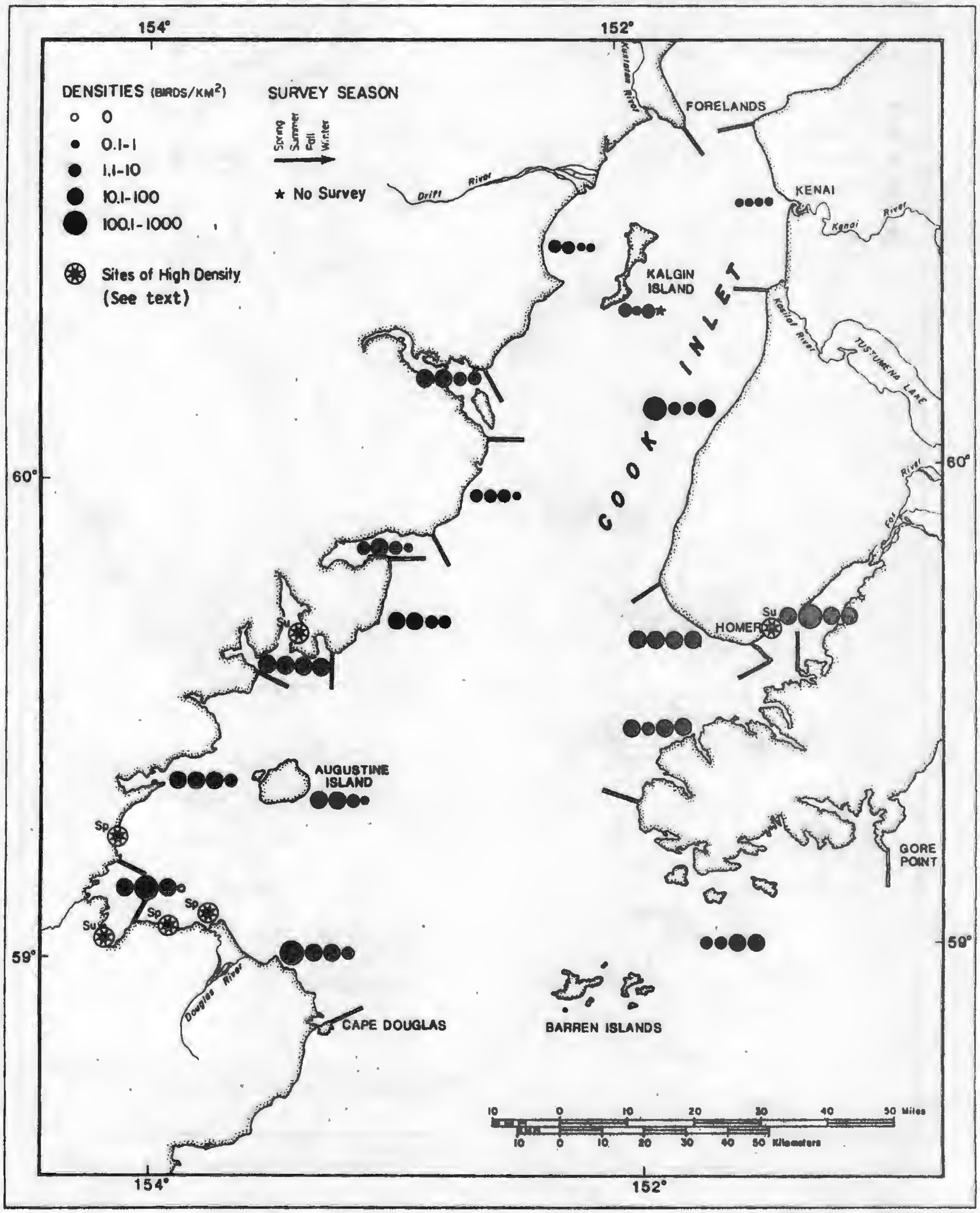


Fig. 67. Sea duck density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

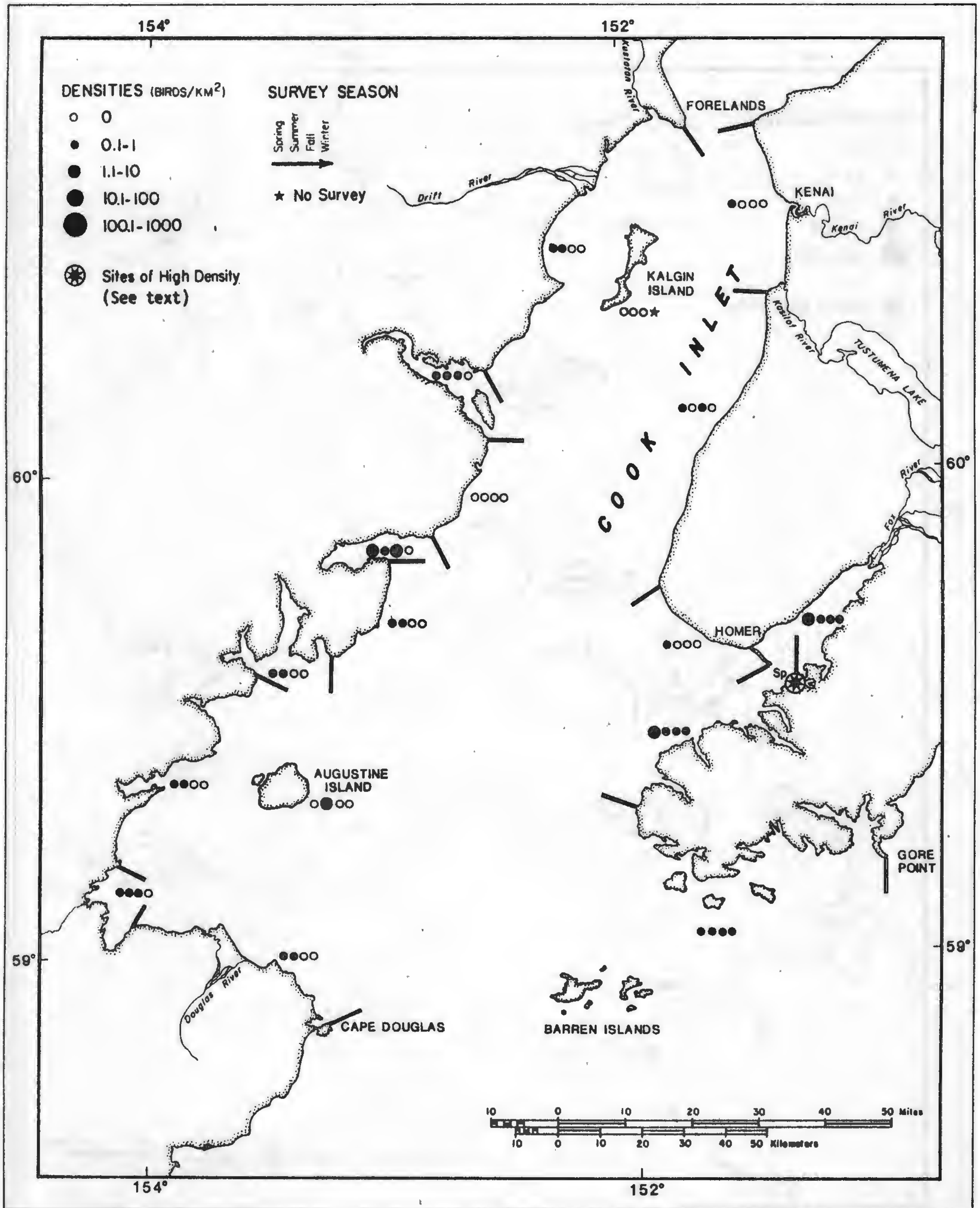


Fig. 68. Merganser density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

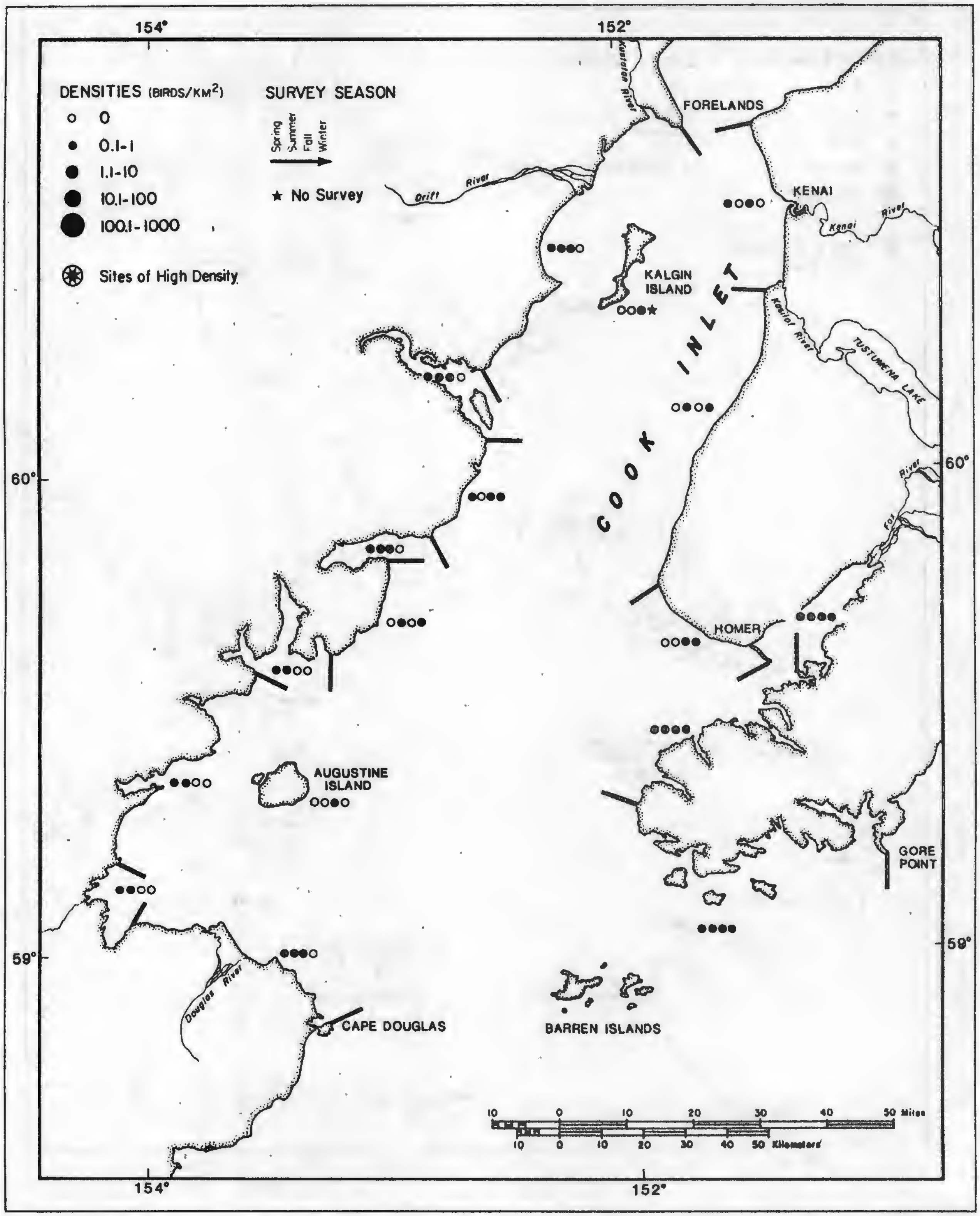


Fig. 69. Raptor density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

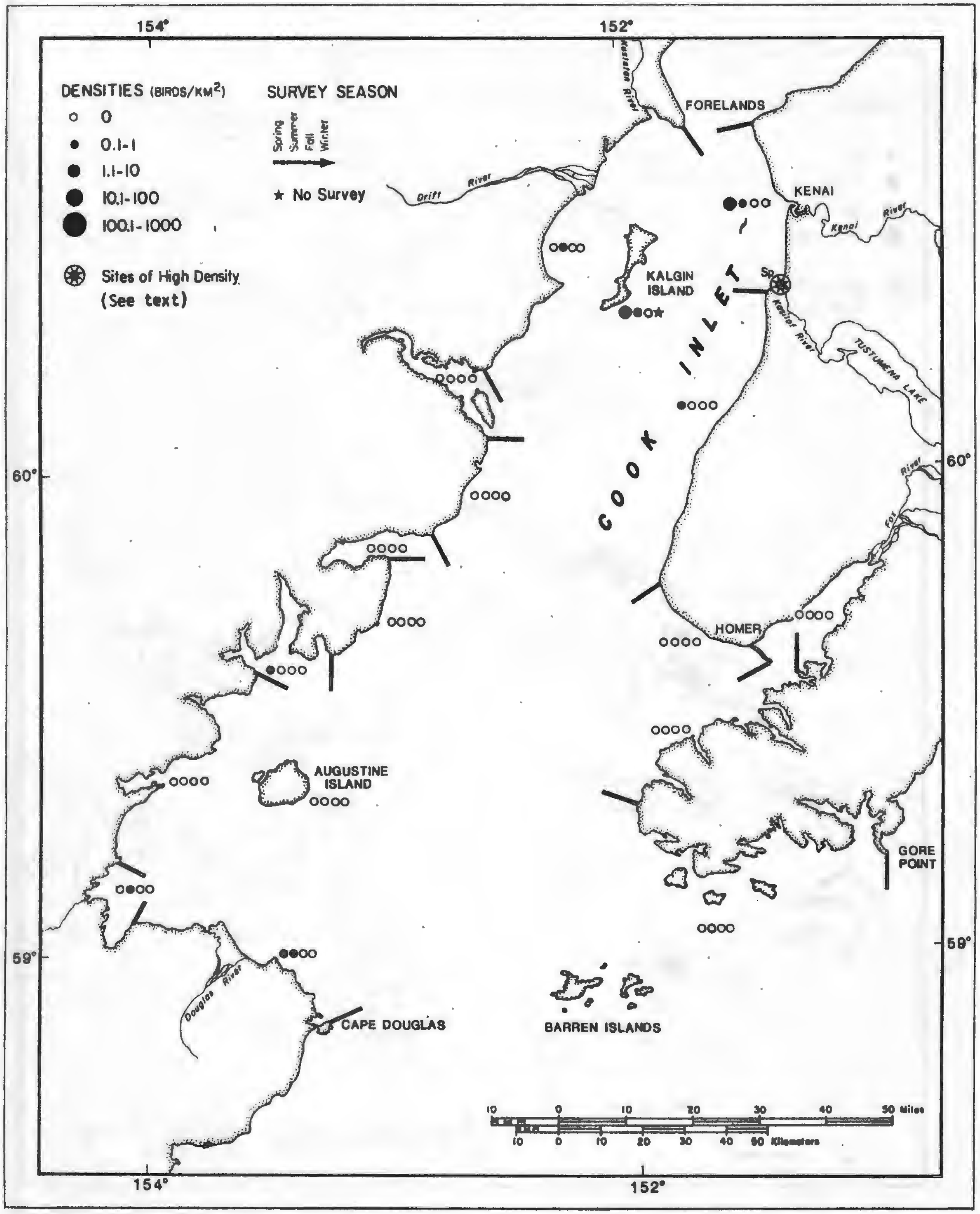


Fig. 70. Crane density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

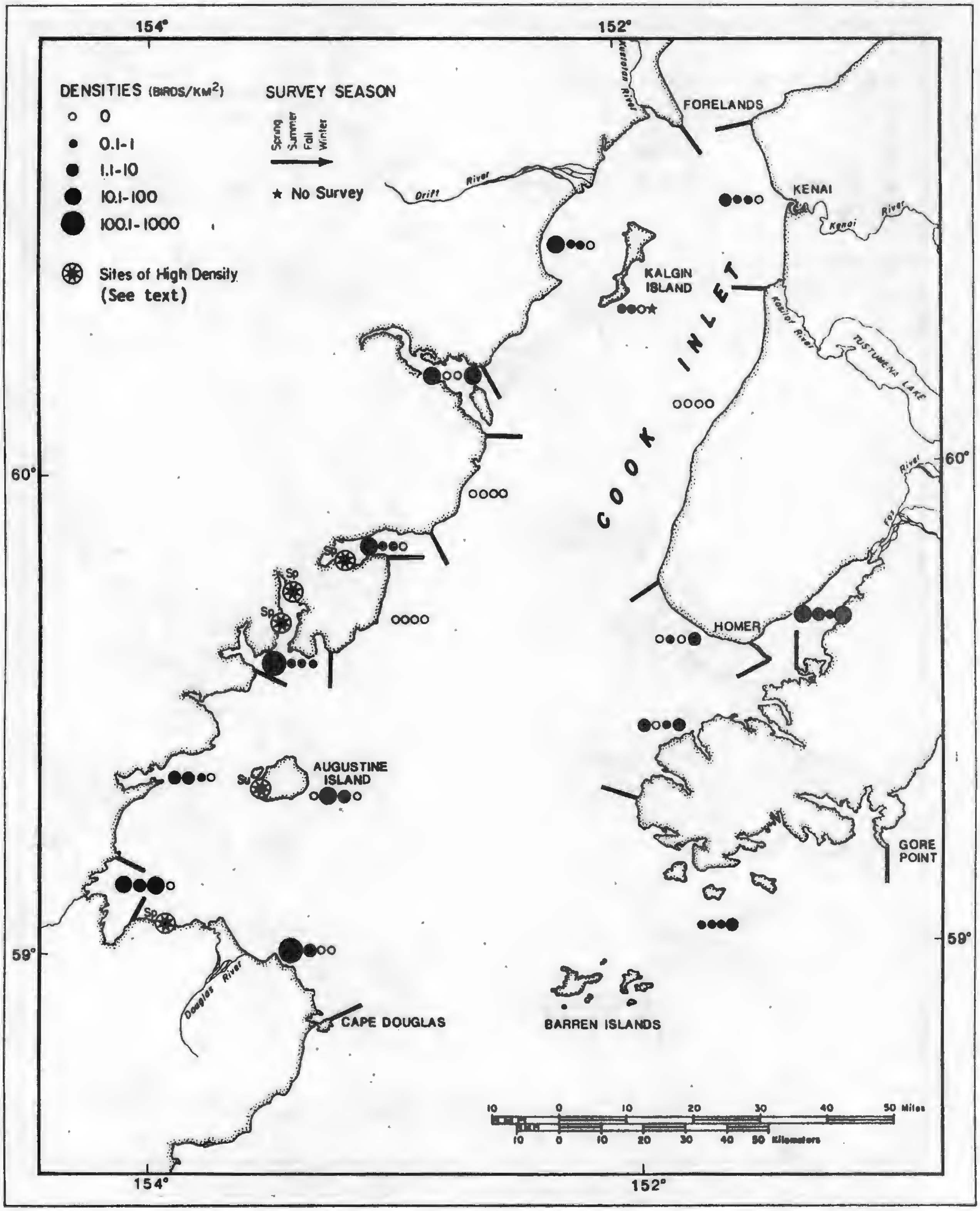


Fig. 71. Shorebird density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

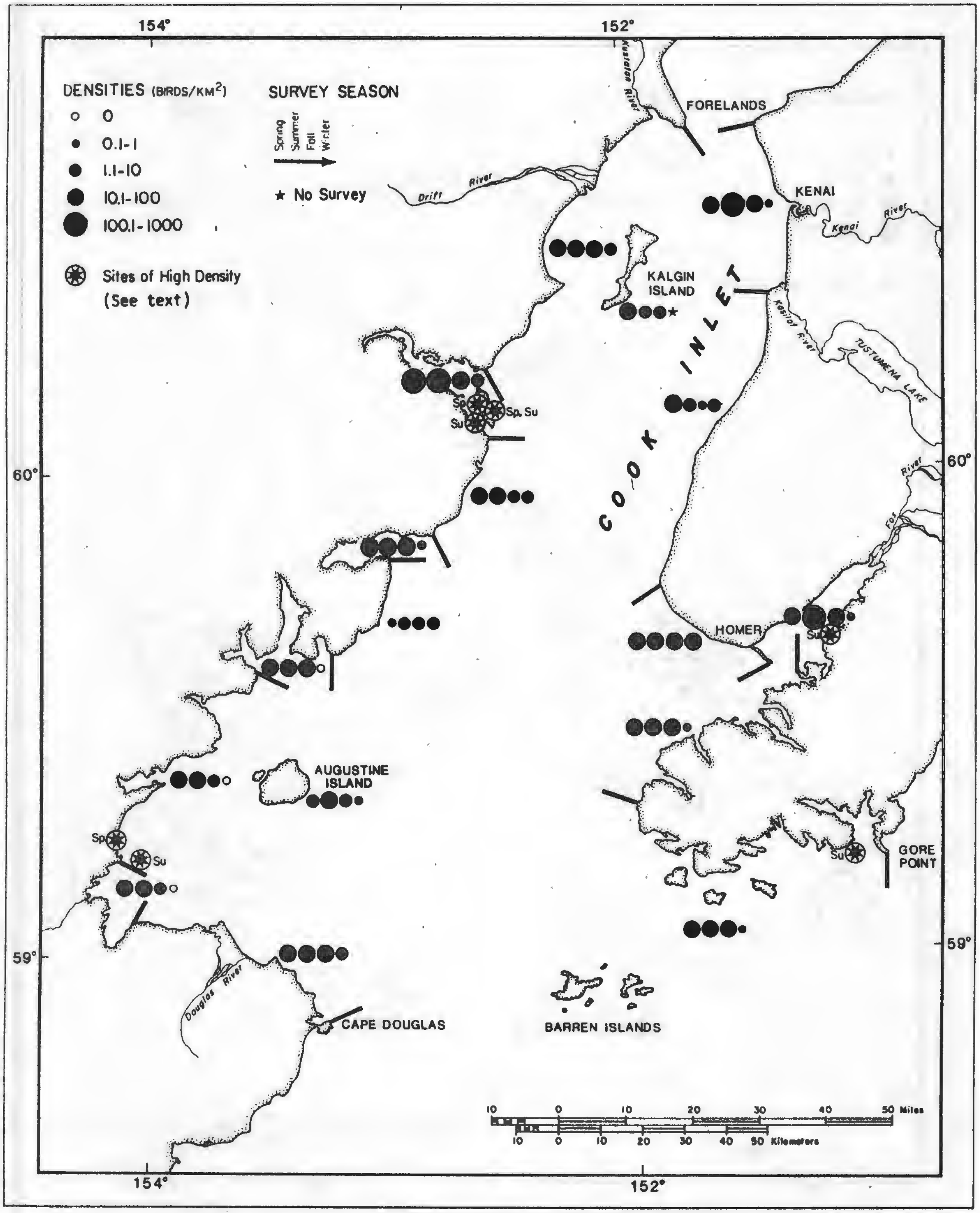


Fig. 72. Gull and jaeger density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

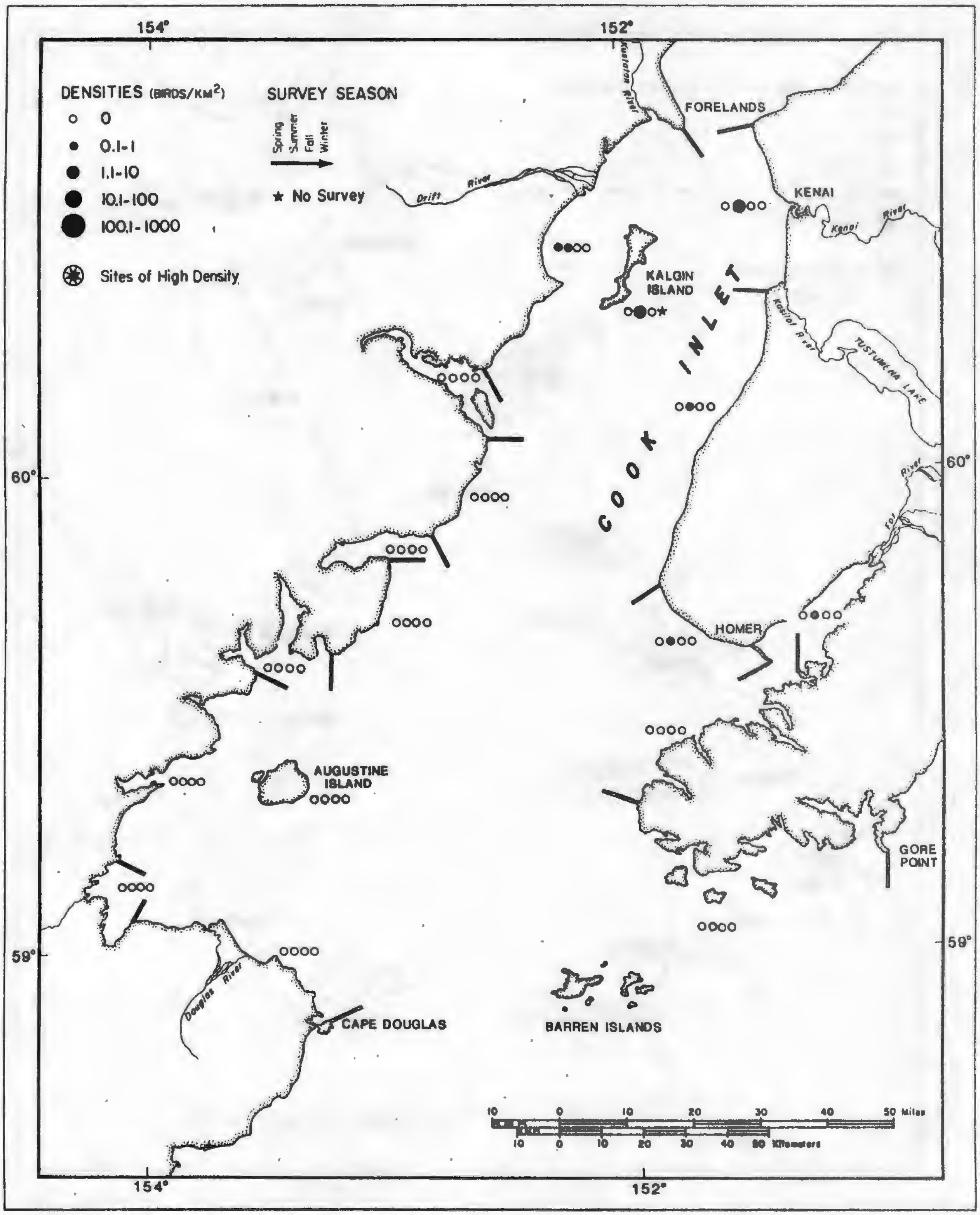


Fig. 73. Tern density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

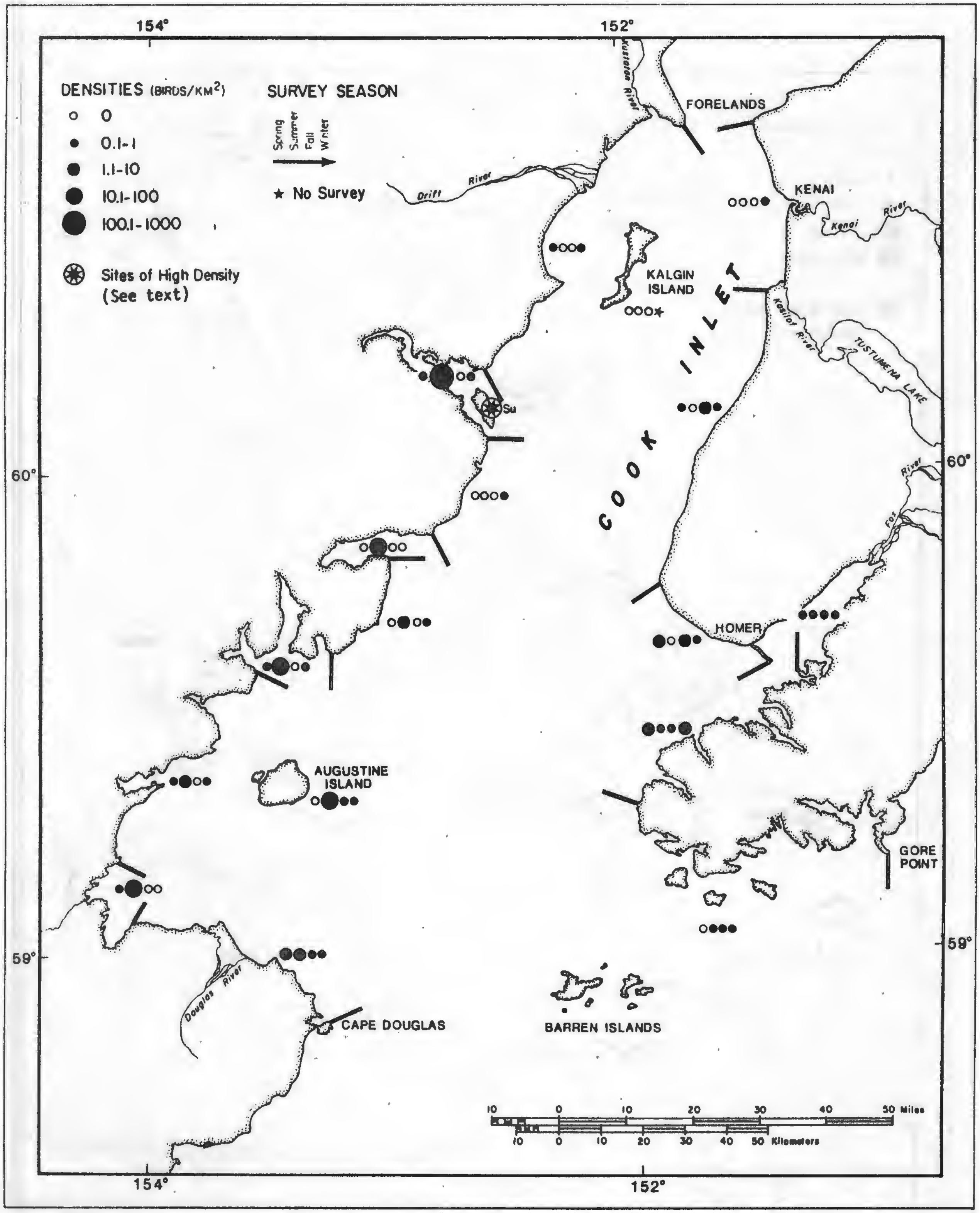


Fig. 74. Alcid density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

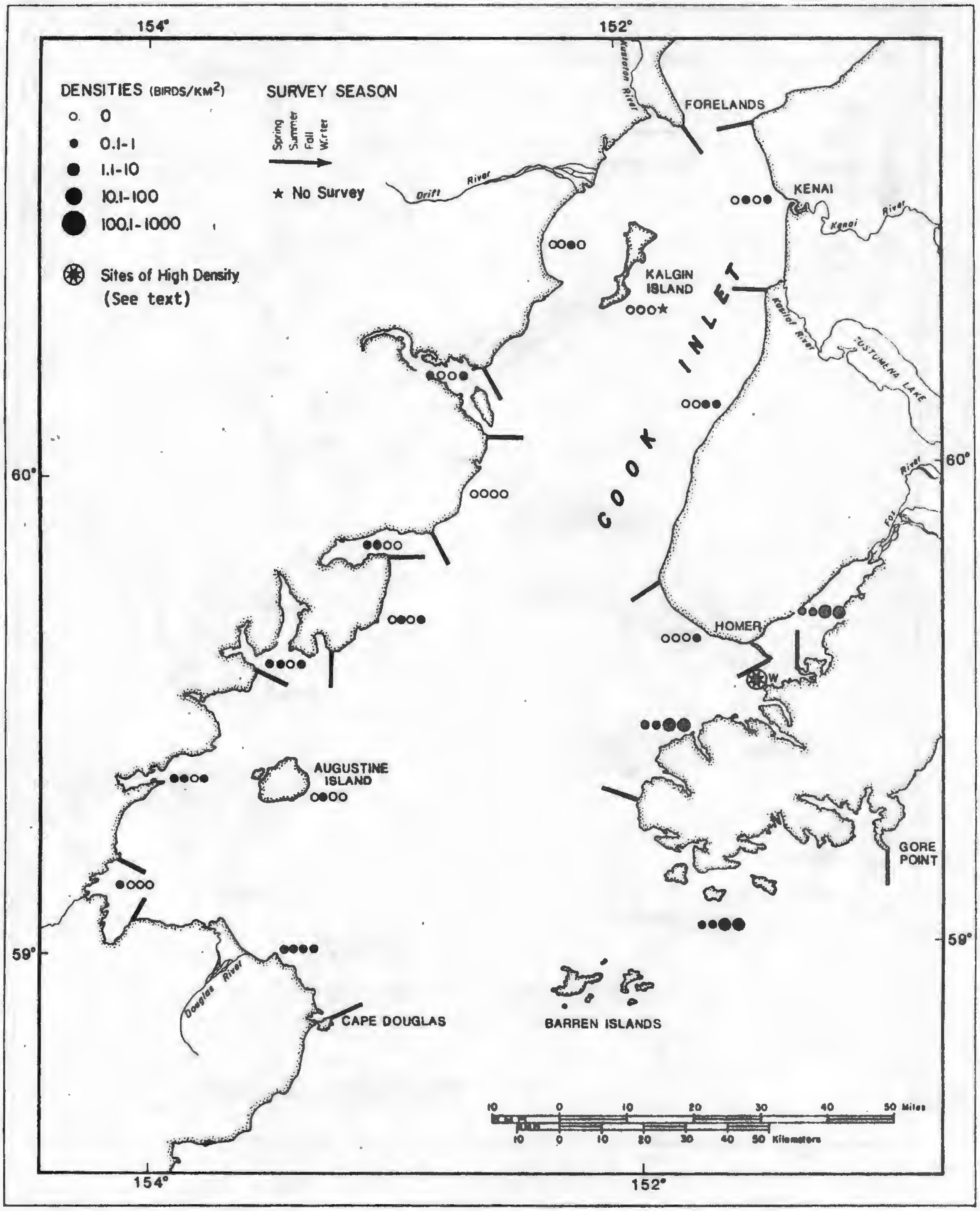


Fig. 75. Corvid density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

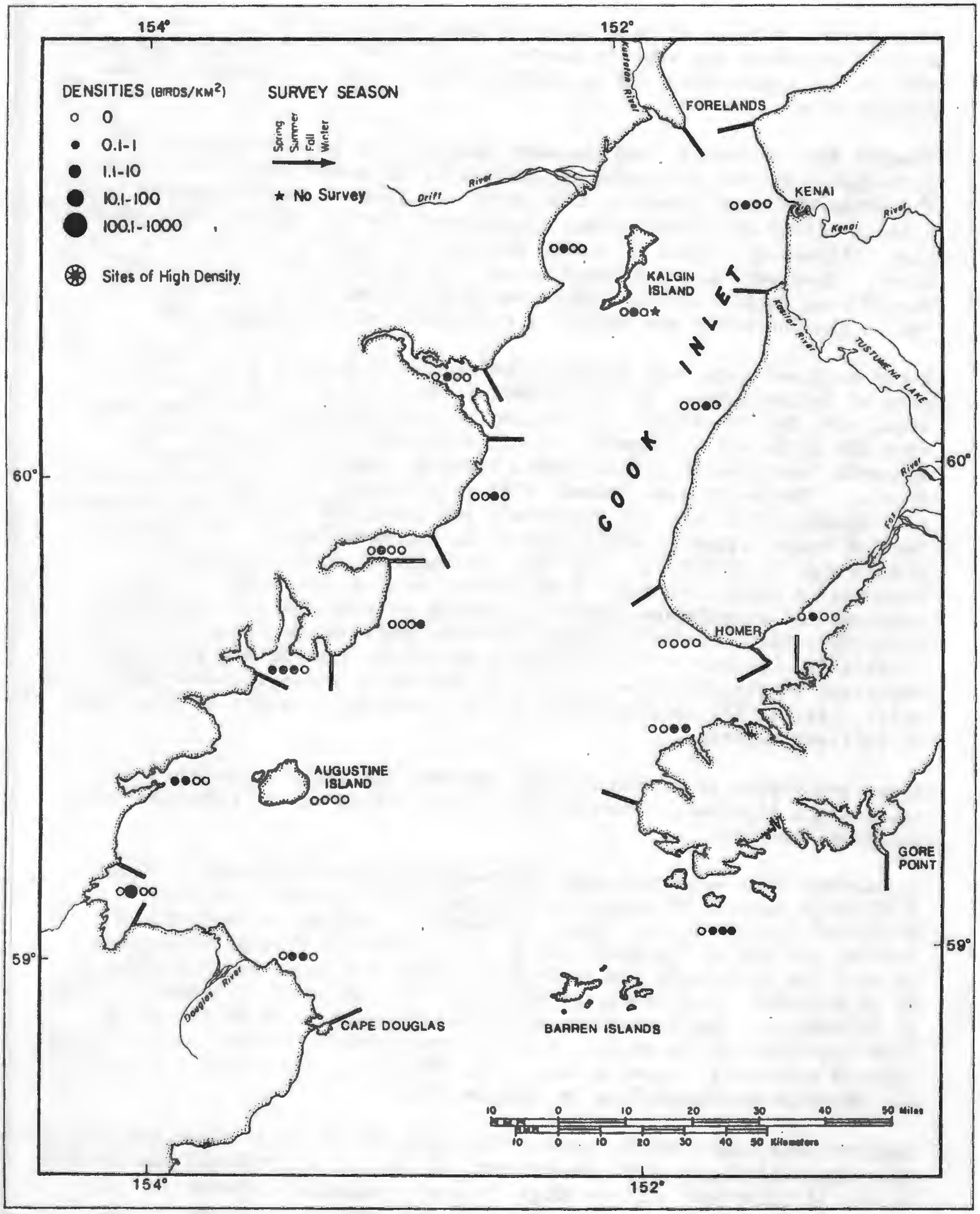


Fig. 76. Passerine (other than corvid) density by coastal survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

birds/km^2). A flock of over 10,000 shorebirds staged at the mouth of an unnamed stream on the western portion of Section 15. Sea ducks (largely scoters) in large rafts fed in shallow waters west of the mouth of the Douglas River.

Tuxedni Bay, Section 8, had the next densest bird populations at 332 birds/km^2. Highest densities of gulls (201 birds/km^2) and diving ducks (50 birds/km^2) were found in this section. Black-legged Kittiwakes from a large colony on Chisik Island contributed most to the high gull density. Many kittiwakes roosted on nearby mudflats and beaches or rafted on the water. They were counted there rather than on the colony site itself. Most diving ducks observed were scaup which lined the waters' edge and fed in shallow water over mudflats throughout most of Tuxedni Bay.

Other sections with over 200 birds/km^2 included Section 4, the inner part of Kachemak Bay with 262 birds/km^2; Section 7, the Redoubt Bay area, with 210 birds/km^2; and Section 12, the Iniskin-Iliamna Bay area with 206 birds/km^2. Kachemak Bay had a variety of bird groups with moderate densities that when summed together gave the high overall density. Sea ducks were densest with 76 birds/km^2 followed by shorebirds (71 birds/km^2), divers (49 birds/km^2) and gulls (33 birds/km^2). Mergansers reached their highest overall density in Kachemak Bay (95 birds/km^2) as did corvids (1 bird/km^2). The large concentration of mergansers was observed in China Poot Bay. Redoubt Bay, with a combination of delta mudflats and sedge/grass meadows, provided suitable habitat for staging shorebirds (91 birds/km^2), geese (58 birds/km^2) and dabbling ducks (40 birds/km^2). Because of its extensive mudflats, Iniskin Bay is another important staging area for shorebirds and diving ducks in Lower Cook Inlet. It had 11 shorebirds/km^2 and 36 divers/km^2 feeding on intertidal or subtidal habitats.

Loons and Grebes were seen in most sections but never in densities exceeding 1 bird/km^2. There were no spring sightings of tubenoses on nearshore surveys.

Cormorants were never abundant but reached highest densities in Sections 6 (Chugach Islands vicinity) and 17 (Augustine Island) with 5 and 4 birds/km^2, respectively. Geese and dabblers were relatively abundant in Redoubt Bay and at the mouths of Kenai and Kasilof Rivers (54 geese and 39 dabbling ducks/km^2) and at Swamp Creek on Kalgin Island (40 geese and 84 ducks/km^2). High densities of divers were observed in Akumwarvik Bay of Section 14. The area north of Anchor Point to about Ninilchik had high densities of sea ducks. North of Ninilchik in Section 2, densities rapidly decreased. Also, a large raft of scoters and eiders (188 birds/km^2) was observed at Chenik Head in Section 13.

Raptors were scattered throughout the Inlet but never in dense concentrations. Most Sandhill Cranes were observed at the mouths of the Kenai and Kasilof Rivers (6 birds/km^2) and on Kalgin Island. Additional shorebird concentrations were noticed in Chinitna Bay where a large intertidal mudflat was located. High densities of gulls, not associated directly with colonies, were in Sections 13 and 14 on the western shore of Kamishak Bay where 55 and 59 gulls/km^2, respectively, were found. The largest concentration was at Chenik Head at the dividing line between the two sections where 777 gulls/km^2 were recorded. Few terns and alcids had arrived by the time of the spring surveys.

Pelagic Density - Bird densities in offshore waters of the five "natural" regions of Lower Cook Inlet are represented in Figs. 77-94. In offshore waters 15 birds/km^2 were observed in spring (Table 8). This region, including outer and inner Kachemak Bay, had the highest density (32 birds/km^2). Fewest birds were observed in the northern region around Kalgin Island. Most of the birds seen in these offshore waters were sea ducks. A mean of 11 sea ducks/km^2 was recorded for all regions. Regions 2 and 3 were highest with 15 and 24 sea ducks/km^2, respectively. Alcids and gulls had the next highest densities overall with only 2 birds/km^2 each. Regions 3 and 4 had the most alcids (7 and 8 birds/km^2, respectively). Other bird groups were only observed in trace amounts. Cormorants were seen in all but the northern region. Tubenoses were recorded only for the Kennedy Entrance area of Regions 1 and 4 when shearwaters began arriving to summer in Alaskan waters.

Habitat Usage - Habitat preferences of each species group and what species groups were found on each habitat type for spring surveys are presented in Figs. 95 and 96. The habitats in Lower Cook Inlet supporting the widest variety and greatest number of bird groups in spring were: exposed inshore water, open water of bays and fjords, mudflats of bays and fjords, open water of bays and lagoons, sedge/grass saltmarshes, protected delta water and alluvial floodplains. Both loons and grebes most frequently used exposed inshore and protected bay waters. Loons also were often found on protected delta water (16% of total). Cormorants selected exposed inshore water 31 percent of the time, bay rock beaches 25 percent of the time and 12 other identified habitats in varying amounts. Sixty-five percent of the geese were found on floodplains at river mouths. Saltmarshes and protected alluvial water were most heavily used by dabbling ducks. Most diving ducks staged on bay waters in spring and fed near intertidal mudflats. Like loons and grebes, sea ducks were observed on exposed inshore and protected bay waters. Bay waters were used by 35 percent of the mergansers while 20 percent were found on lagoon waters and 15 percent on exposed inshore waters.

Raptors used a variety of habitats, but most used protected bay and lagoon areas. Almost 80 percent of the Sandhill Cranes were observed on floodplains at the mouth of rivers. Although over 50 percent of the shorebirds were on bay mudflats, 22 percent were on exposed delta gravel, and a variety of other habitats were used in small amounts. As in other lease areas, gulls have the most ubiquitous distribution. In Lower Cook Inlet they were found on all but one habitat, but most (42% of total) were found on lagoon-type habitats. Few terns had yet arrived, and alcids preferred exposed inshore waters. Corvids (in this case mostly Northwestern Crows) used both bays and lagoons but most frequently were on gravel or mixed sand/gravel/rock beaches.

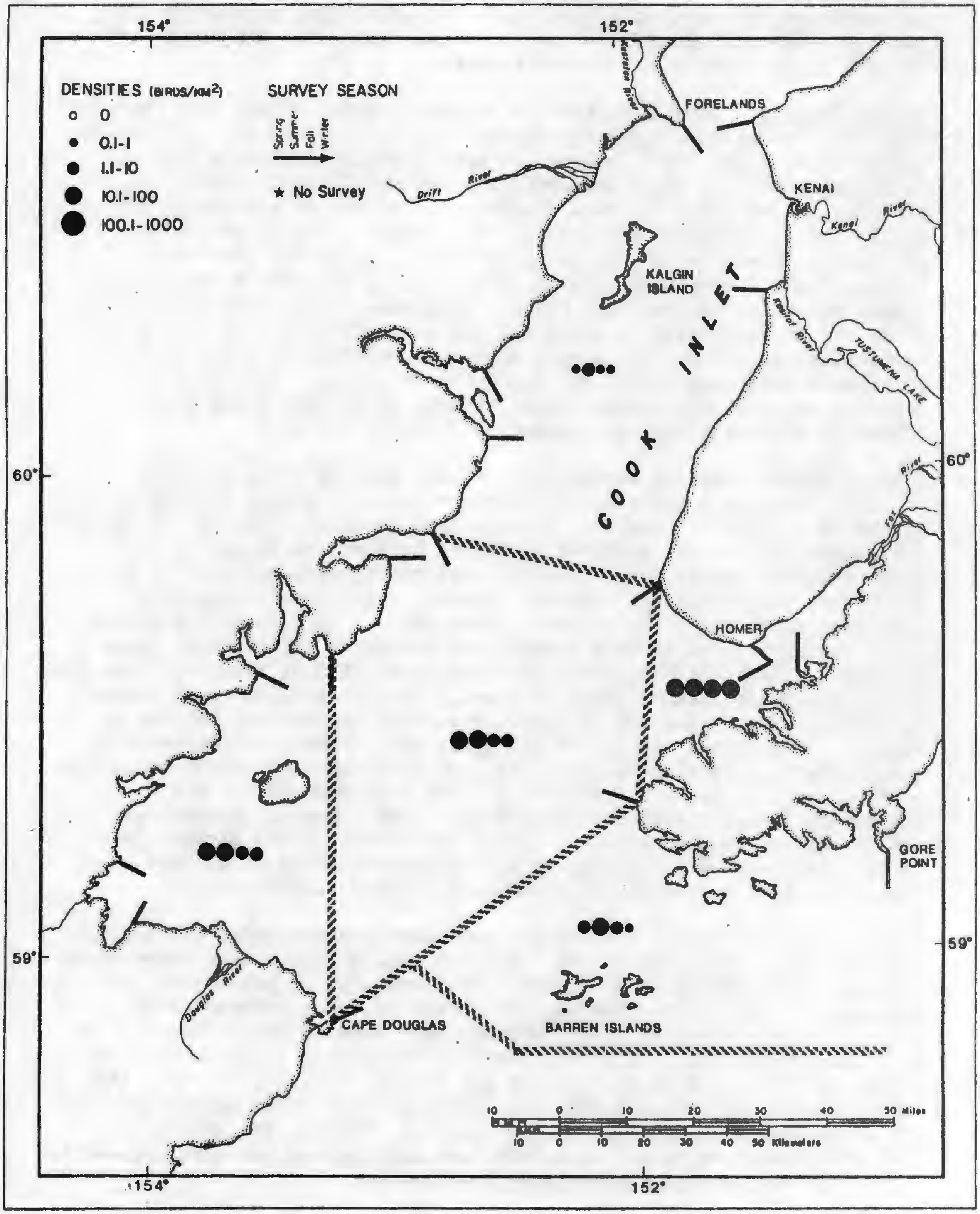


Fig. 77. Total bird density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

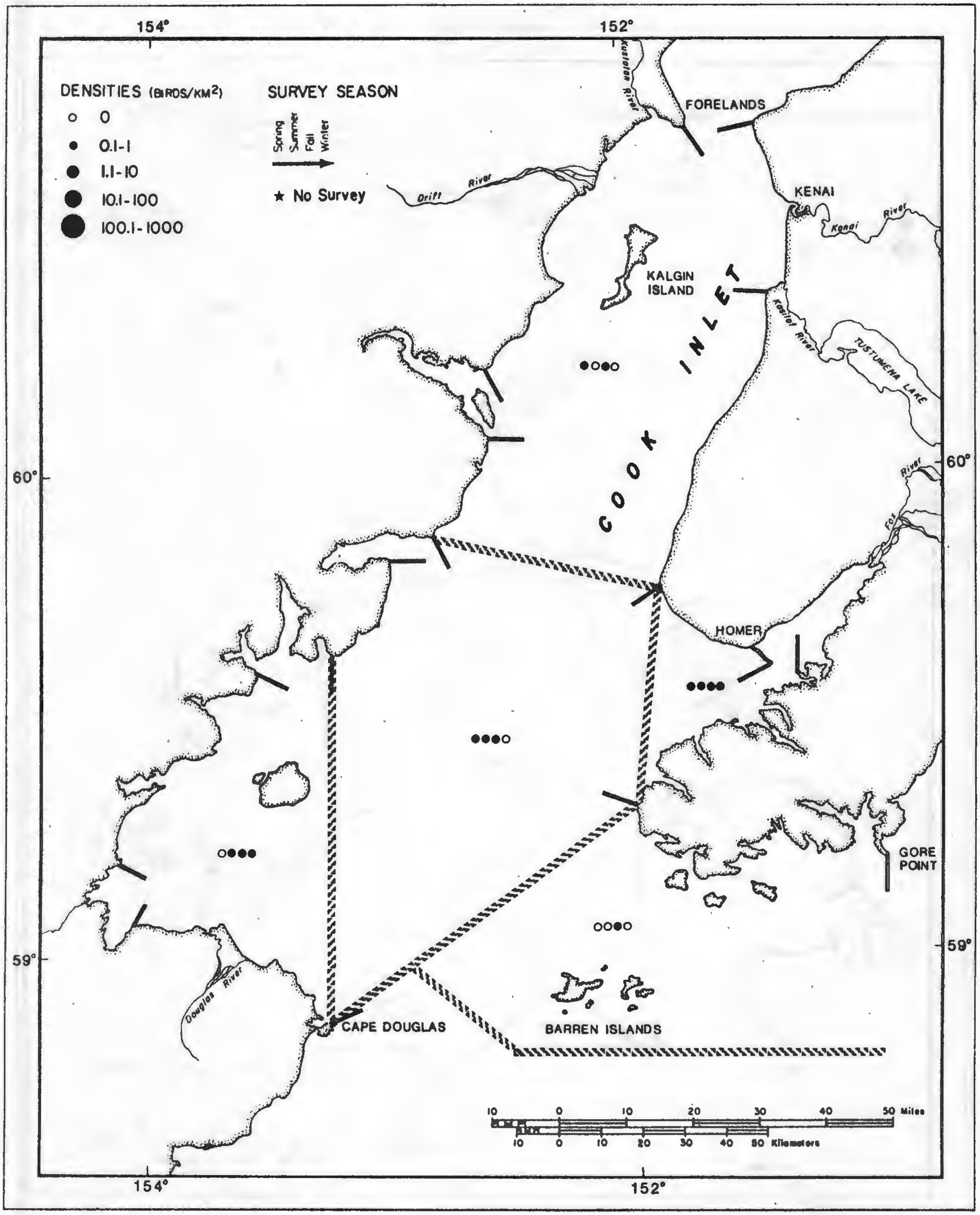


Fig. 78. Loon density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

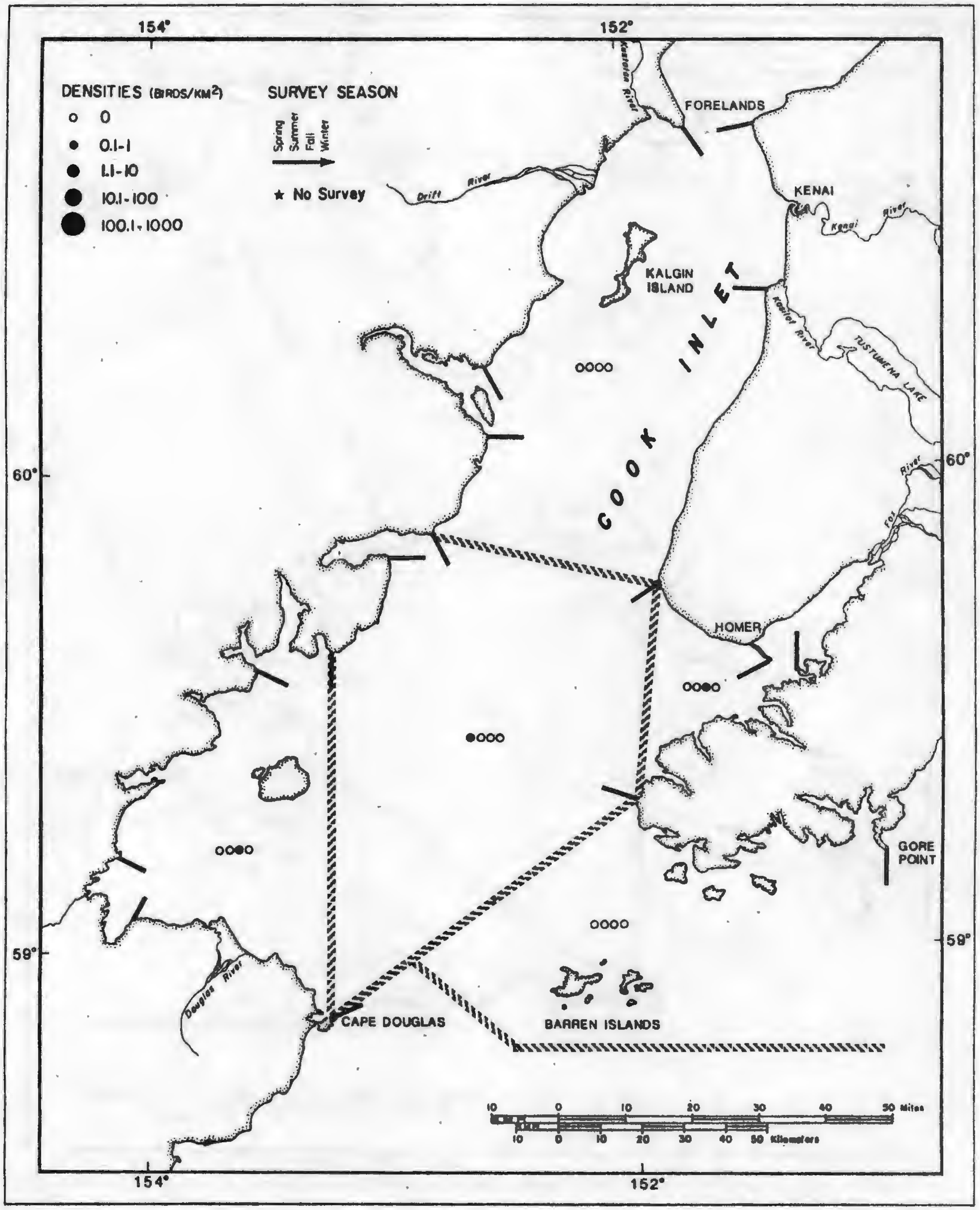


Fig. 79. Grebe density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

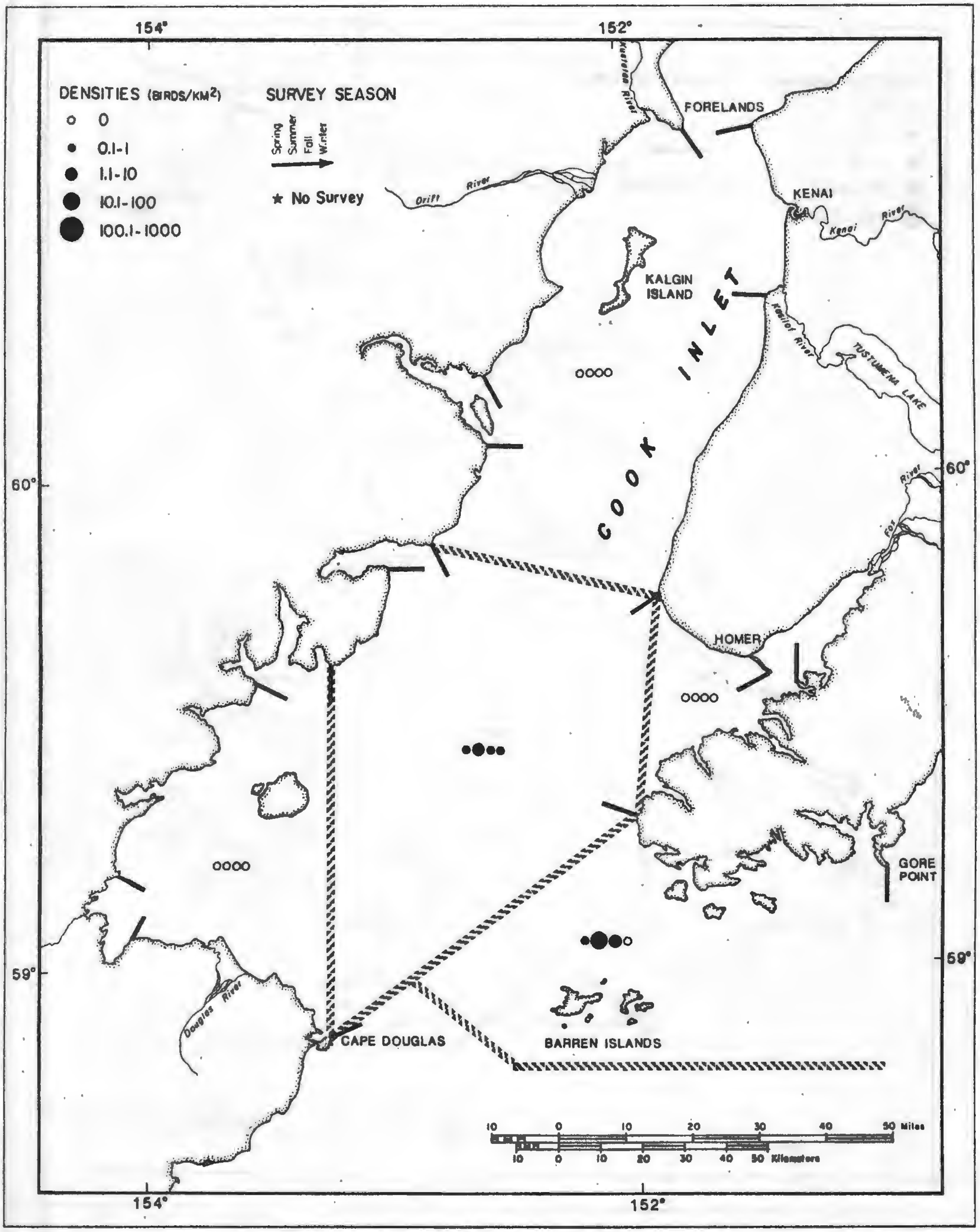


Fig. 80. Tubenose density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

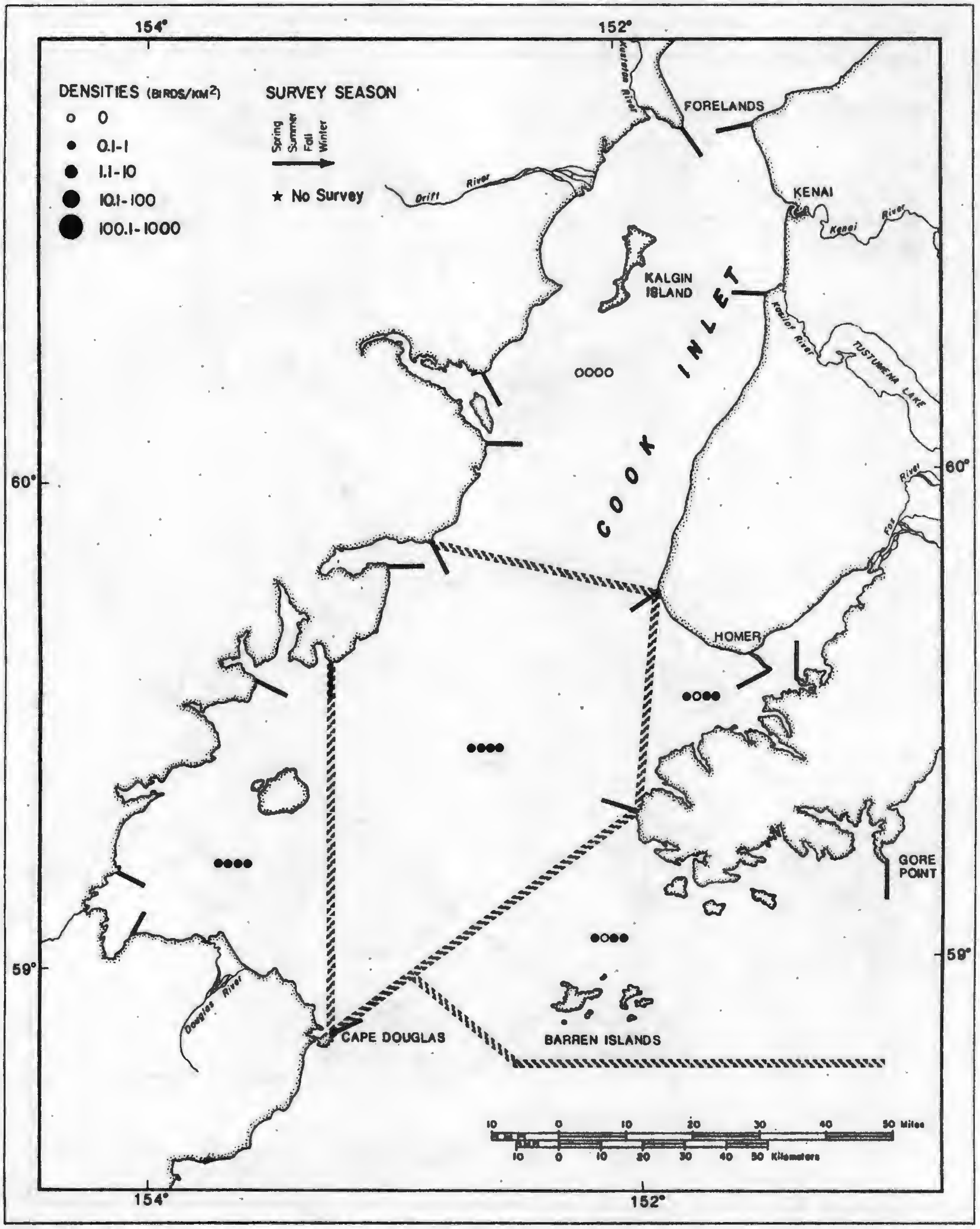


Fig. 81. Cormorant density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

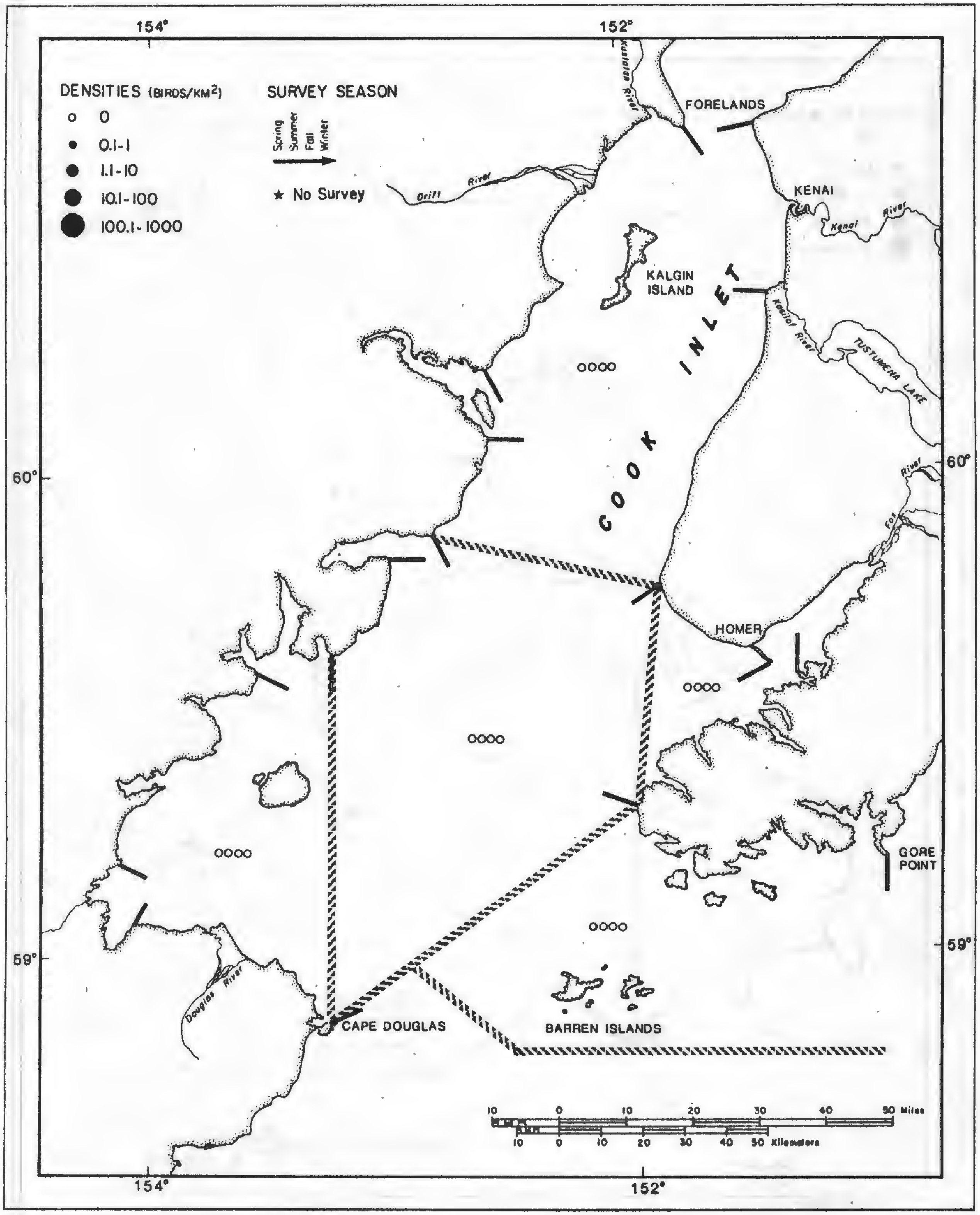


Fig. 82. Goose and swan density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. No geese or swans were sighted.

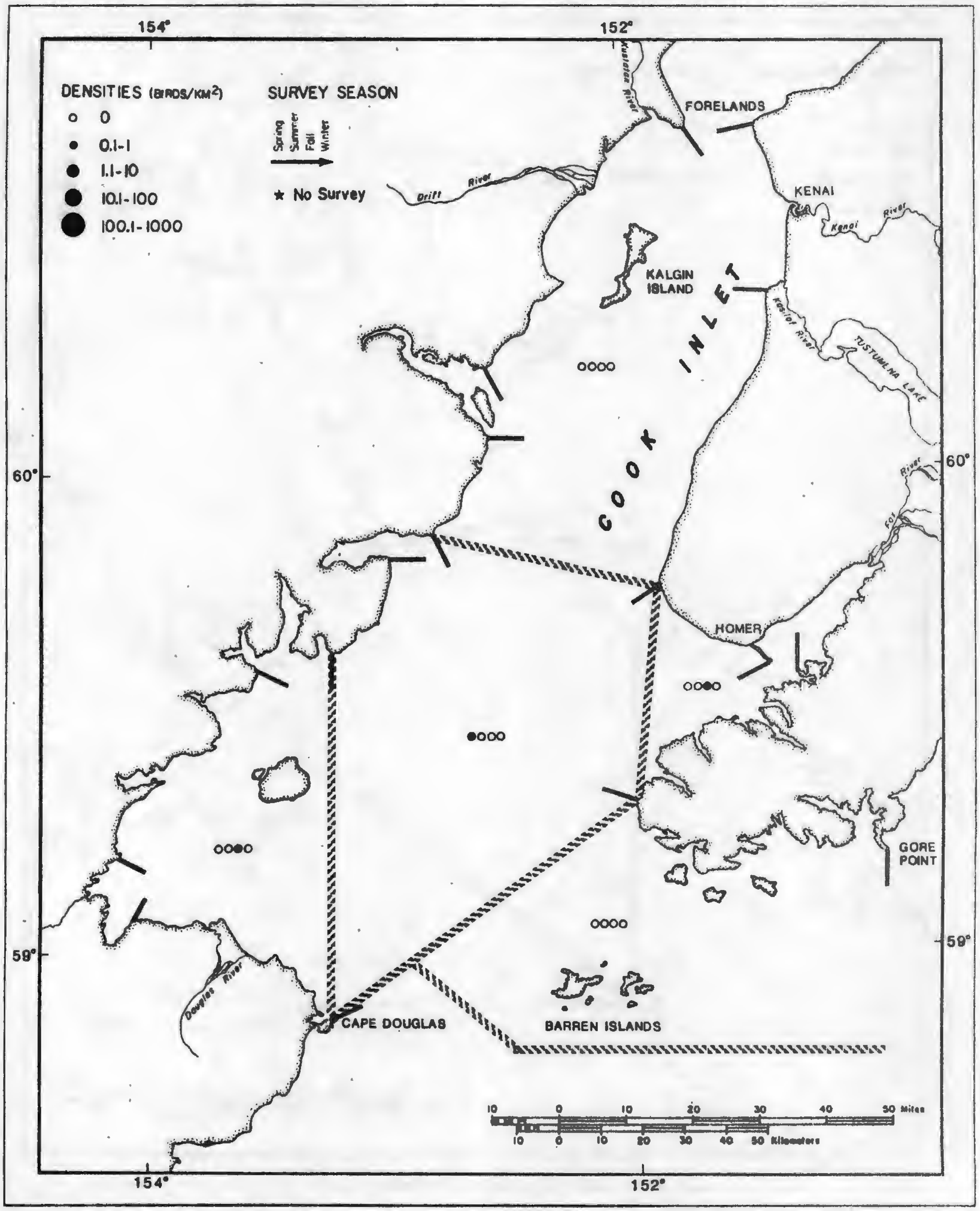


Fig. 83. Dabbling duck density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

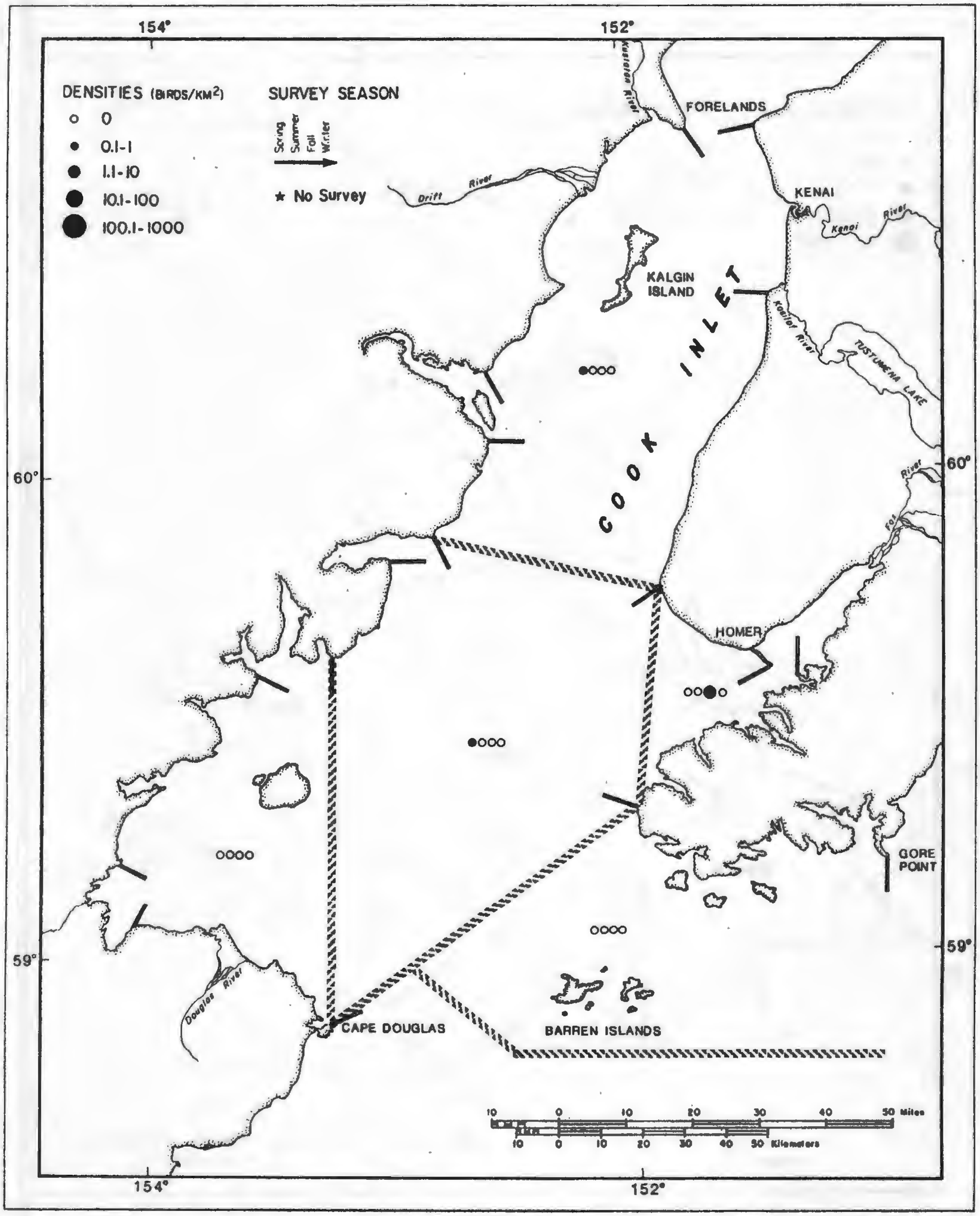


Fig. 84. Diving duck density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

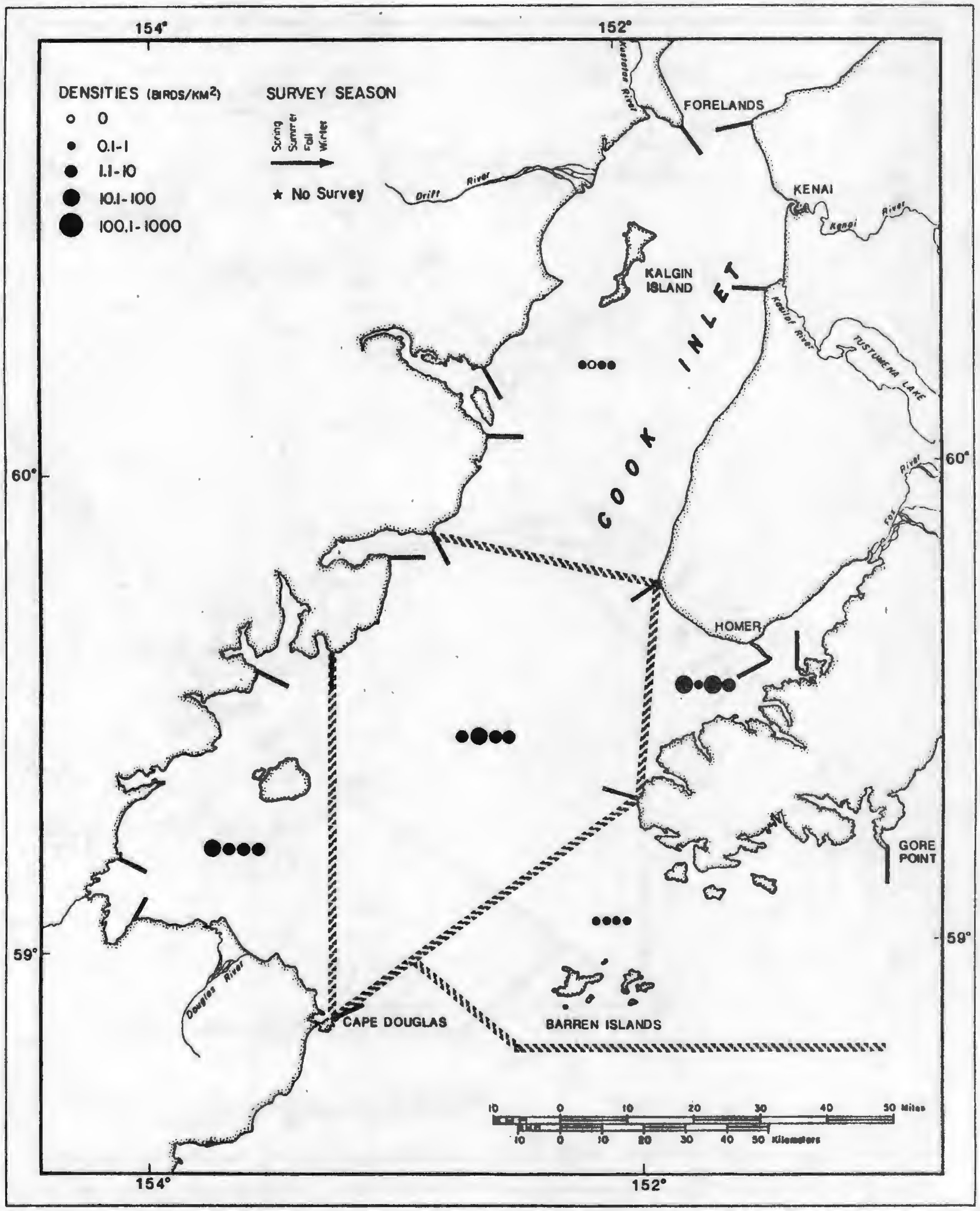


Fig. 85. Sea duck density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

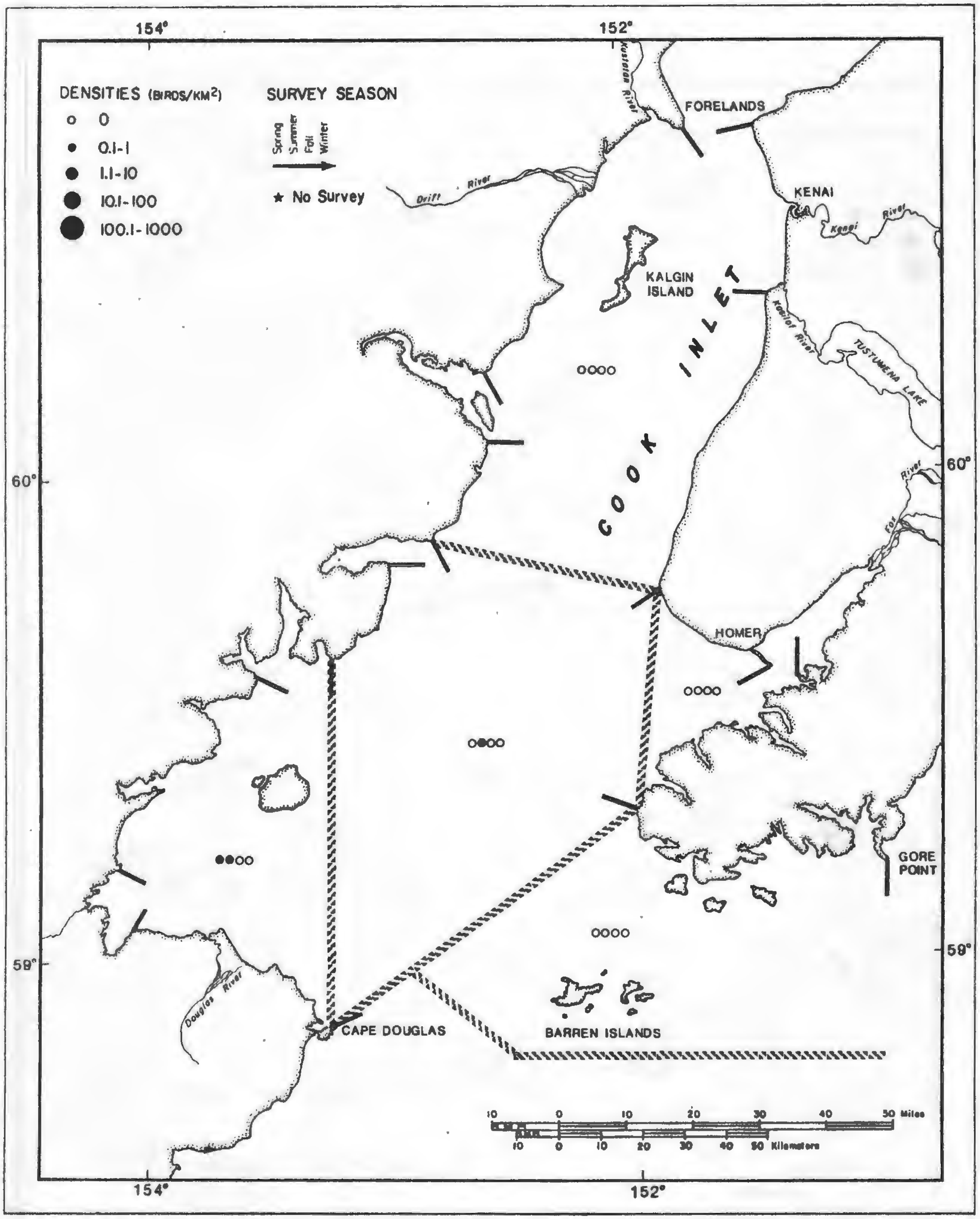


Fig. 86. Merganser density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

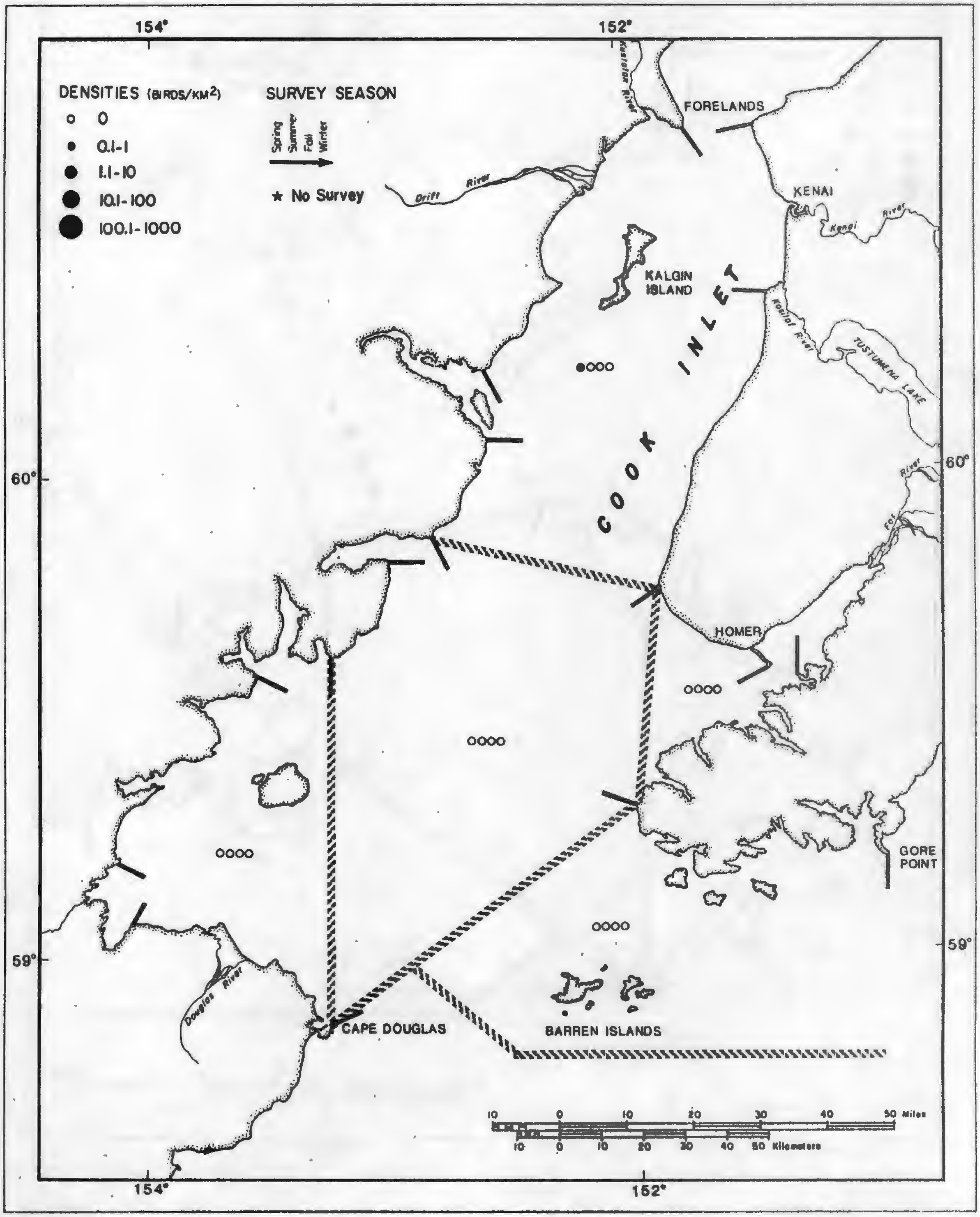


Fig. 87. Raptor density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

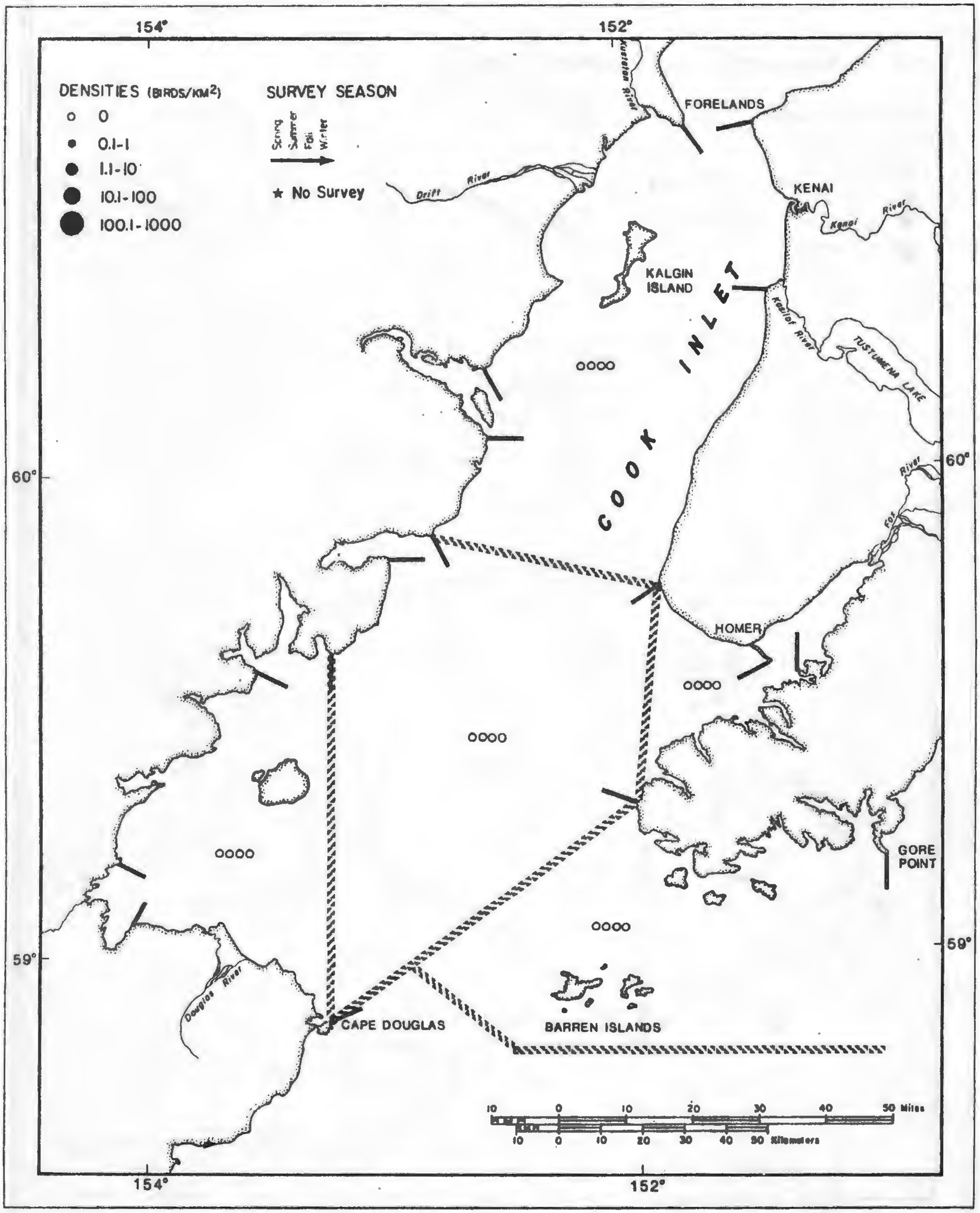


Fig. 88. Crane density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. No cranes were sighted.

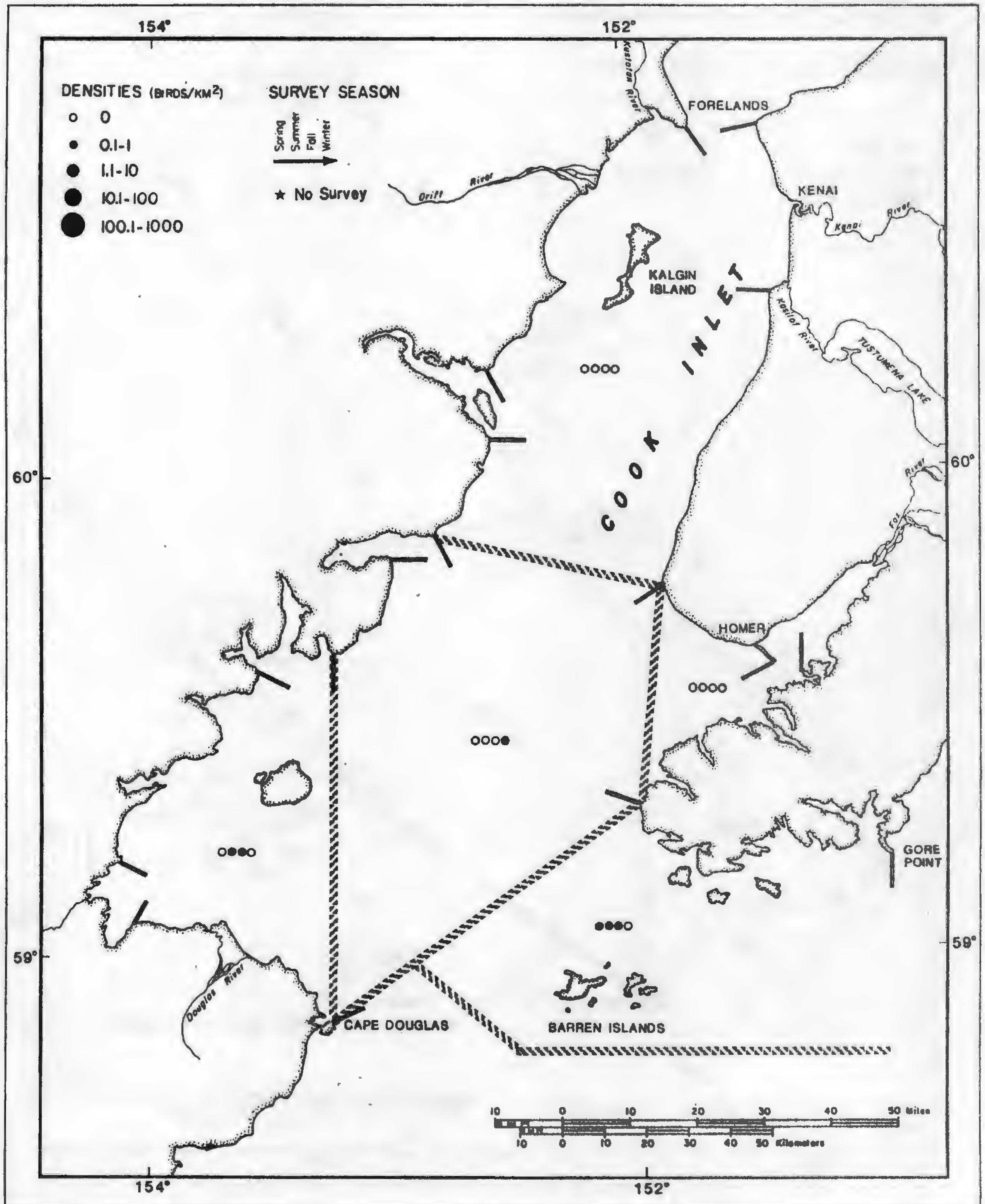


Fig. 89. Shorebird density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

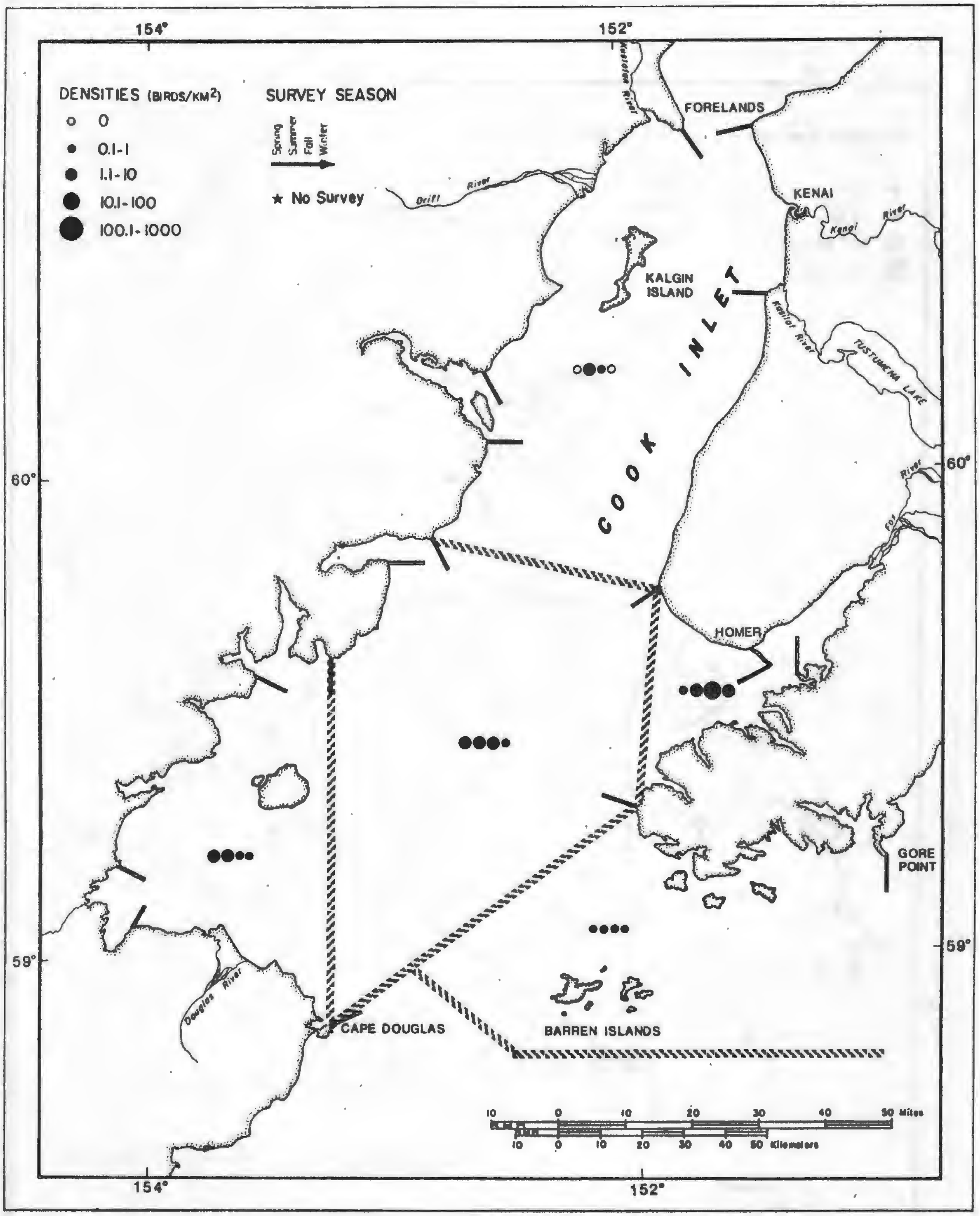


Fig. 90. Gull and jaeger density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

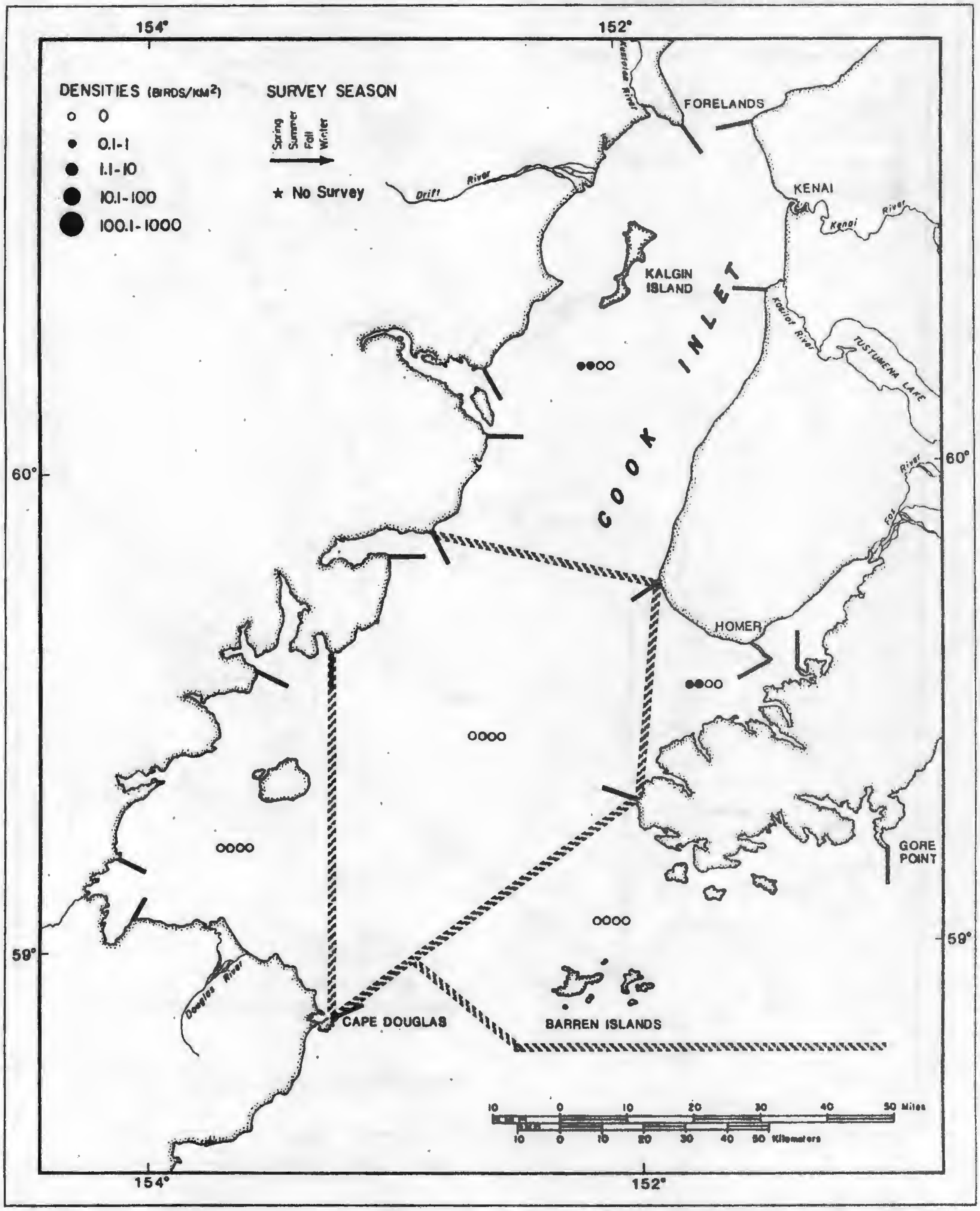


Fig. 91. Tern density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

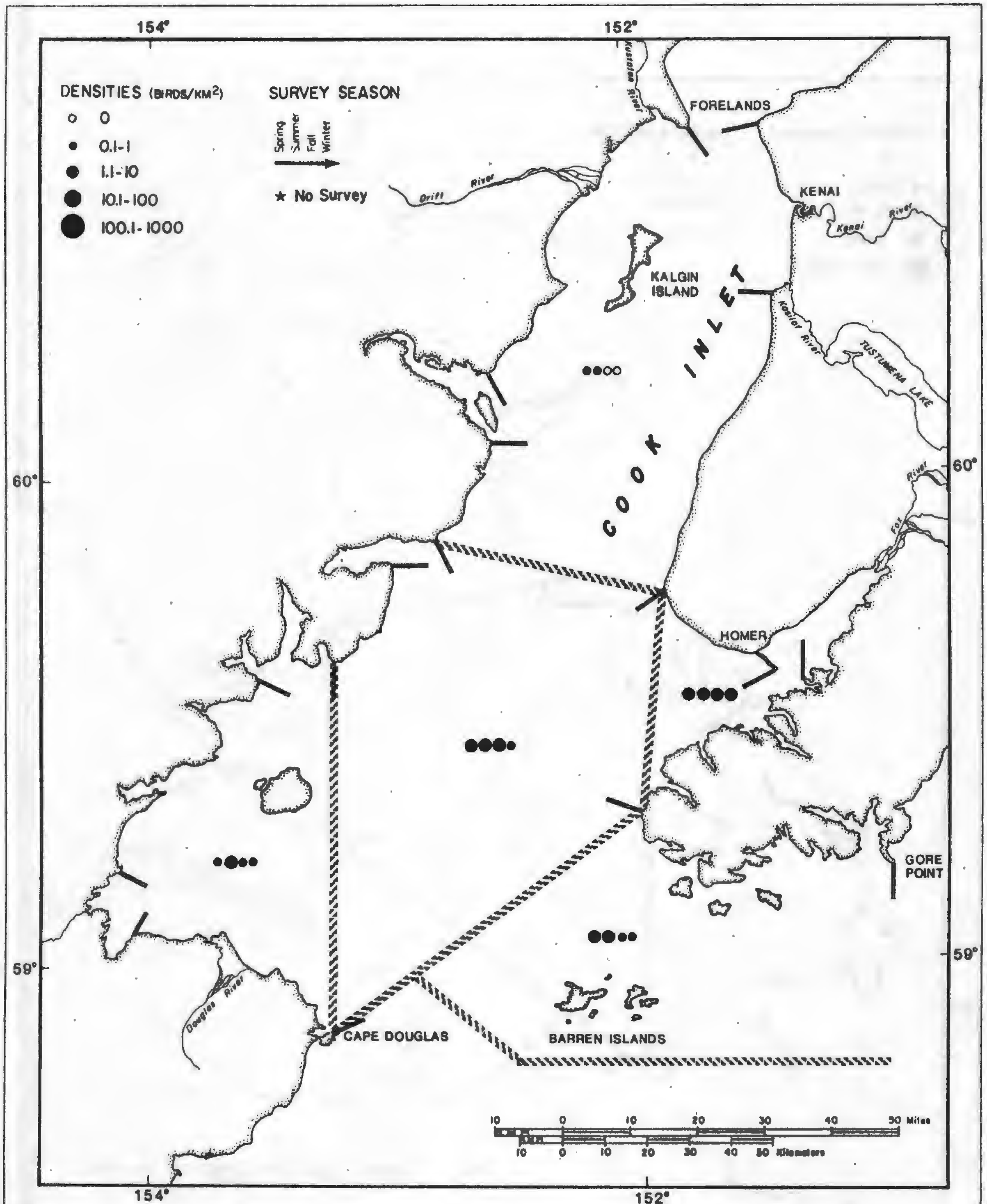


Fig. 92. Alcid density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

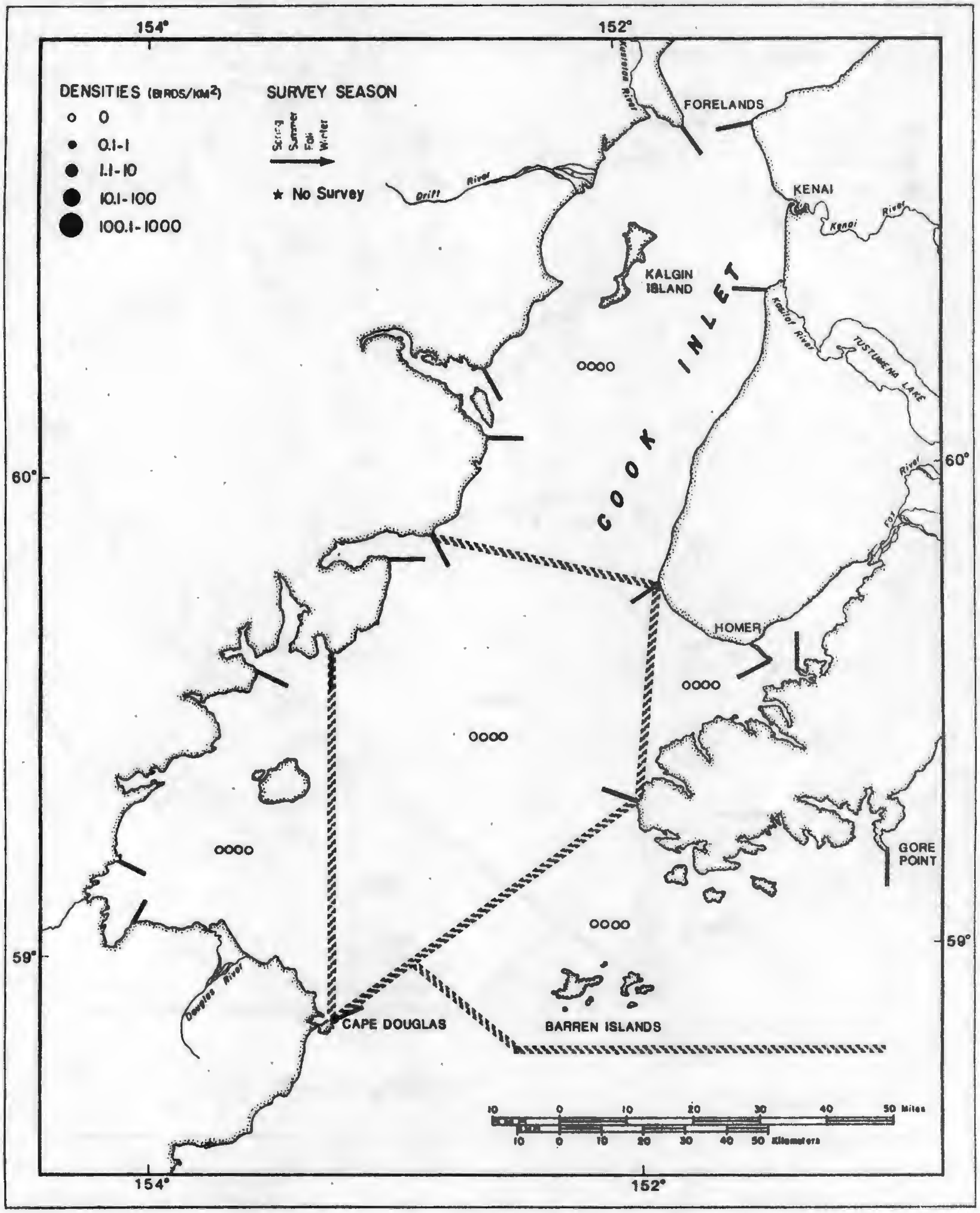


Fig. 93. Corvid density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. No corvids were sighted.

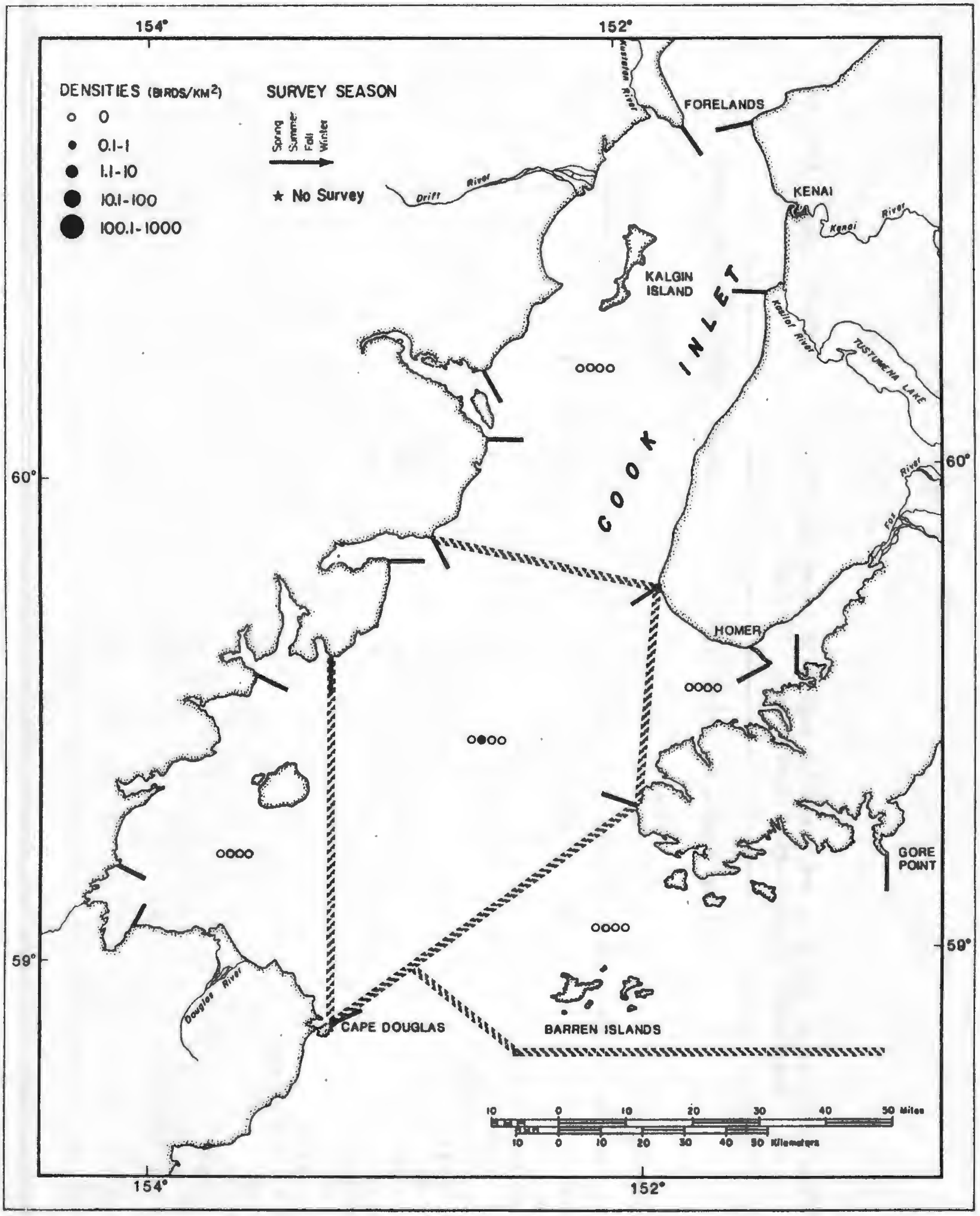
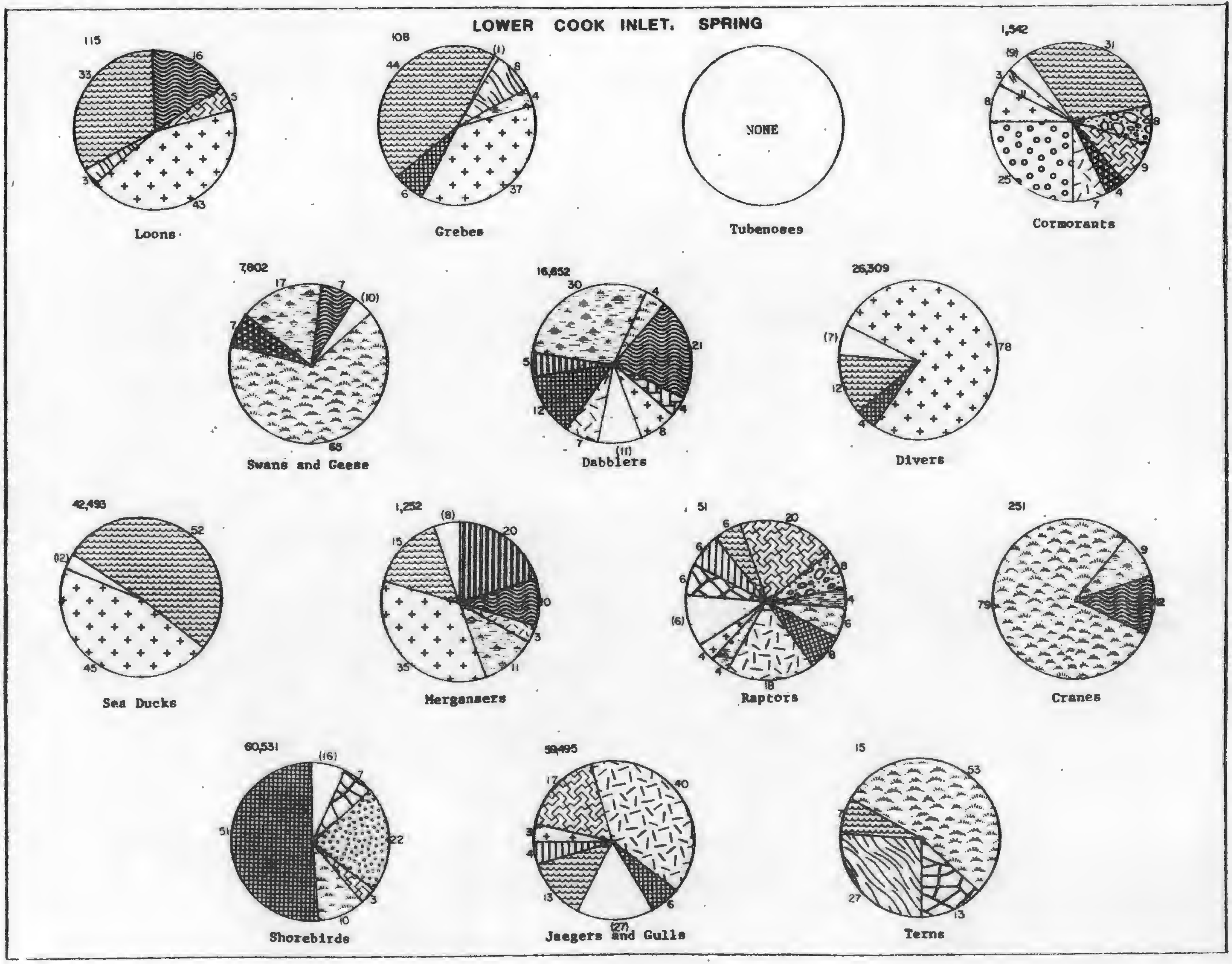


Fig. 94. Passerine (other than corvid) density by pelagic survey section in Lower Cook Inlet during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter.

Table 8. Pelagic densities of birds by region in Lower Cook Inlet, spring and summer 1976, 1978. See Figure 58 for region boundaries. (T=trace).

	Spring Densities (birds/km^2)						Summer Densities (birds/km^2)					
	Region						Region					
Bird Groups	1	2	3	4	5	Total	1	2	3	4	5	Total
Loon	T		T		T	T	T	T	T			T
Grebe	T					T						0
Tubenose	T			T		T	2			11		2
Cormorant	T	T	T	T		T	T	T				T
Goose and Swan						0						0
Dabbler	T					T						0
Diver	T				T	T						0
Sea Duck	5	15	24	T	T	11	58	7	T	1		17
Merganser		T				T	T	T				T
Raptor					T	T						0
Crane						0						0
Shorebird				T		T		T		T		T
Gull and Jaeger	2	3	1	1		2	8	2	9	1	2	4
Tern			T		T	T			1		1	T
Alcid	4	T	7	8	T	2	3	4	2	3	T	3
Corvid						0						0
Other Passerine						0	T					T
Other Bird	T	T		T		T	T				T	T
TOTAL	11	18	32	10	1	15	73	13	12	16	3	26



LOWER COOK INLET, SPRING
115
Loons
108
Grebes
NONE
Tubenoses
1,542
Cormorants
7,802
Swans and Geese
16,652
Dabblers
26,309
Divers
42,493
Sea Ducks
1,252
Mergansers
51
Raptors
251
Cranes
60,531
Shorebirds
59,495
Jaegers and Gulls
15
Terns

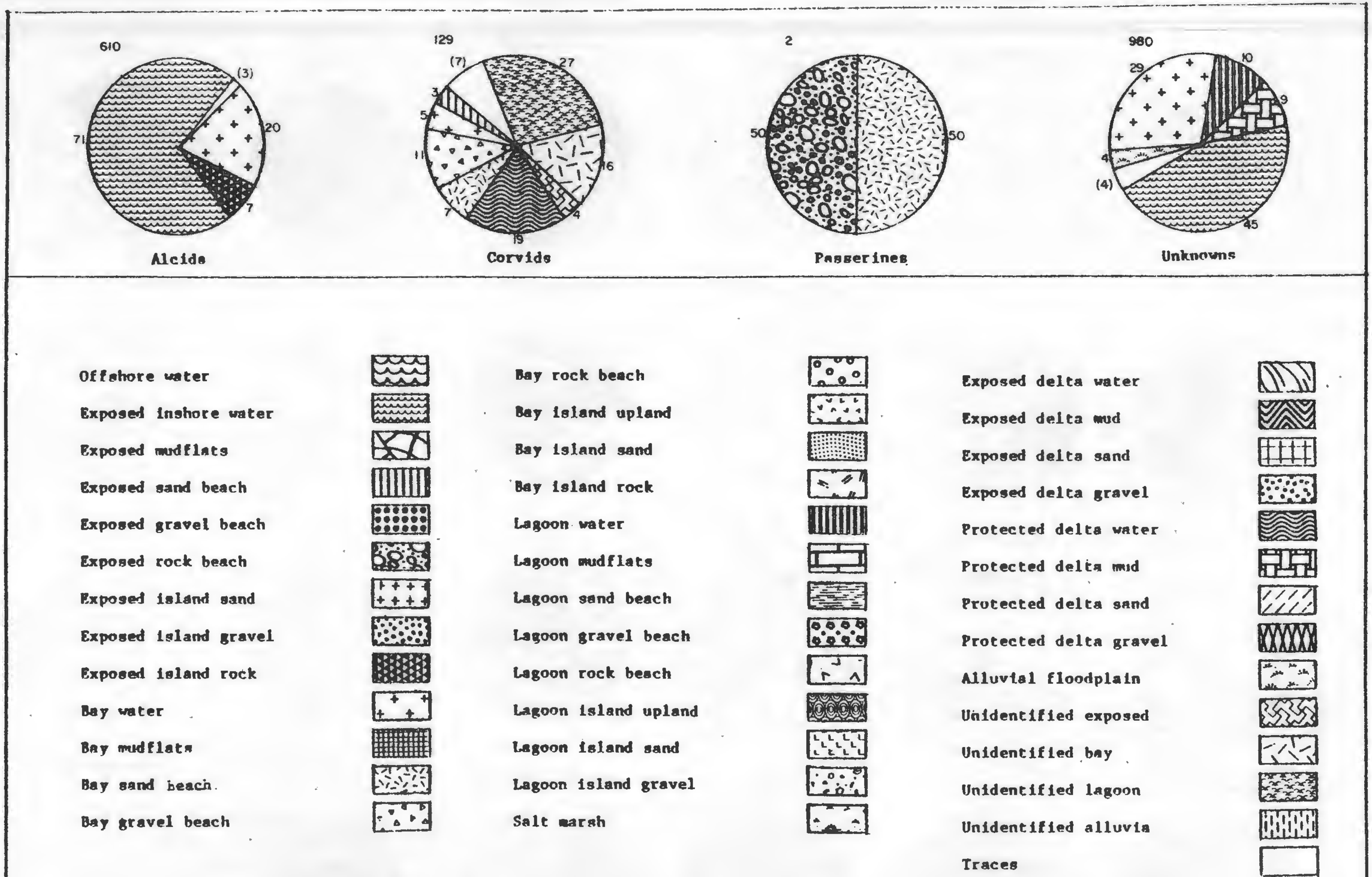
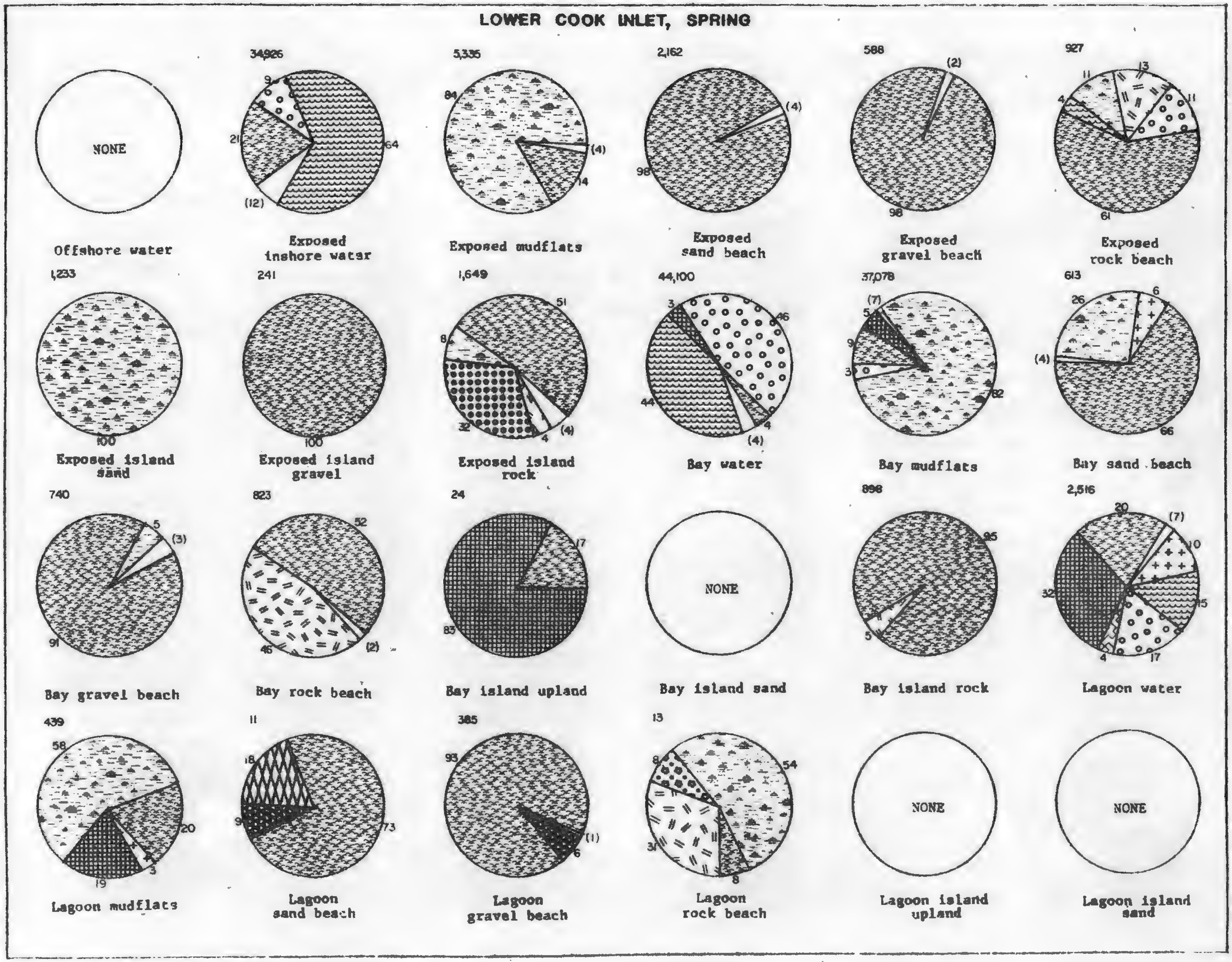


Fig. 95. Lower Cook Inlet, Spring 1976, 1978. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


LOWER COOK INLET, SPRING
NONE
Offshore water
34,926
Exposed inshore water
5,336
Exposed mudflats
2,162
Exposed sand beach
588
Exposed gravel beach
927
Exposed rock beach
1,233
Exposed island sand
241
Exposed island gravel
1,649
Exposed island rock
44,100
Bay water
37,078
Bay mudflats
613
Bay sand beach
740
Bay gravel beach
823
Bay rock beach
24
Bay island upland
NONE
Bay island sand
896
Bay island rock
2,516
Lagoon water
439
Lagoon mudflats
11
Lagoon sand beach
385
Lagoon gravel beach
13
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

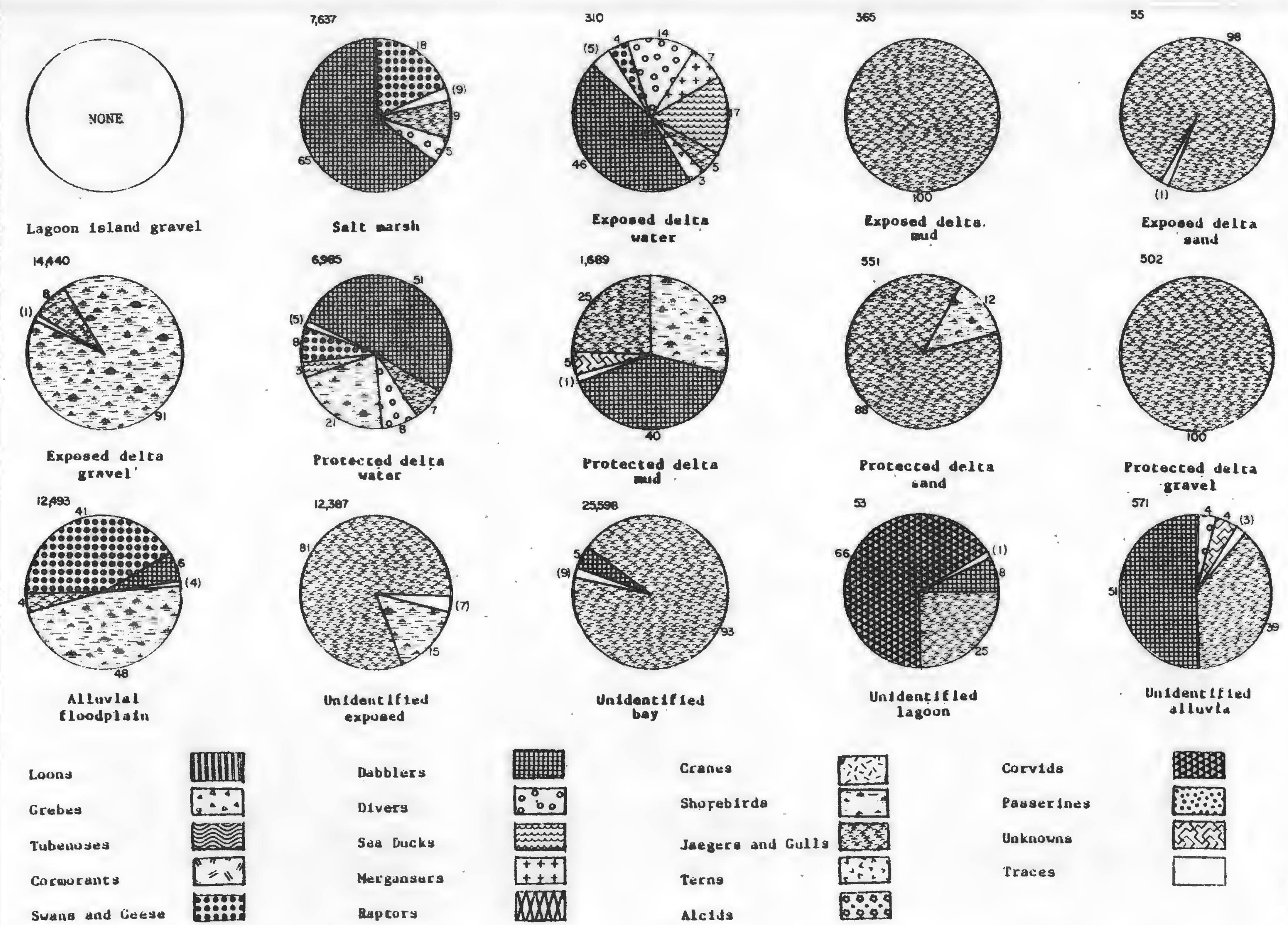


Fig. 96. Lower Cook Inlet, Spring 1976, 1978. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Twenty percent of the total birds seen in spring surveys in Lower Cook Inlet were found on bay water habitat. Diving and sea ducks in about equal numbers comprised over 90 percent of the birds using bay waters. Bay mudflats and exposed inshore waters were the next most used habitats with 17 and 16 percent of the total birds, respectively. On bay mudflats 82 percent of the birds were shorebirds, 9 percent gulls and 5 percent dabbling ducks, while on exposed inshore waters 64 percent of the birds were sea ducks, 21 percent gulls and 9 percent diving ducks. The only other habitats supporting significant numbers of birds were exposed delta gravel (7%) and alluvial floodplain (6%). Only three bird groups were found on the former: shorebirds (91%), gulls (8%), and dabblers (1%). On floodplains, 48 percent of the birds were shorebirds, 41 percent geese, 6 percent dabblers, 4 percent gulls and 2 percent cranes with traces of raptors and terns.

In all, 30 identified coastal habitat types were used in spring by birds in Lower Cook Inlet.

SUMMER

Shoreline density - Coastal bird densities dropped from 192 to 130 birds/km^2 between spring and summer (Table 9). The largest decreases in density were for shorebirds, geese, dabblers and divers. There were slight increases in densities of gulls, alcids and cormorants, and the density of sea ducks remained the same. Section 8, Tuxedni Bay, had the highest summer density 538 birds/km^2. As in spring, much of this high bird use represented kittiwakes at their colony on Chisik Island. In summer, alcids also occupied the colony and 103 birds/km^2 were enumerated on nearby waters. Sea duck densities were higher in summer than spring (49 vs. 22 birds/km^2) in Tuxedni Bay. Diving ducks were much reduced from spring to summer (50 to 7 birds/km^2). Section 8 had the second highest summer density for divers after Chinitna Bay which had 8 birds/km^2. Summer densities were also second highest for dabblers in Tuxedni Bay where 13 birds/km^2 were recorded.

Augustine Island had the second highest overall summer bird density (254 birds/km^2) for Lower Cook Inlet. Gulls, the densest group at 97 birds/km^2, fed and roosted in large flocks around the periphery of the island. Many of the shorebirds, the next densest group (78 birds/km^2), were observed late in July and were likely early fall migrants. A large raft of mixed Horned and Tufted Puffins at Burr Point raised the alcid density to 28 birds/km^2. Non-breeding sea ducks feeding in coastal waters off Augustine Island had a summer density of 45 birds/km^2.

Two other sections had densities over 200 birds/km^2 in summer. Kachemak Bay's 229 birds/km^2 were mostly gulls and sea ducks with 111 and 109 birds/km^2, respectively. Section 14, in the southwestern corner of Kamishak Bay, with a density of 203 birds/km^2, had mostly sea ducks (105 birds/km^2) and gulls (68 birds/km^2) with some alcids (11 birds/km^2) and a relatively high cormorant density (7 birds/km^2).

Tubenoses and cormorants were densest (both with 9 birds/km^2) in Section 6, the Chugach Island area. High density stations for both species were

Table 9. Bird density by section of coastline in Lower Cook Inlet, summer 1976, 1978. See Figure 58 for section boundaries. (T=trace).

Summer Densities (birds/km^2)

Bird Group	Section of Coastline 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Loon	T	T	T	T	T	T	T			T	T	T	T	T	1	T	T	T
Grebe				T										T			T	T
Tubenose		T				9									T		T	1
Cormorant	T	T		T	T	9	T	4	4	3	5	3	4	7	3	T	3	3
Goose and Swan	T						T			1					T		T	T
Dabbler	1			1		T	4	13	3	22		1	T	2	4	2	T	3
Diver				2	T			7		8		1	1	3	2			1
Sea Duck	T	7	93	109	5	2	2	49	3	20	15	96	31	105	57	1	45	38
Merganser				1	T	T	T	T		T	1	T	T	1	1		2	T
Raptor		T		T	T	T	T	T		T	T	T	T	T	T			T
Crane	T						T							T	T	T		T
Shorebird	1		1	2		T	T			T		1	2	3	2	T	78	3
Gull and Jaeger	155	8	35	111	14	92	34	362	68	33	6	33	19	68	49	5	97	70
Tern	3	1	1	1			1									4		T
Alcid				T	T	1		103		24	3	16	5	11	9		28	10
Corvid	T			T	T	T				T	T	T	T		T		T	T
Other Passerine	T			T		T	T	1		1		1	T	2	1	T		T
Other Bird				T	T								T		2			T
TOTAL	160	17	130	229	20	112	43	538	78	113	30	152	64	203	130	13	254	130

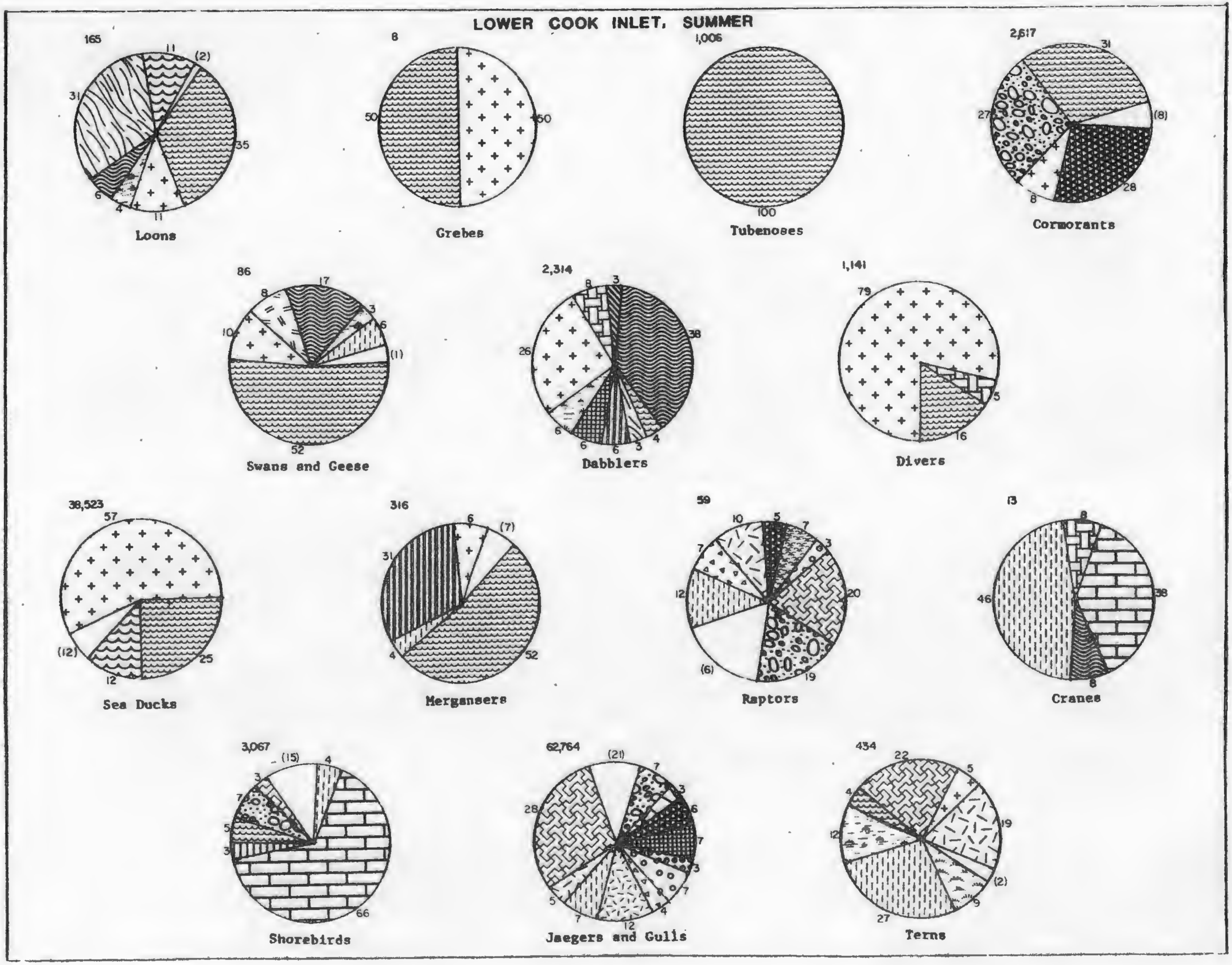
found in that section: 10,000 tubenoses/km^2 at Nagahut Rocks and 601 cormorants/km^2 at Perl Rock. In summer, dabblers were densest in Chinitna Bay at 22 birds/km^2.

Besides high density sea duck areas in Kachemak and Akumwarvik Bays, others were found in Iniskin/Iliamna Bays (96 birds/km^2) and the Bluff Point area of outer Kachemak Bay (93 birds/km^2). In both summers 1976 and 1978, a large raft of non-breeding scoters numbering several thousand was observed in the Iniskin/Iliamna area. Section 1's (Kenai/Kasilof River) density of 160 birds/km^2 was made up almost entirely of gulls (155 birds/km^2) and some terns (3 birds/km^2). Almost 1500 gulls were observed on Nordyke Island, qualifying it as a high density site. Gulls were also dense (92 birds/km^2) in Section 6, the Chugach Island area, where several small gull and kittiwake colonies were located. The section with the lowest total density in summer, Kalgin Island, did have the highest tern density (4 birds/km^2).

Pelagic density - In summer offshore bird densities increased to 26 birds/km^2 for transects surveyed in Lower Cook Inlet (Table 8). Region 1, the central portion of the Inlet, had by far the greatest overall density - 73 birds/km^2. Regions 2, 3, and 4 were all comparable with densities of 13, 12 and 16 birds/km^2, respectively. The lowest density (3 birds/km^2) was found in the northern portion, Region 5. Sea ducks had the highest density with 17 birds/km^2 for all regions. The highest density for a single region was 58 sea ducks/km^2 in Region 1. Almost 4,000 of the sea ducks were Surf and White-winged Scoters. Gulls and alcids were the only two bird groups found in all regions. Regions 1 and 3 had the most gulls with 8 and 9 birds/km^2, respectively. The total summer pelagic density for gulls in Lower Cook Inlet was 4 birds/km^2. Only 3 alcids/km^2 were found in summer with almost equal densities in Regions 1 through 4. Two regions, 1 and 4, had tubenoses present for an overall density of 2 birds/km^2, but most were in Region 4, the Kennedy Entrance area, with 11 birds/km^2. Terns were the only other bird group with densities of one or more birds/km^2 and both Regions 3 and 5 had densities of one bird/km^2. Bird groups present in trace amounts included loons, cormorants, mergansers, shorebirds and passerines.

Habitat Usage - Habitat preferences of each species group and the species groups present on each habitat type are shown in Figs. 97 and 98, respectively. In summer, 44 percent of the marine birds were found along exposed coastal habitats in Lower Cook Inlet, 40 percent in bays or fjords, 6 percent on protected delta areas, 3 percent in lagoons and 2 percent on exposed delta habitats. Of identified habitats, bay waters had the largest numbers of birds present (20%), followed by exposed inshore water (16%), bay sand beach (6%), bay mudflats (4%), exposed rock beach (4%), and bay rock beach (3%). In all, 32 habitats with birds present were identified.

Of 165 loons, 35 percent were found along exposed inshore waters, 31 percent on exposed delta water, 11 percent on both offshore and bay waters and 6 percent in protected delta water. Most tubenoses observed on the coastal surveys used exposed inshore waters. Cormorants were


LOWER COOK INLET, SUMMER
165
11
(2)
31
35
6
4
11
Loons
8
50
50
Grebes
1,006
100
Tubenoses
2,617
31
27
(8)
8
28
Cormorants
86
8
17
3
10
6
(1)
52
Swans and Geese
2,314
8
3
38
26
6
6
6
3
4
Dabblers
1,141
79
5
16
Divers
38,523
57
(12)
12
25
Sea Ducks
316
6
(7)
31
4
52
Mergansers
59
10
5
7
7
3
12
20
(6)
19
Raptors
13
8
46
38
8
Cranes
3,067
(15)
4
3
7
5
3
66
Shorebirds
62,764
(21)
7
3
28
6
7
3
7
5
7
12
4
Jaegers and Gulls
434
22
5
4
19
12
(2)
27
9
Terns

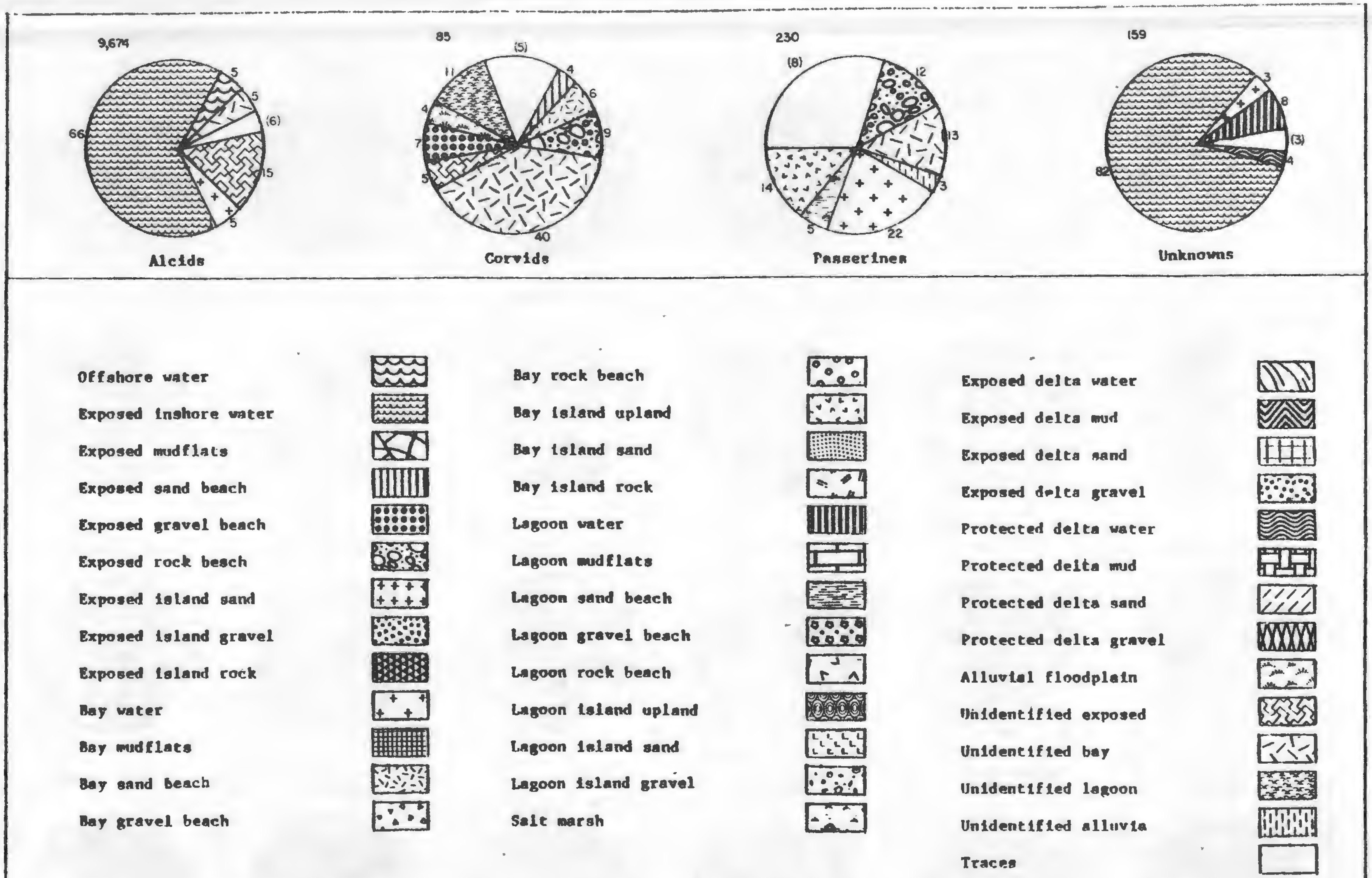
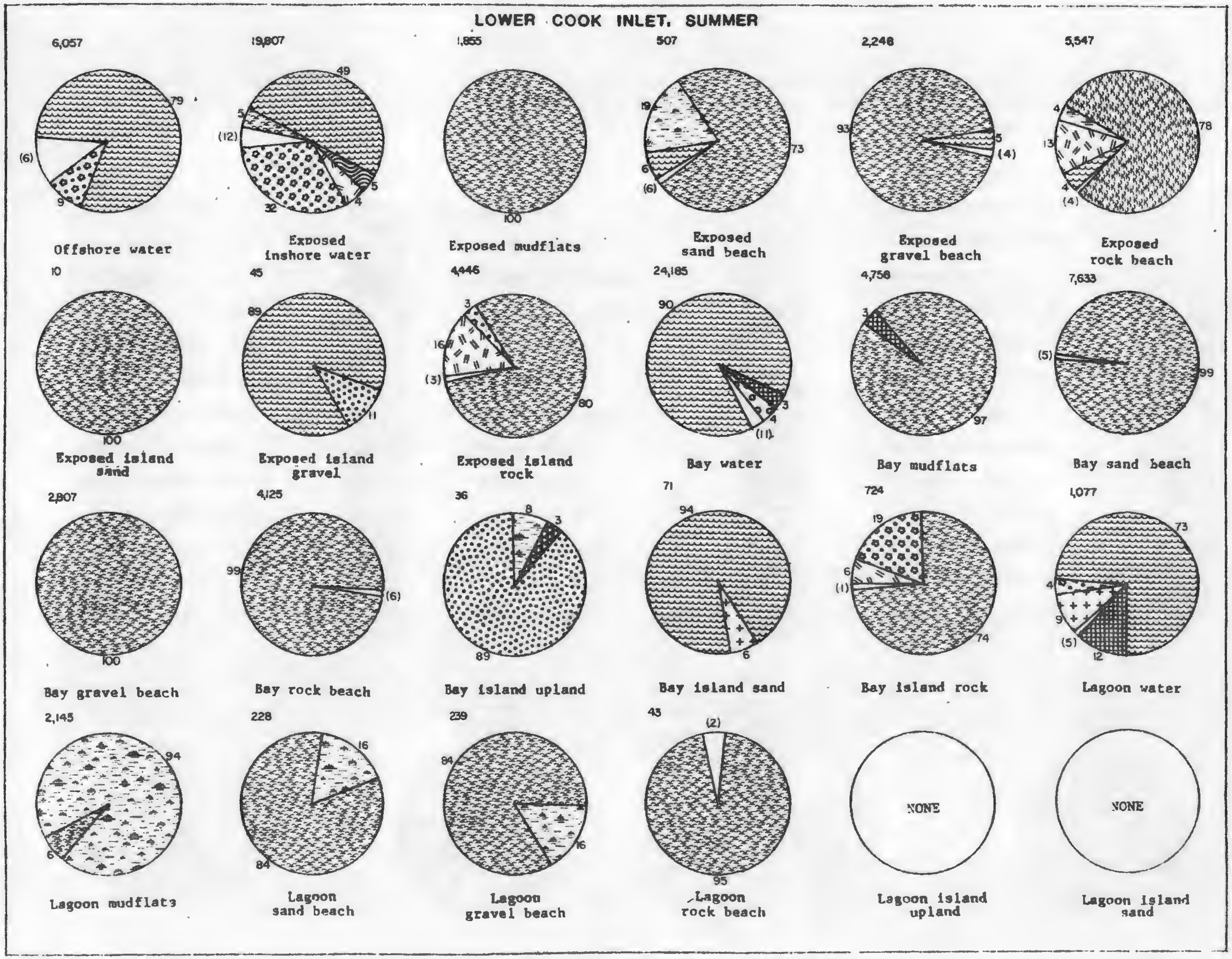


Fig. 97. Lower Cook Inlet, Summer 1976, 1978. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


LOWER COOK INLET, SUMMER
6,057
79
(6)
9
Offshore water
19,807
49
5
(12)
32
4
5
Exposed inshore water
1,855
100
Exposed mudflats
507
19
73
6
(6)
Exposed sand beach
2,248
93
5
(4)
Exposed gravel beach
5,547
4
78
13
4
(4)
Exposed rock beach
10
100
Exposed island sand
45
89
11
Exposed island gravel
4,446
3
16
(3)
80
Exposed island rock
24,185
90
3
4
(11)
Bay water
4,758
3
97
Bay mudflats
7,633
(5)
99
Bay sand beach
2,807
100
Bay gravel beach
4,125
99
(6)
Bay rock beach
36
8
3
89
Bay island upland
71
94
6
Bay island sand
724
19
6
(1)
74
Bay island rock
1,077
73
4
9
(5)
12
Lagoon water
2,145
94
6
Lagoon mudflats
228
16
84
Lagoon sand beach
239
84
16
Lagoon gravel beach
43
(2)
95
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

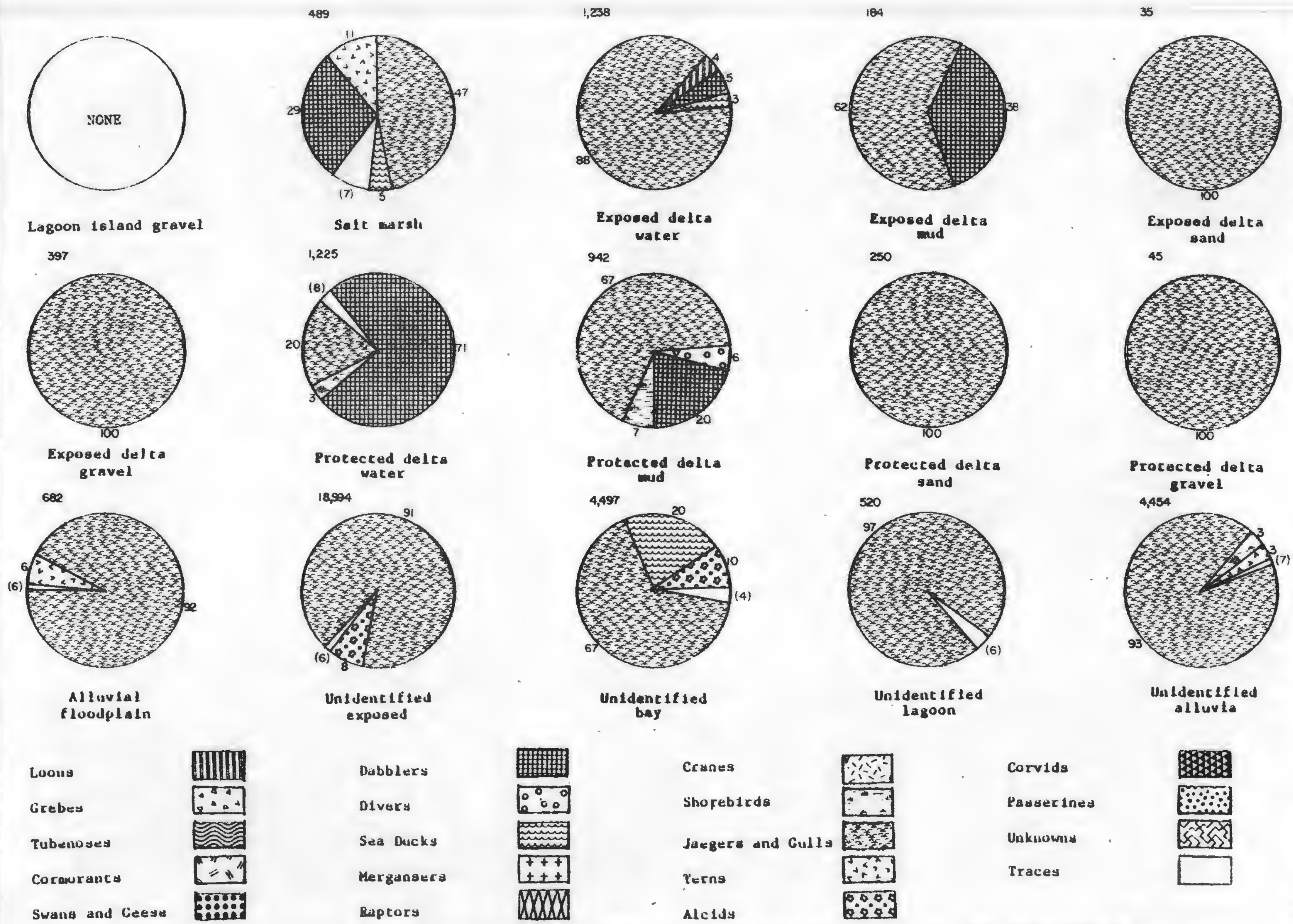


Fig. 98. Lower Cook Inlet, Summer 1976, 1978. Marine bird usage of habitats as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

primarily found on three habitats: exposed inshore water (31%), exposed island rock (28%) and exposed rock beach (27%). Lagoon and bay waters were the habitats used by most dabbling ducks (38% and 26%, respectively) while diving and sea ducks preferred bay and exposed inshore waters (79% and 16% for diving ducks and 57% and 25% for sea ducks, respectively). Mergansers were found most on exposed inshore water (52%) and lagoon water (31%). Almost two-thirds of the shorebirds were on lagoon mudflats and the remainder were distributed among 20 other habitat types. Gulls, too, were widespread on 31 identified habitat types. Fifty percent were on exposed, 36 percent on bay, 10 percent on protected delta, 3 percent on exposed delta and 2 percent on lagoon habitats. Protected delta habitats were preferred summer habitat for 38 percent of the terns in Lower Cook Inlet, while 26 percent of the terns were on exposed, 24 percent on bay, and 12 percent on salt marsh habitats. Eighty-six percent of the alcids were on exposed inshore and offshore waters.

For Lower Cook Inlet in summer, all but three habitat types were used predominantly by one species group. On 21 habitat types, gulls comprised 73 percent, or more, of the total birds seen. Sea ducks predominated (73% or more) on five habitats: offshore water, exposed island gravel, bay and lagoon water and bay island sand. Seventy-one percent of the birds on protected delta water were dabblers, 94% on lagoon mudflats were shorebirds and 89% on bay island upland were passerines (excluding corvids).

On exposed inshore waters two bird groups predominated: sea ducks (49%) and alcids (32%). For saltmarshes, 47 percent were gulls and 29 percent were dabblers; on exposed delta mud, 62 percent were gulls and 38 percent dabblers. On unclassified exposed inshore, bay, lagoon and alluvial habitats gulls predominated.

FALL

<u>Shoreline density</u> - In fall, shoreline densities of 66 birds/km^2 (Table 10) were one-half of summer and one-third of spring densities. The largest drop was in gull densities which went from 70 birds/km^2 in summer to 26 birds/km^2 in fall. There also was a significant decrease in sea duck densities from 38 birds/km^2 in spring and summer to 14 birds/km^2 in fall. Most alcids had departed for pelagic waters by the late September/early October survey. Only a trace of alcids remained inshore, whereas 10 birds/km^2 were present in summer. Migrating dabblers and geese increased fall densities of those groups to 15 and 30 birds/km^2, respectively, from 3 birds/km^2 and trace numbers in summer. Corvids, too, increased as Common Ravens and Northwestern Crows left timbered breeding grounds and came to the coast for fall and winter. No cranes or terns were sighted on fall surveys.

Four sections in Lower Cook Inlet had fall bird densities greater than 100 birds/km^2. Section 4, Kachemak Bay, had the highest fall density with 152 birds/km^2. Gulls predominated in that section at 66 birds/km^2. Dabblers and sea ducks accounted for most of the remainder of birds in Kachemak Bay (38 and 29 birds/km^2, respectively). Diving ducks and corvids were most dense in Kachemak Bay in fall, but only seven and three birds/km^2, respectively, were found.

Table 10. Bird density by section of coastline in Lower Cook Inlet, fall 1976, 1977. See Figure 58 for section boundaries. (T=trace).

	Fall Densities (birds/km^2)																	
	Section of Coastline																	
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Loon		T	1		T	T				T		T		T	T		T	T
Grebe			T	T	T	T		T	T				T	T	T		T	T
Tubenose						T												T
Cormorant			4	4	6	14		T			T	T	3	T	1	T	4	3
Goose and Swan	T			4				41							4			3
Dabbler	3			38	8	4	20	47		60		3	4	29	9	T	1	15
Diver			T	7	T		T	T		1		2	2	2	5	T		1
Sea Duck	T	6	78	29	27	19	1	5	2	5	3	12	11	32	13	3	3	14
Merganser		T		T	T	1		T		3				1				T
Raptor	T		T	T	T	T	T	T	T	T					T	T	T	T
Crane																		0
Shorebird	1			1	T	1	1			T		T	T	54			4	2
Gull and Jaeger	20	1	19	66	33	24	34	17	4	28	3	15	10	8	50	8	5	26
Tern																		0
Alcid		2	2	T	T	T									T		T	T
Corvid		T		3	2	2	T								T			1
Other Passerine		T			T	T			1			T			T			T
Other Bird					1	1		T		T		T					1	T
TOTAL	24	10	105	152	79	68	55	111	6	97	6	32	31	125	81	12	18	66

A fall density of 125 birds/km^2 in Section 14, the McNeil Cove/Akumwarvik Bay area, was the second highest. Nearly half of the birds were shorebirds (54 birds/km^2). Sea ducks (32 birds/km^2) and dabbling ducks (29 birds/km^2) made up most of the remainder. Only eight gulls/km^2 were found in that region.

Most of the birds in Section 8, Tuxedni Bay, which had a density of 111 birds/km^2, were dabblers (47 birds/km^2) and geese (41 birds/km^2). Few gulls and sea ducks were found (17 and 5 birds/km^2, respectively). However, Section 3, with 105 birds/km^2, had mostly sea ducks (78 birds/km^2) and again few gulls (19 birds/km^2). This section also had cormorants (4 birds/km^2), alcids (2 birds/km^2) and loons (1 bird/km^2).

Tubenoses were sighted only in Section 6 and in trace amounts. Cormorants densities were highest in the southeastern portion of Lower Cook Inlet, particularly in Section 6 (14 birds/km^2). Two sites of high cormorant density were in Section 6 with 1500 and 123 birds/km^2 and others were in Section 5 (2950 birds/km^2) and Section 4 (2060 birds/km^2). These high densities represent large flocks on relatively small island-type stations. Geese were present in measurable quantities in only three sections. Most were in Tuxedni Bay with small amounts at the head of Kachemak Bay and at the mouth of the Douglas River. Chinitna Bay (Section 10) had the highest dabbler density (60 birds/km^2). Mergansers were also most dense in that section (3 birds/km^2). Besides Section 4, mentioned earlier, gulls were abundant in Section 15 on the south side of Kamishak. Fall densities (50 birds/km^2) in that section were comparable to summer densities (49 birds/km^2).

Pelagic density - Offshore densities in fall dropped to only 9 birds/km^2 for Lower Cook Inlet (Table 11). Sea ducks, gulls, alcids and tubenoses were the most frequently observed species (3, 2, 2 and 1 birds/km^2, respectively). Six other groups were recorded in trace amounts. Region 3, Kachemak Bay, had the greatest density - 44 birds/km^2. Here gulls, sea ducks, alcids and diving ducks comprised 16, 13, 9 and 5 birds/km^2, respectively. Diving ducks were found only in this region.

Almost equal densities of alcids, gulls, sea ducks and tubenoses were found in Region 1 (total density: 8 birds/km^2). Four of five birds/km^2 in Section 2 (Kamishak Bay) were sea ducks. Tubenoses comprised five of the total seven birds/km^2 in Section 4. Section 5 had the lowest density (1 bird/km^2) and sea ducks were the predominant species group. Sea ducks, gulls and loons were the only groups sighted in all five regions.

Habitat Usage - During in fall surveys of Lower Cook Inlet, birds selected bay and exposed inshore waters in almost equal numbers - each with 20 percent of the total. Likewise, these habitats were used by the widest variety of bird groups recorded. Exposed inshore waters were used by all groups except geese, and bay waters by all groups except raptors and shorebirds. Most of the birds in exposed inshore waters were sea ducks (59%) followed by gulls (20%), dabbling ducks (9%) and cormorants (6%). Sea ducks (37%) predominated on bay waters followed closely by dabbling

Table 11. Pelagic densities of birds by region in Lower Cook Inlet, fall and winter 1976, 1978. See Figure 58 for region boundaries. (T=trace).

	Fall Densities (birds/km^2)						Winter Densities (birds/km^2)					
	Region						Region					
Bird Group	1	2	3	4	5	Total	1	2	3	4	5	Total
Loon	T	T	T	T	T	T		T	T			T
Grebe		T	T			T						0
Tubenose	1			5		1	T					T
Cormorant	T	T	T	T		T	T	T	T	T		T
Goose and Swan						0						0
Dabbler		T	T			T						0
Diver			5			T						0
Sea Duck	2	4	13	T	1	3	4	4	7	T	1	3
Merganser						0						0
Raptor						0						0
Crane						0						0
Shorebird		T	T			T	T					T
Gull and Jaeger	2	1	16	1	T	2	1	1	3	T		1
Tern						0						0
Alcid	3	T	9	T		2	T	T	8	T		1
Corvid						0						0
Other Passerine						0						0
Other Bird		T	T			T	T		T			T
TOTAL	8	5	44	7	1	9	6	4	18	1	1	5

ducks (34%). Gulls comprised 18 percent, diving ducks 6 percent and cormorants 3 percent of the birds observed on that habitat. Habitat preferences of each species group and what species groups were found on each habitat type are shown on Figs. 99 and 100.

Exposed habitats, in general, were the ones most used by birds (42% of the total). Exposed mudflats were the third most important habitat with 12 percent of the total use. Gulls (80%) and dabblers (19%) were the groups most frequently using the mudflats. Sixty-two percent of the almost 2,000 birds on exposed gravel were shorebirds.

Thirty-one percent of the birds were found in protected bay/fjord habitats. Besides bay water, the habitats most used were bay gravel beach (3%), bay mudflats (2%) and bay rock beach (2%). On all three habitats, gulls were the predominant species group.

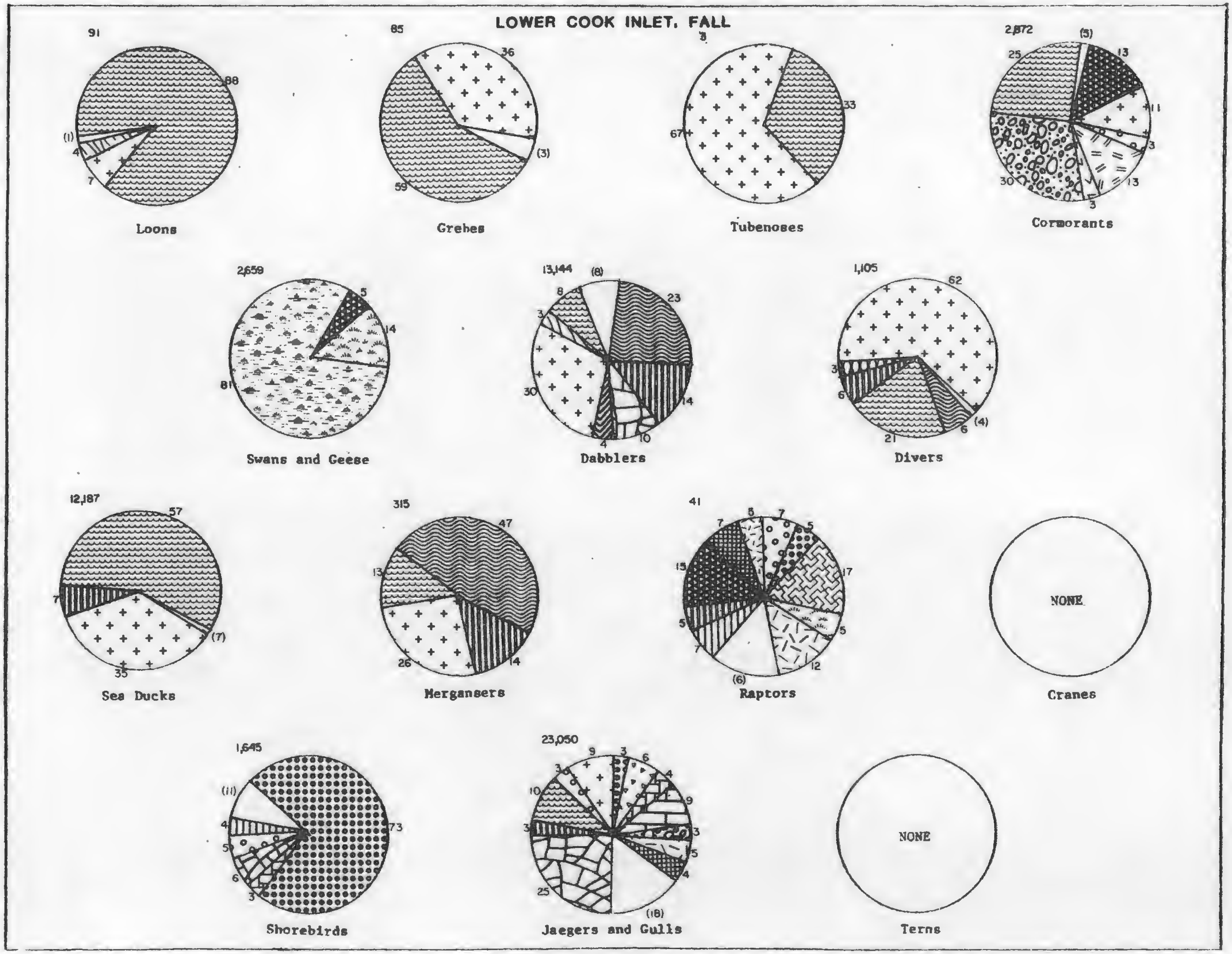
Lagoon and protected delta habitats each had 11 percent of the total birds. For lagoons, most birds were observed on the water (6% of total). Over half the birds on lagoon water were dabblers (52%), 23 percent were sea ducks and 16 percent gulls. Lagoon mudflats were used by 4 percent of the birds and 99 percent of the birds on this habitat were gulls. Six percent of the total birds were found on protected delta water. Over 90 percent of the birds found were dabblers. On protected delta mud (2% of total), 72 percent of the birds were gulls and 23 percent dabblers.

Four percent of all birds were on saltmarshes. Ninety-eight percent of these birds were geese. Two percent of the birds were observed on exposed delta habitats. Most of these were dabbling ducks.

Gulls were the most abundant bird group found in the fall Lower Cook Inlet surveys (40% of the total). They were observed on 26 of 28 identified habitats. Twenty-five percent used exposed mudflats, 10 percent exposed inshore water, 9 percent lagoon mudflats and 9 percent bay water. The rest were scattered on the remainder of the habitats.

Twenty-three percent of the birds were dabbling ducks. Most (30%) were on bay water while 23 percent used protected delta water, 14 percent lagoon water and 8 percent exposed inshore water. Sea ducks made up 21 percent of the birds and 57 percent of this group were found on exposed inshore water. Thirty-five percent used bay water and 7 percent lagoon water.

Cormorants and geese were the only other groups comprising a significant portion of the total birds, each with 5 percent. Cormorants were found largely on five habitats: exposed rock beach (30%), exposed inshore water (25%), bay island rock (13%), exposed island rock (13%) and bay water (11%). Eighty-one percent of the geese were found on saltmarshes, 14 percent on alluvial floodplains and 5 percent on exposed island rock.


LOWER COOK INLET, FALL
91
Loons
85
Grebes
Tubenoses
2,872
Cormorants
2,659
Swans and Geese
13,144
Dabblers
1,105
Divers
12,187
Sea Ducks
315
Mergansers
41
Raptors
NONE
Cranes
1,645
Shorebirds
23,050
Jaegers and Gulls
NONE
Terns

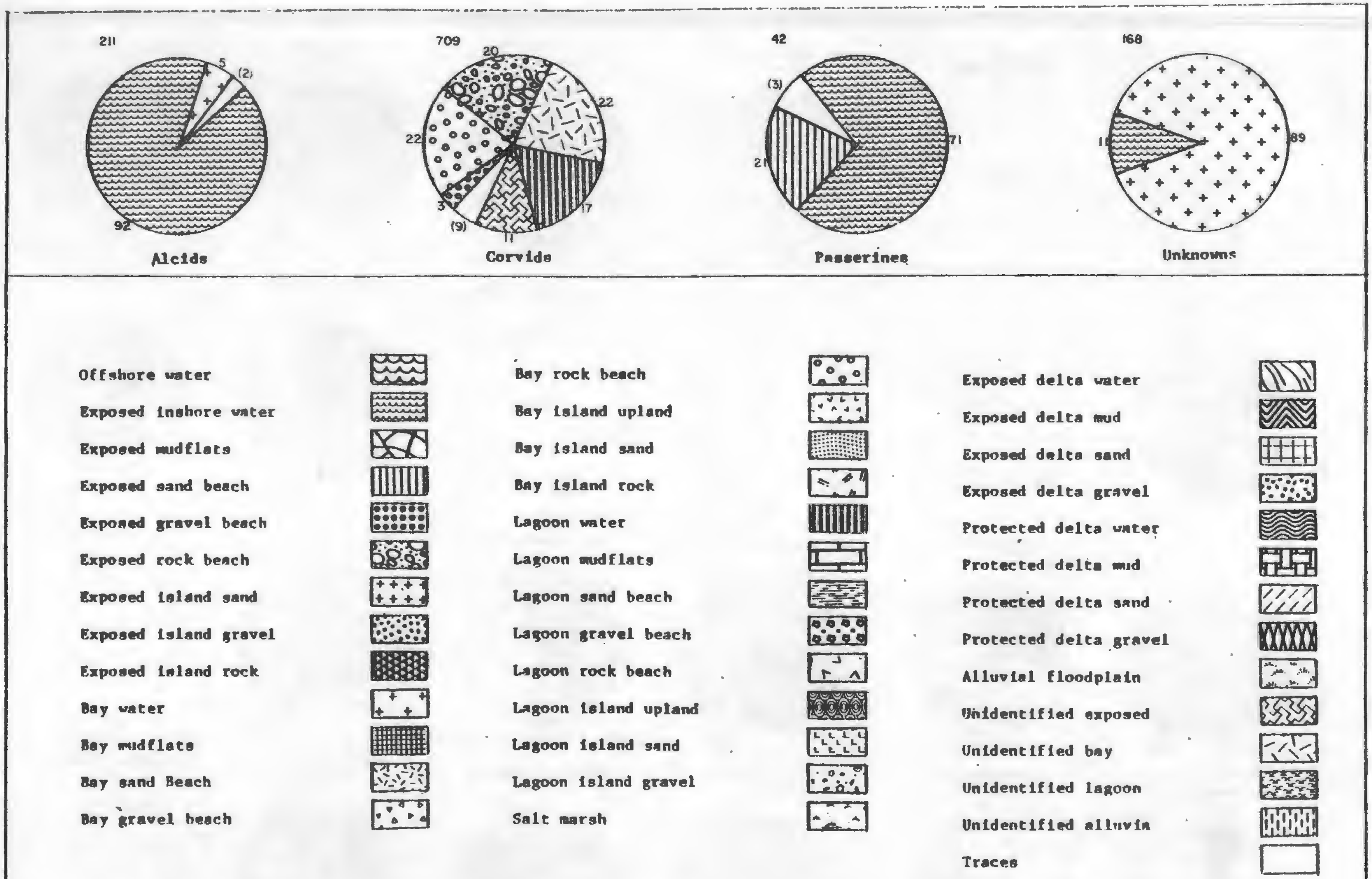
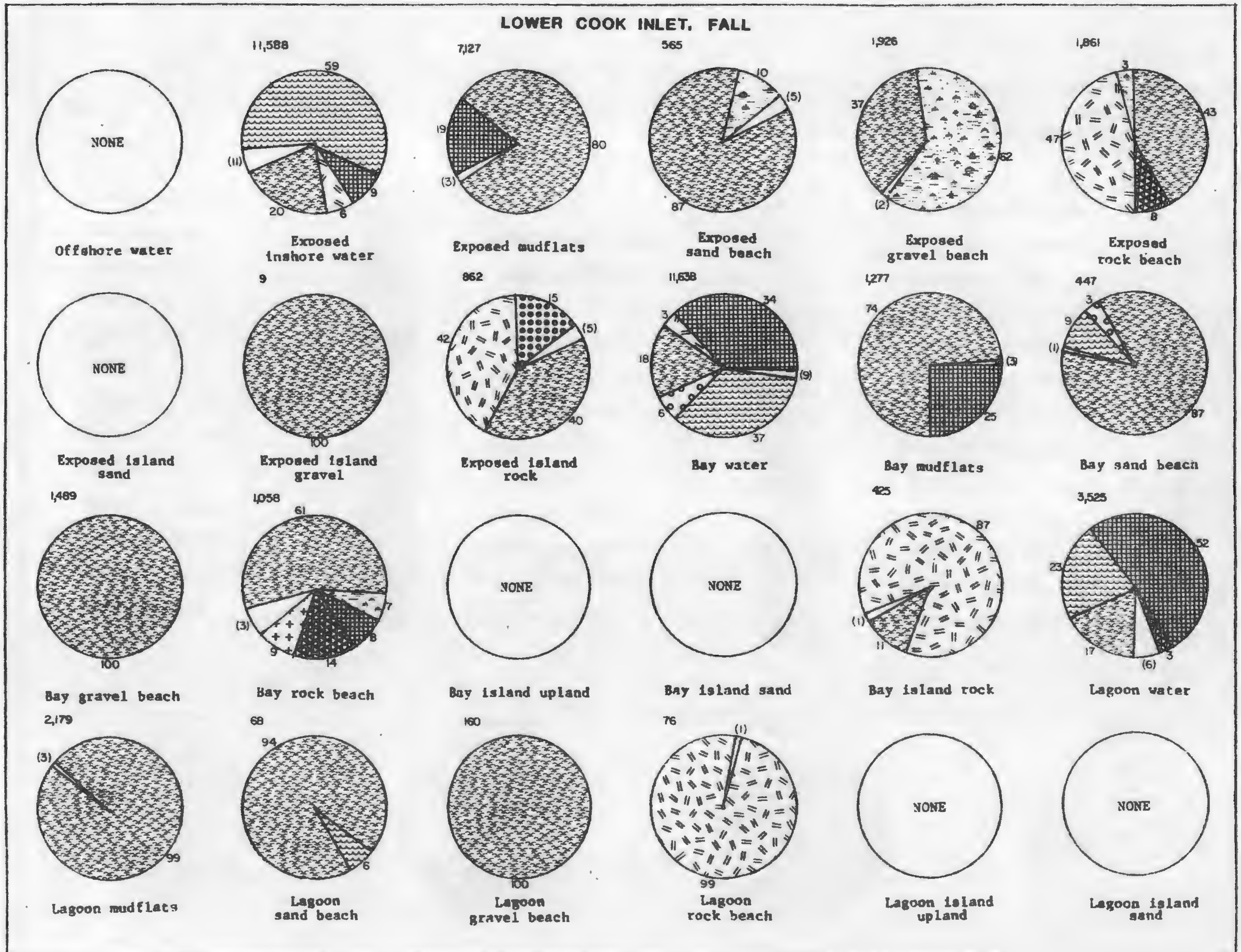


Fig. 99. Lower Cook Inlet, Fall 1976-1977. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


LOWER COOK INLET, FALL
NONE
Offshore water
11,588
59
(11)
20
6
9
Exposed inshore water
7,127
19
(3)
80
Exposed mudflats
565
10
(5)
87
Exposed sand beach
1,926
37
62
(2)
Exposed gravel beach
1,861
3
47
43
8
Exposed rock beach
NONE
Exposed island sand
9
100
Exposed island gravel
862
15
(5)
42
40
Exposed island rock
11,638
34
3
18
(9)
6
37
Bay water
1,277
74
(3)
25
Bay mudflats
447
3
9
(1)
87
Bay sand beach
1,489
100
Bay gravel beach
1,058
61
7
(3)
8
9
14
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
425
87
(1)
11
Bay island rock
3,525
52
23
17
(6)
3
Lagoon water
2,179
(3)
99
Lagoon mudflats
68
94
6
Lagoon sand beach
160
100
Lagoon gravel beach
76
(1)
99
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

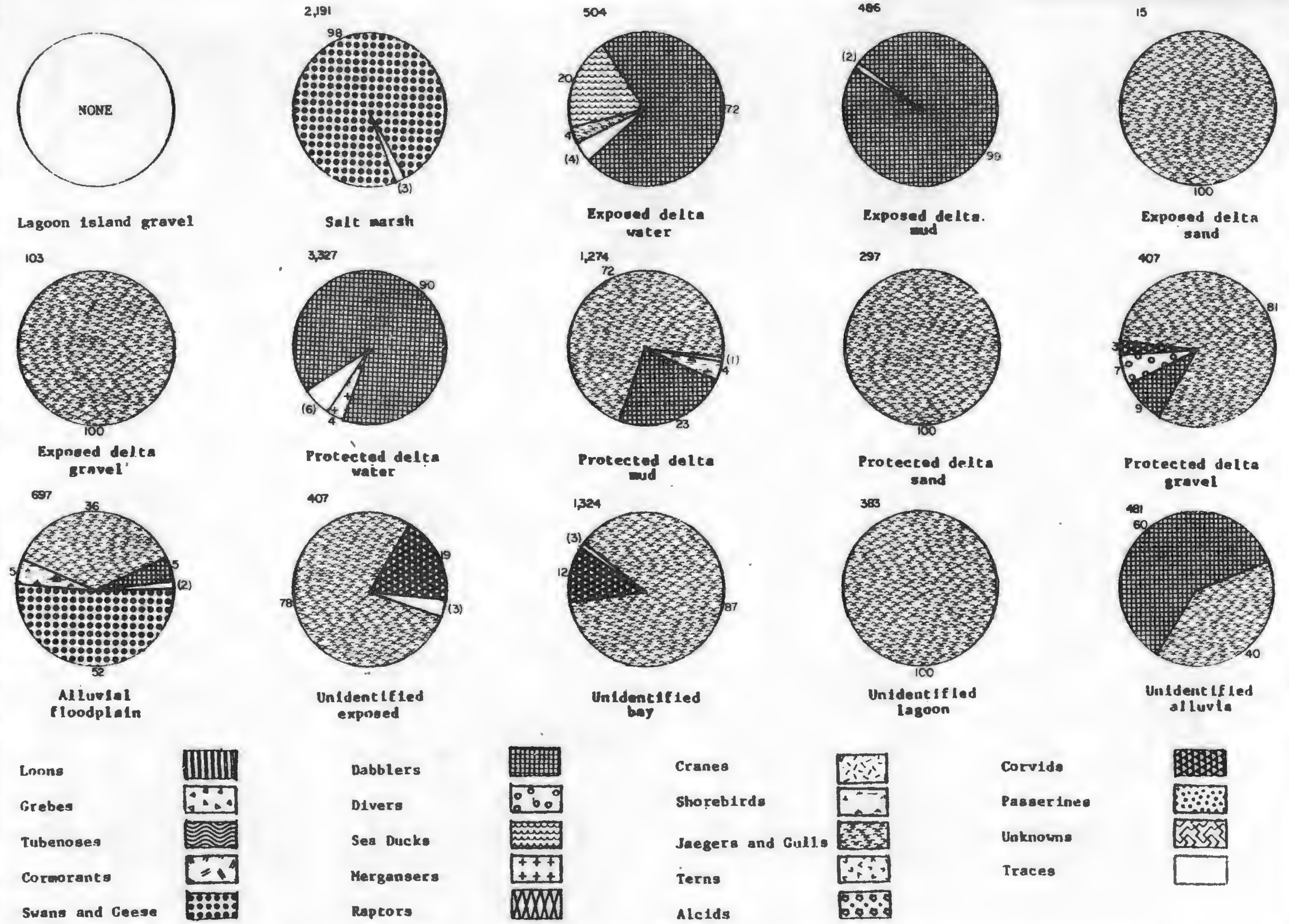


Fig. 100. Lower Cook Inlet, Fall 1976-1977. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Almost three-fourths of the shorebirds, which comprised less than 3 percent of the total birds, were on exposed gravel beaches. Six percent were on exposed mudflats, 5 percent on bay rock beach, 4 percent on exposed sand beach, and 3 percent on both exposed rock beach and protected delta mud. Diving ducks made up less than 2 percent of birds seen; almost two-thirds of these were observed on bay water and 21 percent were on exposed inshore water. Corvids were the only other group with over 1 percent of the total and most of these were on unspecified habitats, likely because they were flying and could not be associated with a particular habitat.

WINTER

Shoreline Denisty - In winter coastal densities of birds dropped to over one-half of their fall densities, 66 to 32 birds/km^2 (Table 12). The largest decrease was in gull densities (26 birds/km^2 in fall to 3 birds/km^2 in winter). When fall migrating dabblers (15 birds/km^2) left the area, a wintering population of 2 dabblers/km^2 remained. Sea duck densities were about the same in winter as in fall (15 vs. 14 birds/km^2). A slight increase in density was noted for diving ducks and shorebirds, from 1 bird/km^2 in fall to 4 birds/km^2 in winter for divers and from 2 to 5 birds/km^2 for shorebirds. Corvid densities remained the same fall and winter and were slightly higher than in spring and summer.

In winter, there was a marked difference in densities between the east and west sides of the Inlet. A density of 47 birds/km^2 was observed on the six eastern sections. Section 4, in inner Kachemak Bay, had the highest density, 99 birds/km^2. Several species groups made up that total. One-third were sea ducks (33 birds/km^2) plus 23 divers/km^2, 20 dabblers/km^2, 12 shorebirds/km^2 and 5 corvids/km^2. There was 1 bird/km^2 for mergansers, gulls and alcids. A density of 82 birds/km^2 was found on the north side of outer Kachemak Bay (Section 3). Most of the birds in this section were sea ducks (43 birds/km^2) and gulls (29 birds/km^2). Four birds/km^2 were recorded for both cormorants and shorebirds in Section 3. The only winter site of high density was 321 corvids/km^2 on Cohen Island in Section 5 on the south side of outer Kachemak Bay. The north portion of the eastern side of the Inlet (Section 1) had only a trace of birds and Section 2 had 14 birds/km^2.

On the west side, the overall density was 16 birds/km^2. Except for Section 8, with a density of 81 birds/km^2, densities were low in all sections for all bird groups. Most of the birds in Section 8 represented two large flocks of shorebirds in Tuxedni Channel which resulted in a density of 75 shorebirds/km^2. Twenty-seven sea ducks/km^2 were found in Section 12, and the remaining densities were 10 birds/km^2 or less. Many of the sections had few bird types present and one, Section 14, had no birds at all. Gull densities were highest in Section 15 at 5 birds/km^2. Sea ducks, alcids and gulls were the most frequently observed groups.

Pelagic Density - Five birds/km^2 were recorded in offshore waters for Lower Cook Inlet in winter (Table 11). Sea ducks were the most abundant

Table 12. Bird density by section of coastline in Lower Cook Inlet, winter 1976, 1978. See Figure 58 for section boundaries. (T=trace).

	Winter Densities (birds/km^2)																	
	Section of Coastline																	
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Loon		T	T	T	1	T												T
Grebe			T			T									T			T
Tubenose																		0
Cormorant		T	4	T	1	3					T		T					1
Goose and Swan			T															T
Dabbler				20	T	2												2
Diver		T	T	23	10	7			T		T	T						4
Sea Duck	T	11	43	33	31	27	T	3	T	2	4	27	7		10		1	15
Merganser				1	1	1												T
Raptor		T	T	T	T	T			T		T							T
Crane																		0
Shorebird			4	12	2	2		75				T						5
Gull and Jaeger	T	3	29	1	1	1	2	2	3	T	2				5		1	3
Tern																		0
Alcid	T	T	1	1	2	T	T	T	T		1	T	1		T		T	T
Corvid	T	T	T	5	2	3		T			T	T	T		T			1
Other Passerine					T	T					T							T
Other Bird			T	3	1	2												T
TOTAL	T	14	82	99	52	48	3	81	4	2	7	27	7	0	15		1	32

group (3 birds/km^2) followed by gulls and alcids with 1 bird/km^2 each. Region 3, Kachemak Bay, had the greatest density (18 birds/km^2) and led other regions in species group densities for alcids (8 birds/km^2), sea ducks (7 birds/km^2) and gulls (3 birds/km^2). Sea ducks had a density of 4 birds/km^2 in both Sections 1 and 2. Only sea ducks were present in Region 5 (1 bird/km^2). Cormorants, sea ducks, gulls and alcids were each found in Regions 1-4. Tubenoses, in this case Northern Fulmars (*Fulmarus glacialis*), were present in Region 1 only.

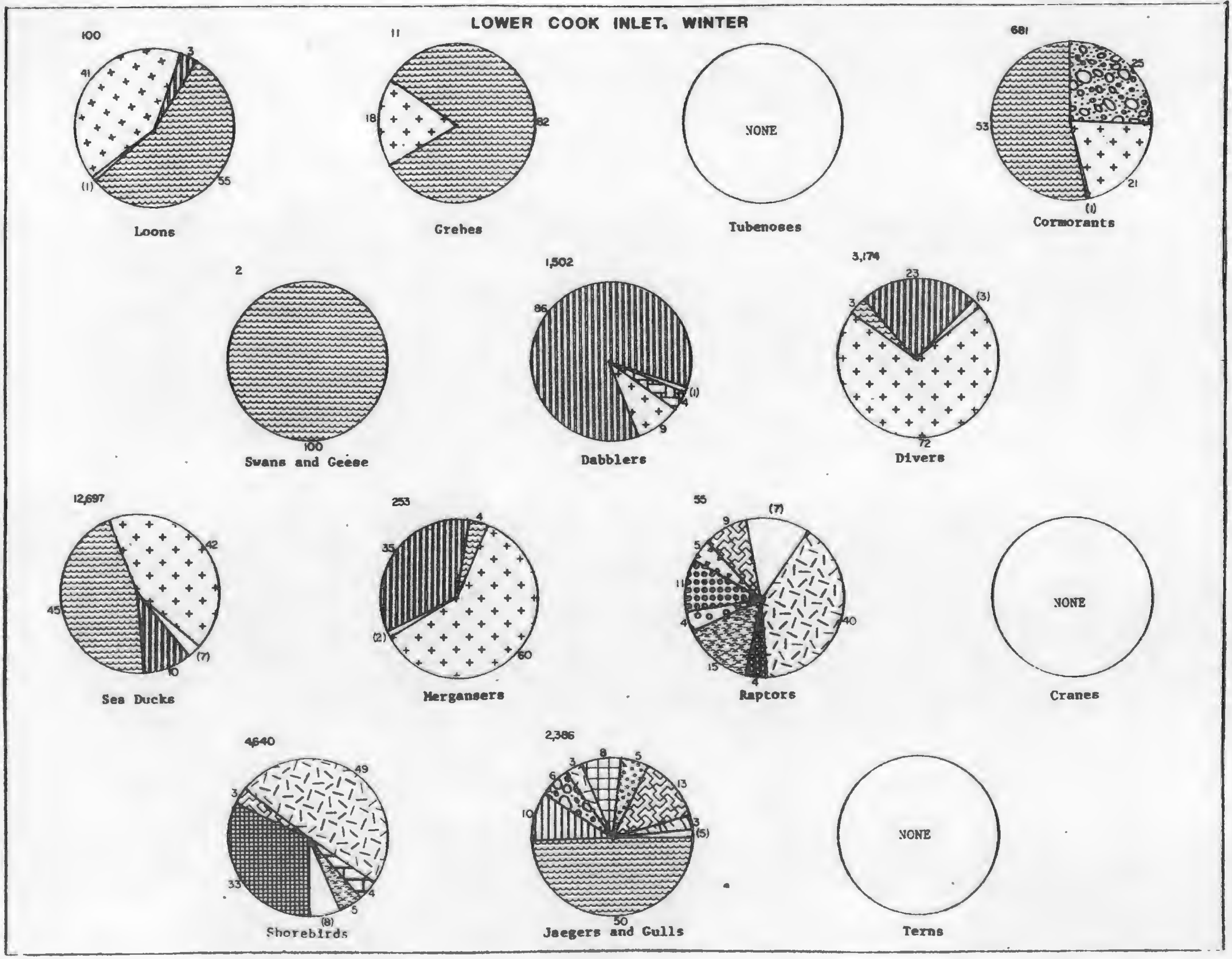
Habitat Usage - In winter, birds of Lower Cook Inlet concentrated on four basic habitat types: bay water (32%), exposed inshore water (28%), lagoon water (12%) and bay mudflats (11%). Fourteen other habitat types were used but in lesser intensities. Combined bay/fjord areas provided habitat for 48 percent of the birds, exposed habitats 34 percent and lagoon/embayment habitats 15 percent. Only 3 percent were on river/stream deltas, 2 percent on protected and 1 percent on exposed.

Diagrams of winter habitat preferences of each species group and of what species groups were found on each habitat type are shown on Figs. 101 and 102. On bay waters, 62 percent of the birds were sea ducks and 27 percent diving ducks. Seventy-five percent of the birds on exposed inshore waters were sea ducks, 16 percent gulls and 5 percent cormorants. Waterfowl species predominated on lagoon/embayment water; 39 percent of the birds were dabblers, 36 percent sea ducks, 22 percent divers and 3 percent mergansers.

Forty-seven percent of the winter birds in Lower Cook Inlet surveys were sea ducks. Forty-five percent were found on exposed inshore waters, 42 percent on bay waters and 10 percent on lagoon waters. Shorebirds were next most abundant (17% of total), and 33 percent were on bay mudflats. Almost half of the shorebirds were on unspecified bay habitats. When birds were sighted in the air, as shorebirds often were, the habitat from which they flushed often was unknown. Diving ducks made up 12 percent of the total and were most commonly found on bay water (72%) and lagoon water (23%). One-half the gulls, which made up 9 percent of the total, were observed on exposed inshore waters, 10 percent on exposed sand beach, 6 percent on exposed rock beach and an additional 13 percent on unspecified exposed habitats. Most of the rest were on exposed delta habitats: 8 percent sand, 5 percent gravel and 3 percent water. Only 6 percent of the gulls were on protected habitats. The only other bird group found in relatively high numbers (dabblers) were observed on lagoon waters 86 percent of the time, on bay water 9 percent and protected delta mud 4 percent. Raptors, although found in small numbers, were recorded on the most habitat types (11).

SOUTH - ALASKA PENINSULA

Three aerial surveys were conducted in this region (Fig. 103 and 104). One in fall 1976 covered only the southern three sections from Cold Bay to Unimak Island (Fig. 104). The first winter survey covered only


LOWER COOK INLET, WINTER
100
41
3
(1)
55
Loons
11
18
82
Grebes
NONE
Tubenoses
681
25
53
21
(1)
Cormorants
2
100
Swans and Geese
1,502
86
(1)
4
9
Dabblers
3,174
23
3
(3)
72
Divers
12,697
42
45
(7)
10
Sea Ducks
253
4
35
(2)
60
Mergansers
55
9
(7)
5
11
4
15
4
40
Raptors
NONE
Cranes
4,640
49
3
33
(8)
5
4
Shorebirds
2,386
6
3
8
5
13
10
3
(5)
50
Jaegers and Gulls
NONE
Terns

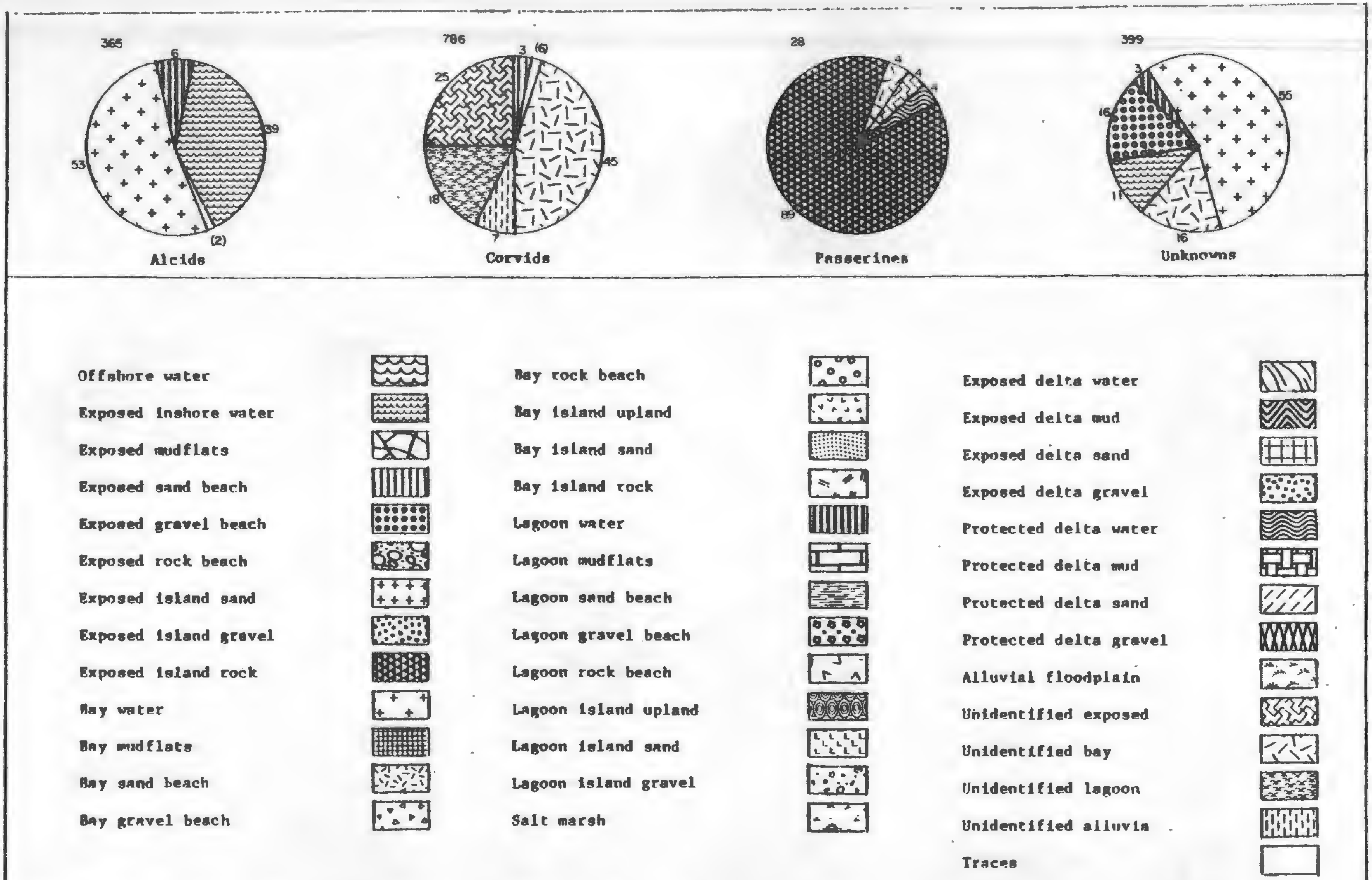
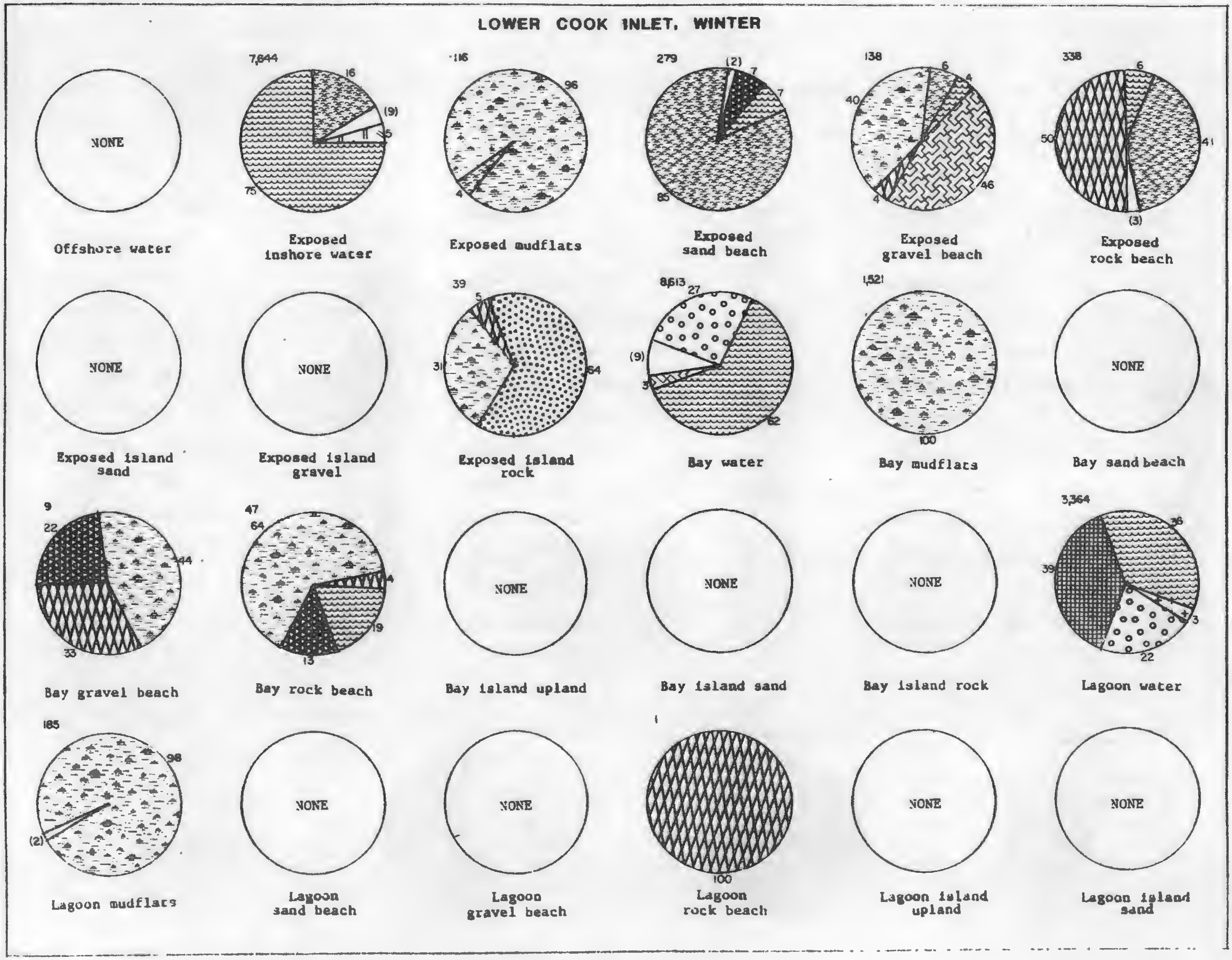


Fig. 101. Lower Cook Inlet, Winter 1976, 1978. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


LOWER COOK INLET, WINTER
NONE
Offshore water
7,644
16
(9)
5
75
Exposed inshore water
116
96
4
Exposed mudflats
279
(2)
7
7
85
Exposed sand beach
138
6
4
40
46
4
Exposed gravel beach
338
6
50
41
(3)
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
39
5
31
64
Exposed island rock
8,613
27
(9)
3
62
Bay water
1,521
100
Bay mudflats
NONE
Bay sand beach
9
22
44
33
Bay gravel beach
47
64
4
19
13
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
3,364
36
39
3
22
Lagoon water
185
98
(2)
Lagoon mudflats
NONE
Lagoon sand beach
NONE
Lagoon gravel beach
1
100
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

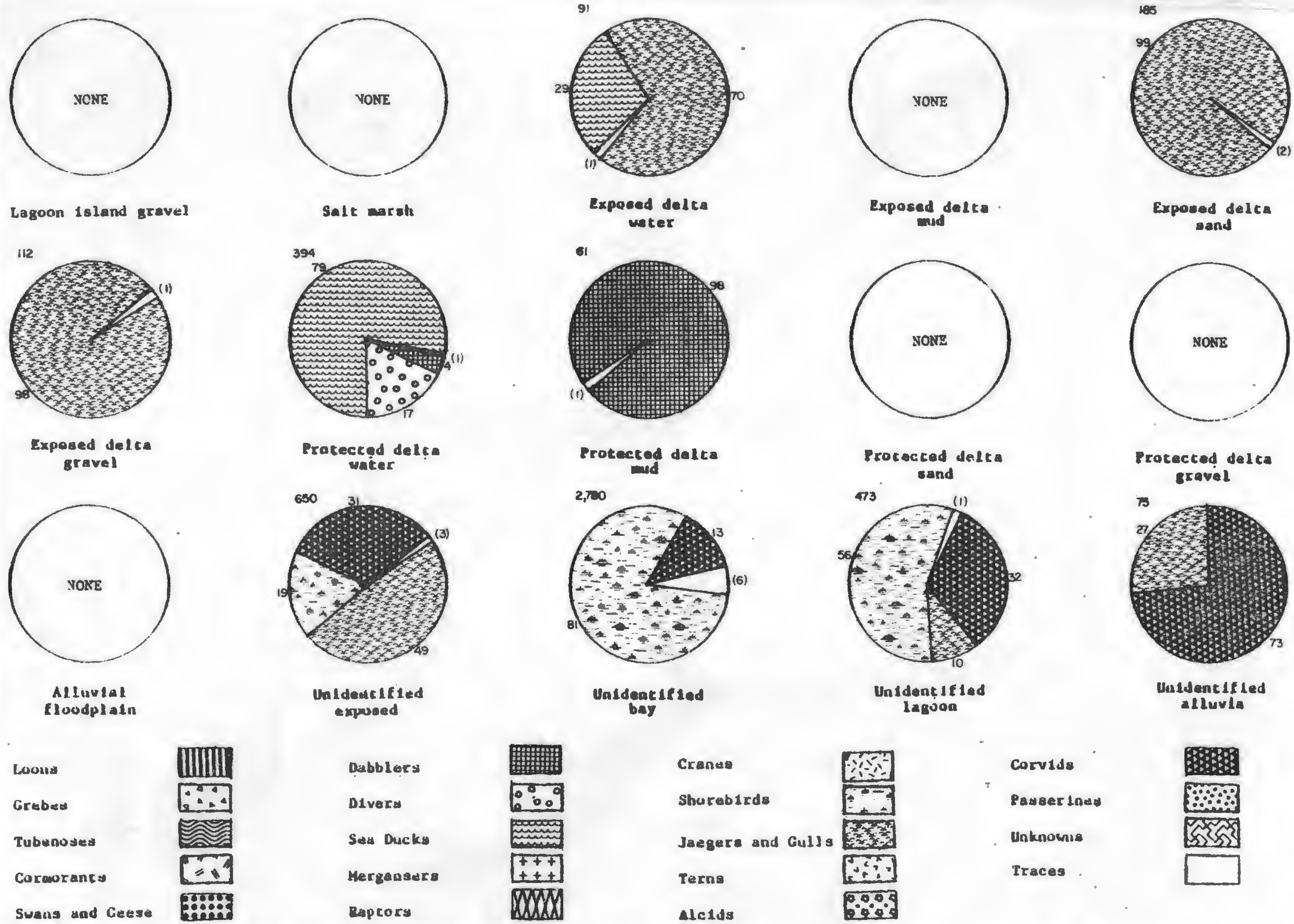


Fig. 102. Lower Cook Inlet, Winter 1976, 1978. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

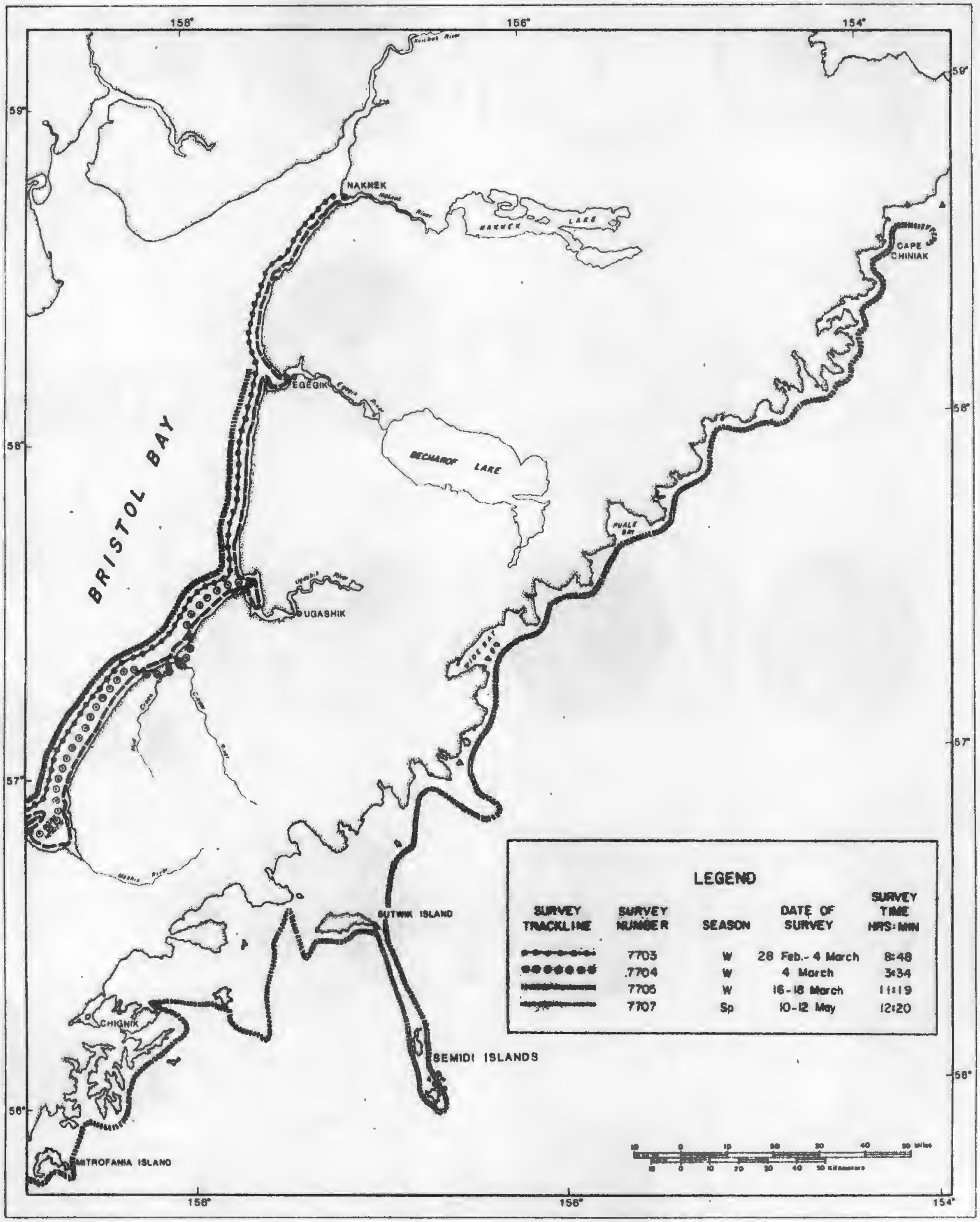


Fig. 103. Tracklines of aerial bird surveys along North- and South-Alaska Peninsula, 1977. Continued on next page.

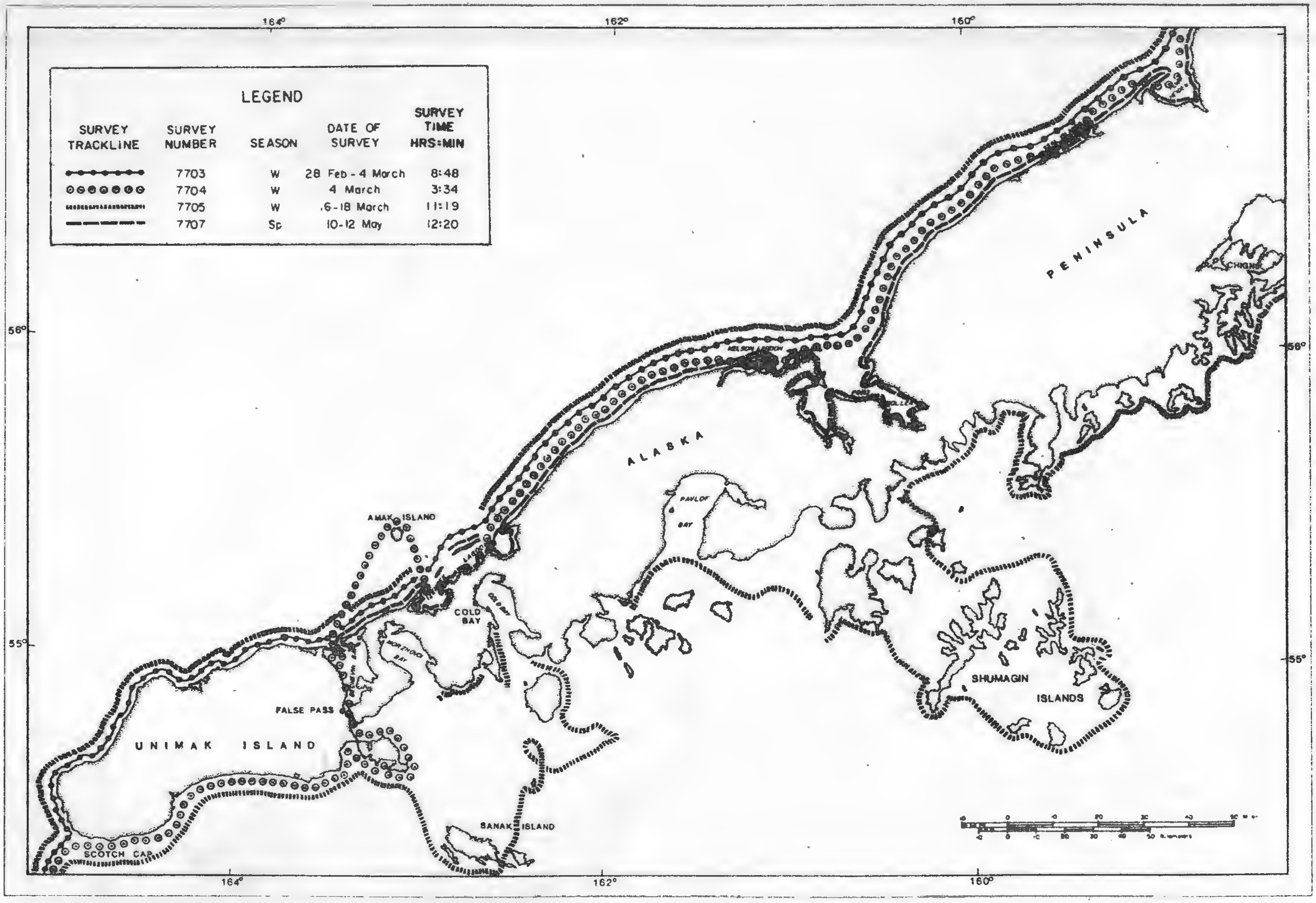


Fig. 103 (cont.). Tracklines of aerial bird surveys along North- and South-Alaska Peninsula, 1977.

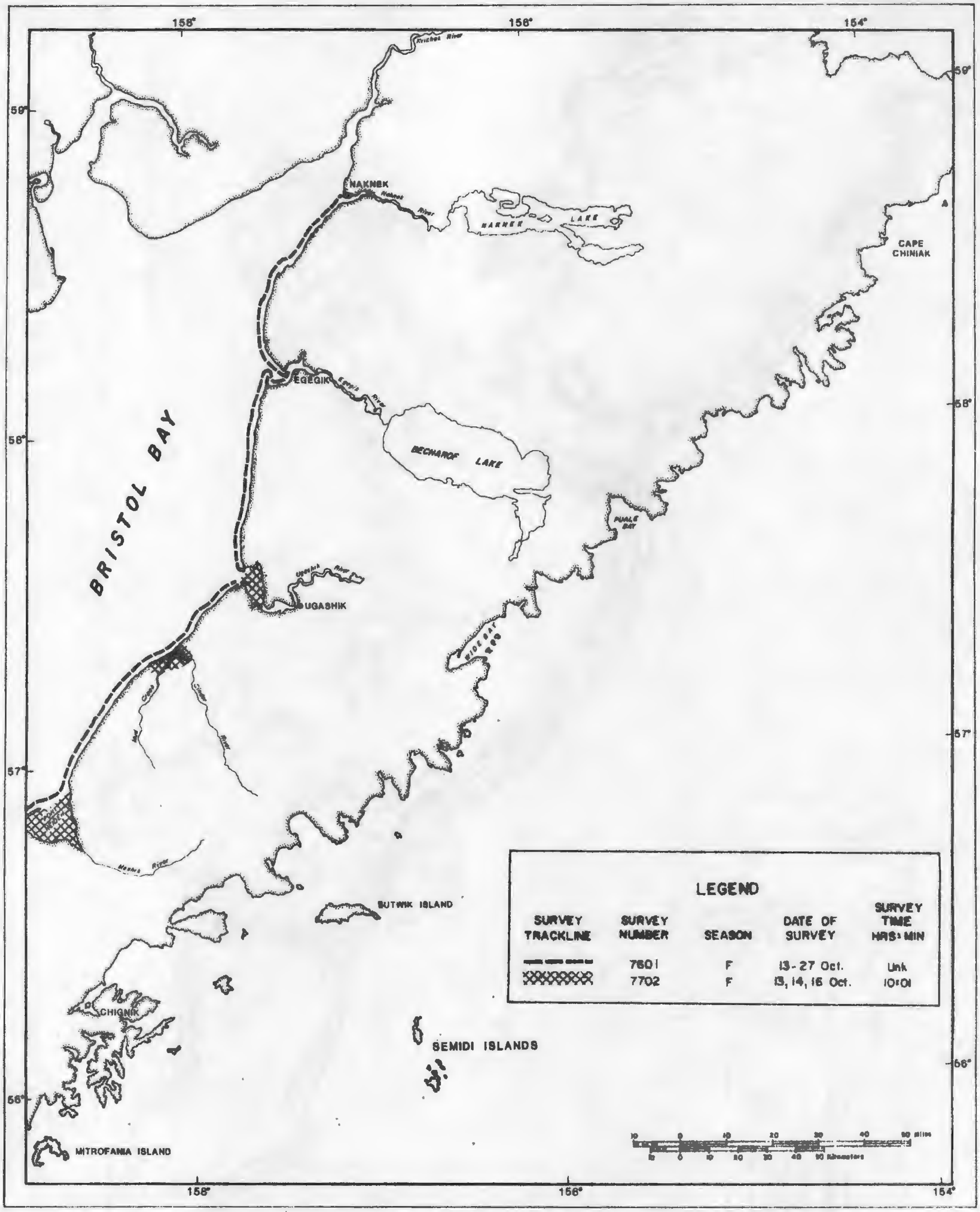


Fig. 104. Tracklines of aerial bird surveys along North-Alaska Peninsula, 1975 and 1976. Continued on next page.

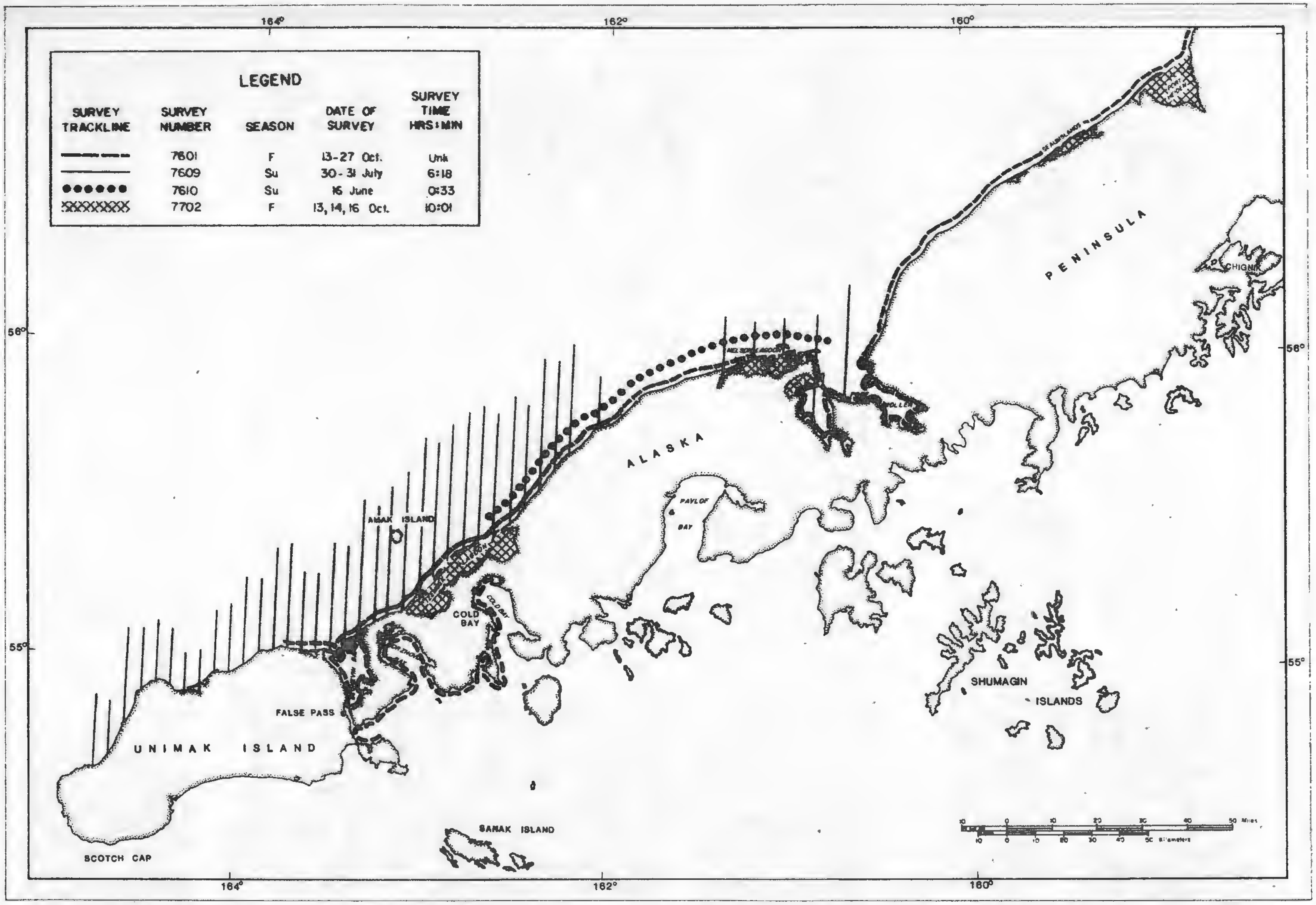


Fig. 104 (cont.). Tracklines of aerial bird surveys along North-Alaska Peninsula, 1975 and 1976.

Unimak Island (Section 8). Another winter survey was conducted in mid-March 1977 in conjunction with an ADF&G marine mammal survey (Fig. 103). On this survey only one bird observer was present, and the trackline was generally offshore or in exposed nearshore waters as we headed between islands or promontories that were traditional hauling areas for sea lions. Few protected habitats were searched, and the species densities and habitat selection recorded reflected this.

The region was subdivided into eight sections (Fig. 105) following the winter trackline. The first section corresponds to the boundary of the Shelikof Strait area. The rest, up to Cold Bay, encompasses island groups or the coastline between. These groups from Cold Bay to Scotch Cap, sections are more typical coastal physiographic areas.

FALL

Density - Bird density information for South-Alaska Peninsula is pictorially displayed in Figs. 106-123. Fall bird densities were high (279 birds/km^2) in the three sections surveyed (Table 13). Most of the birds were geese (227 birds/km^2, 82 percent of the total) including Brant, Canada and Emperor geese. Gull densities were only 17 birds/km^2, dabblers 14 birds/km^2, sea ducks 10 birds/km^2, divers 4 birds/km^2, cormorants 3 birds/km^2 and shorebirds 1 bird/km^2.

Of the three sections surveyed, Section 7 (Morzhovoi Bay area) had the highest bird densities (363 birds/km^2) and Section 8, the south side of Unimak Island, the lowest (90 birds/km^2). Geese comprised over 90 percent of the birds in Section 7 and 75 percent of the birds in Section 6. Most of the geese were found in lagoons at the heads of both bays. Highest goose densities were found at Old Man's Lagoon in Cold Bay and Big Lagoon in Morzhovoi Bay (over 1,000 and 2,000 birds/km^2, respectively). Geese were not found in Section 8 in fall. Its avifauna was comprised of gulls (69 birds/km^2), sea ducks (11 birds/km^2) and cormorants (10 birds/km^2). Dabblers were most abundant in Section 6 where 20 birds/km^2 were recorded. The remaining bird groups were seen in small or trace amounts. Although tubenoses were not recorded during the 20 October 1975 survey, on 17 October 1976, when we mapped the area and were not recording birds except for incidental observations, tens of thousands of shearwaters were feeding in scattered groups throughout Morzhovoi Bay. They were, most likely, opportunistically feeding there and may not visit the bay in fall on a regular basis. Also on that mapping flight, we observed hundreds of Emperor Geese along the coast to Pavlof Bay, the terminus of our flight.

Habitat Usage - Only a few habitats were recorded during the abbreviated fall survey. Information is depicted in diagrams in Figs. 124 and 125. Only seven discrete habitats on which birds were found were recorded for this area. Eighty-four percent of the birds observed were in lagoon habitats, 6 percent in bays and 5 percent in both saltmarsh and exposed inshore habitats. On lagoon waters, 97 percent of the birds were geese and on lagoon beaches 84 percent were geese. On bay waters only 41

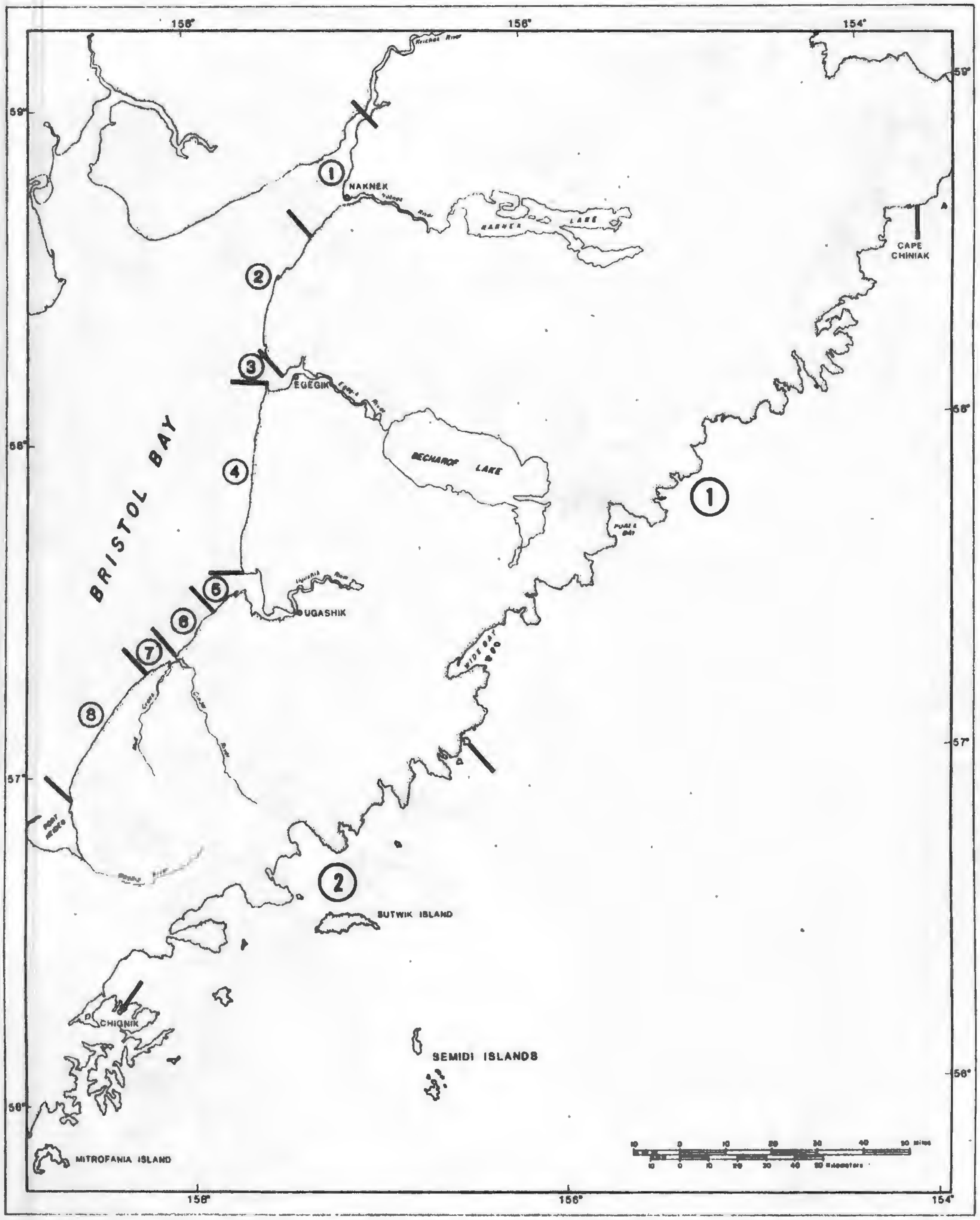


Fig. 105. Physiographic subdivision of North- and South-Alaska Peninsula for bird density analysis. The North-Alaska Peninsula survey region is labeled with the smallest circled numbers. Each numbered section contains several survey stations. (Figure continued on next page.)

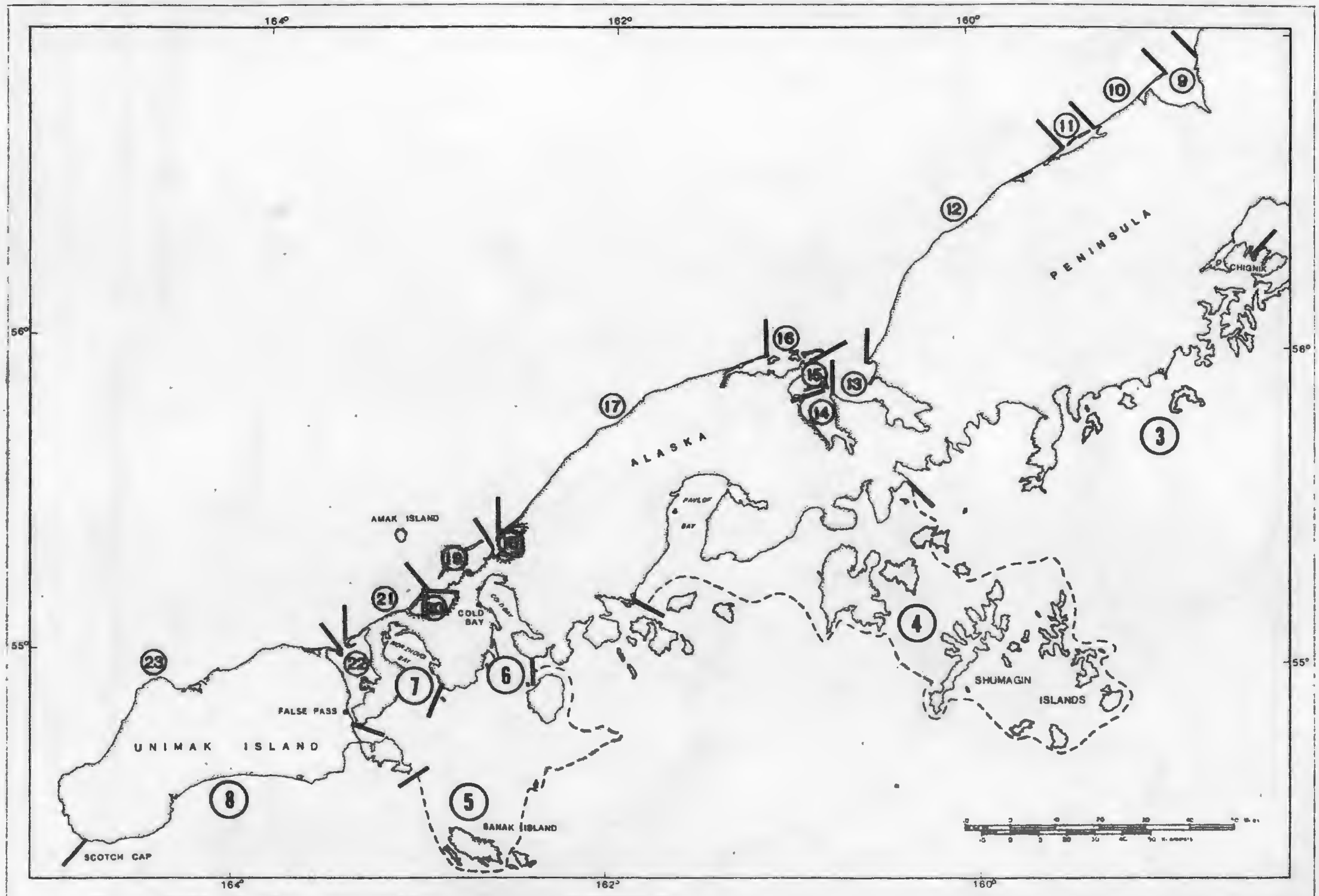


Fig. 105 (cont.). Physiographic subdivision of North- and South-Alaska Peninsula for bird density analysis. The North-Alaska Peninsula survey region is labeled with the smallest circled numbers. Each numbered section contains several survey stations.

Table 13. Bird density by section of coastline in South-Alaska Peninsula, fall 1976, winter 1977. See Figure 105 for section boundaries. (T=trace).

	Fall Densities (birds/km²)				Winter Densities (birds/km²)								
	Section of Coastline				Section of Coastline								
Bird Group	6	7	8	Total	1	2	3	4	5	6	7	8	Total
Loon	1			T	T	T	T	T	T	T		T	T
Grebe		T		T			T	T	T			T	T
Tubenose				0		T							T
Cormorant	2	3	10	3	2	4	3	4	4	4		2	3
Goose and Swan	195	335		227	10	3	1	1	7	T		1	3
Dabbler	20	7		14			T	T		9		T	T
Diver	6	3		4	T		1			12			1
Sea Duck	13	3	11	10	20	3	20	18	8	41		26	18
Merganser	T	T		T			T		T	1			T
Raptor	T		T	T	T	T	T	T	T			T	T
Crane				0									0
Shorebird	1	2		1	3	T	1	5	7	5		T	2
Gull and Jaeger	16	7	69	17	10	2	20	6	4	26		12	9
Tern				0									0
Alcid	T	T	T	T	1	3	92	90	20			T	29
Corvid	T	T		T	1	T		T	T	T		T	T
Other Passerine	T			T								T	T
Other Bird		2		1								T	T
TOTAL	255	363	90	279	47	15	138	124	50	99	*	42	67

* Not surveyed.

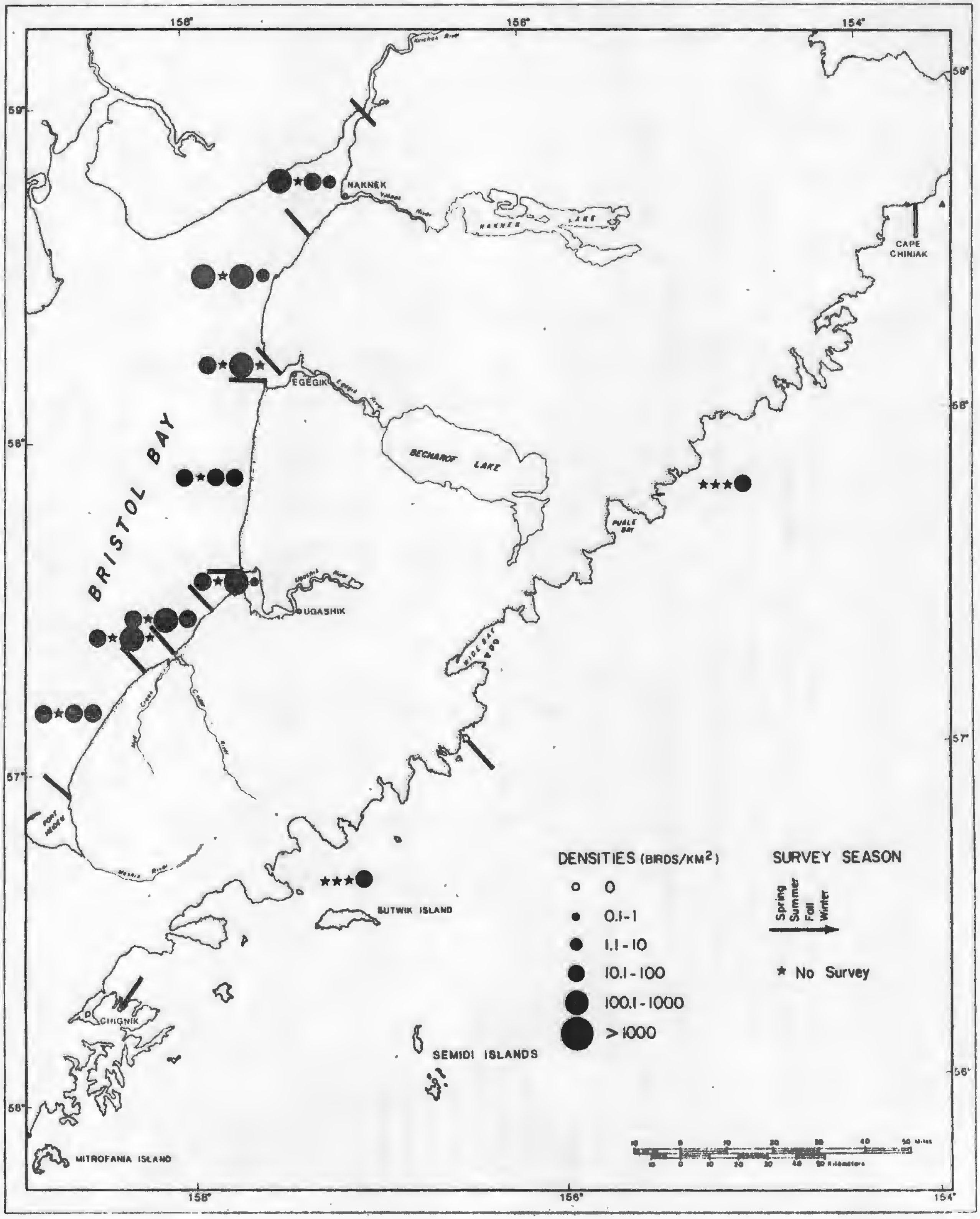


Fig. 106. Total bird density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

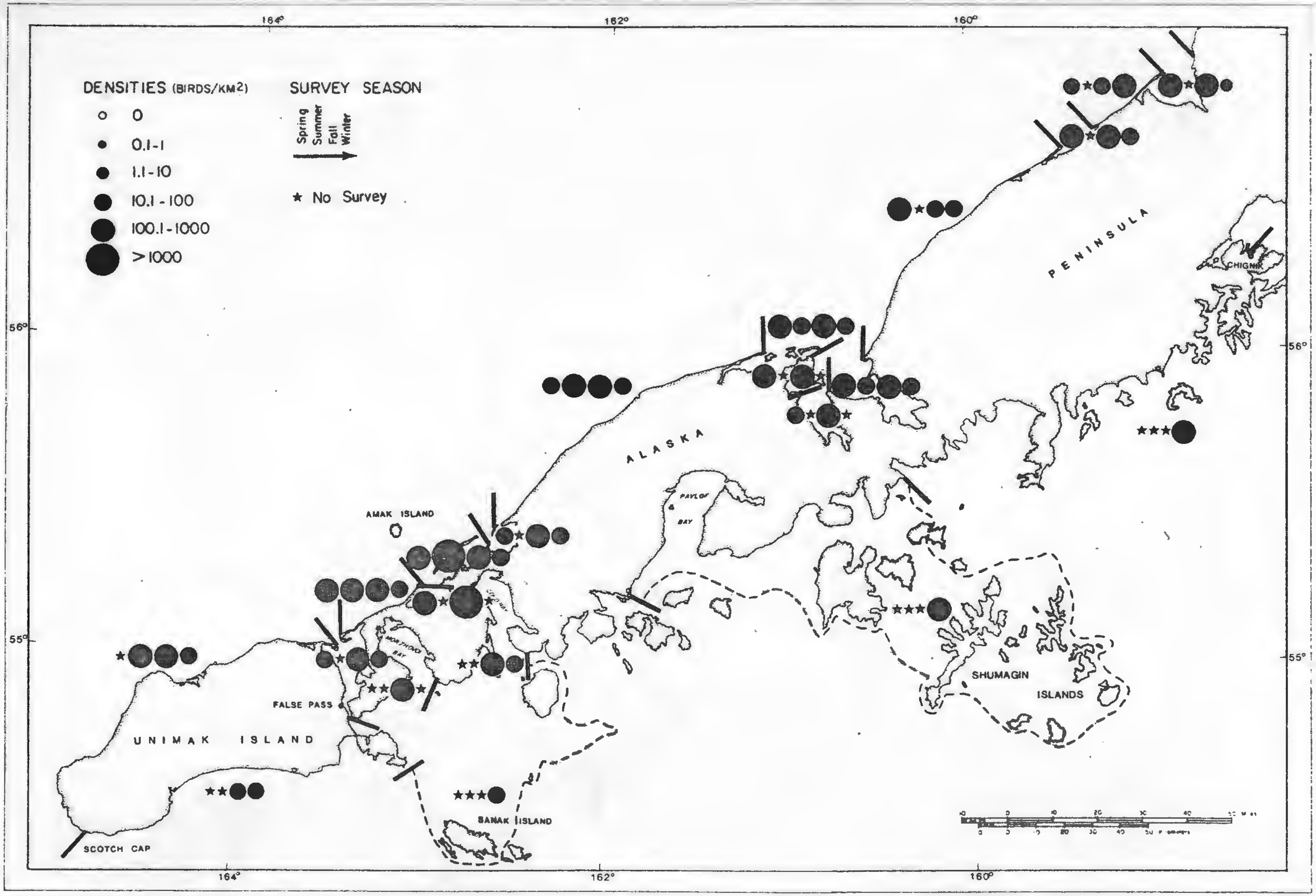


Fig. 106 (co'nt.). Total bird density by section along North- and South Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

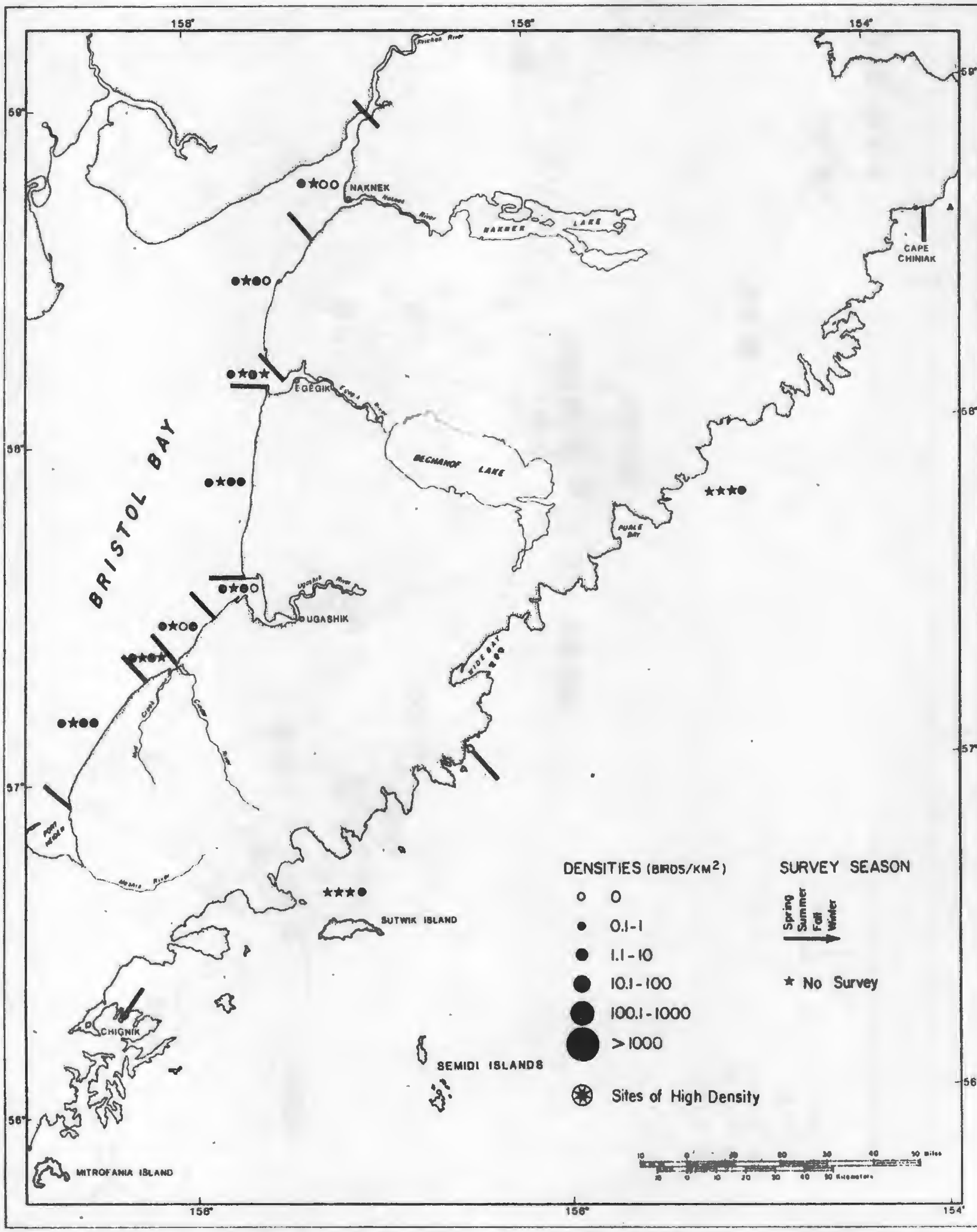


Fig. 107. Loon density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

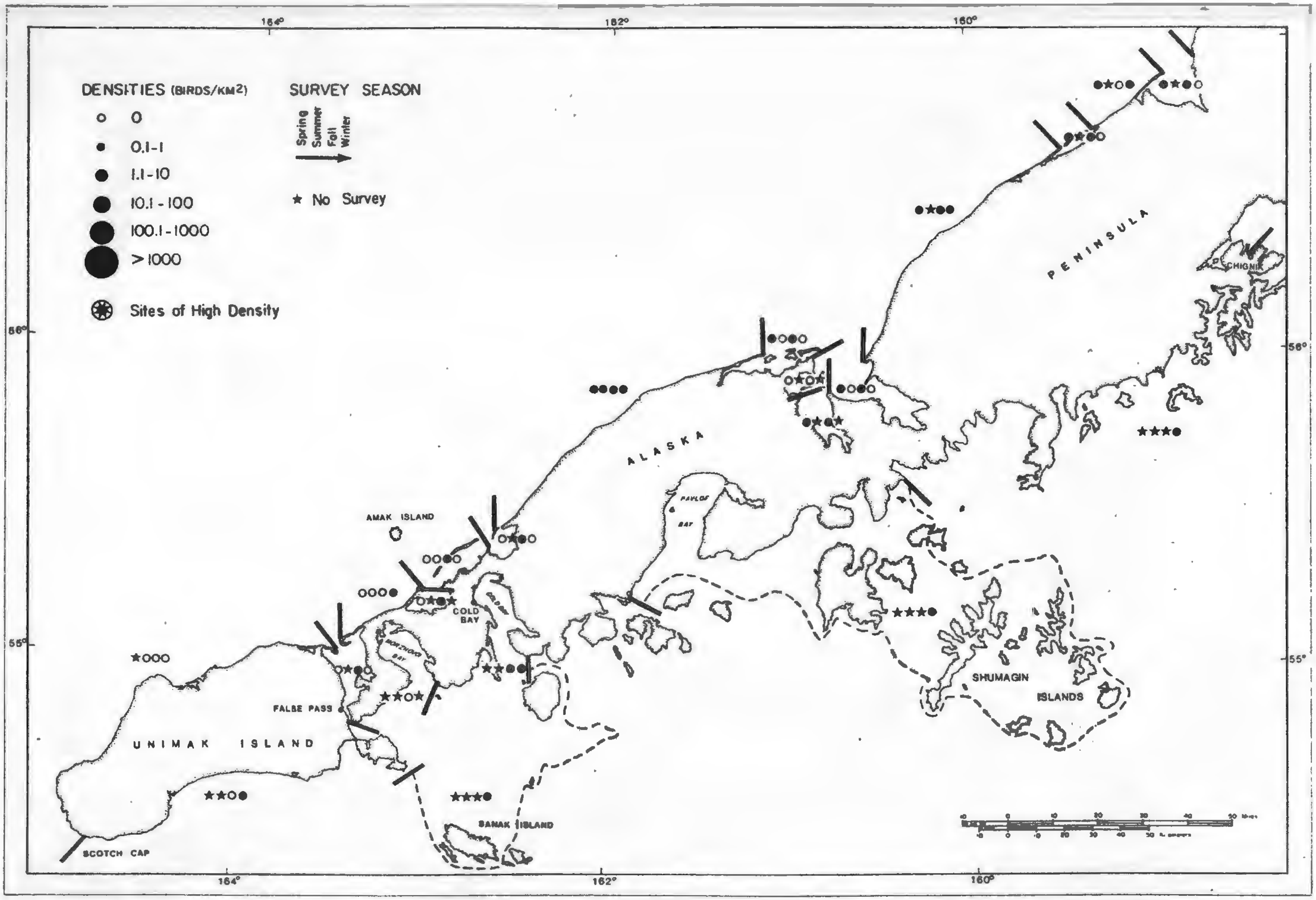


Fig. 107 (cont.). Loon density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

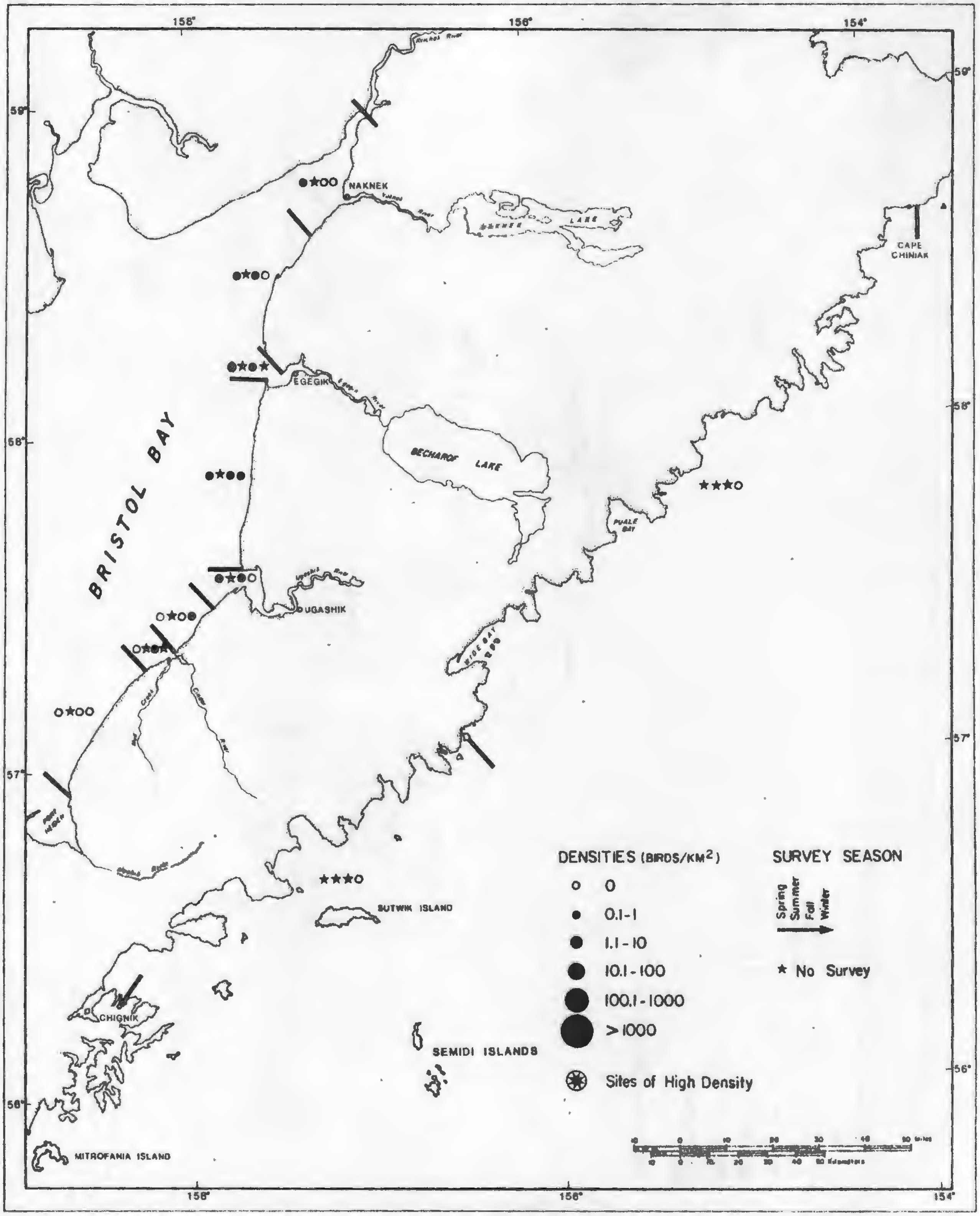


Fig. 108. Grebe density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

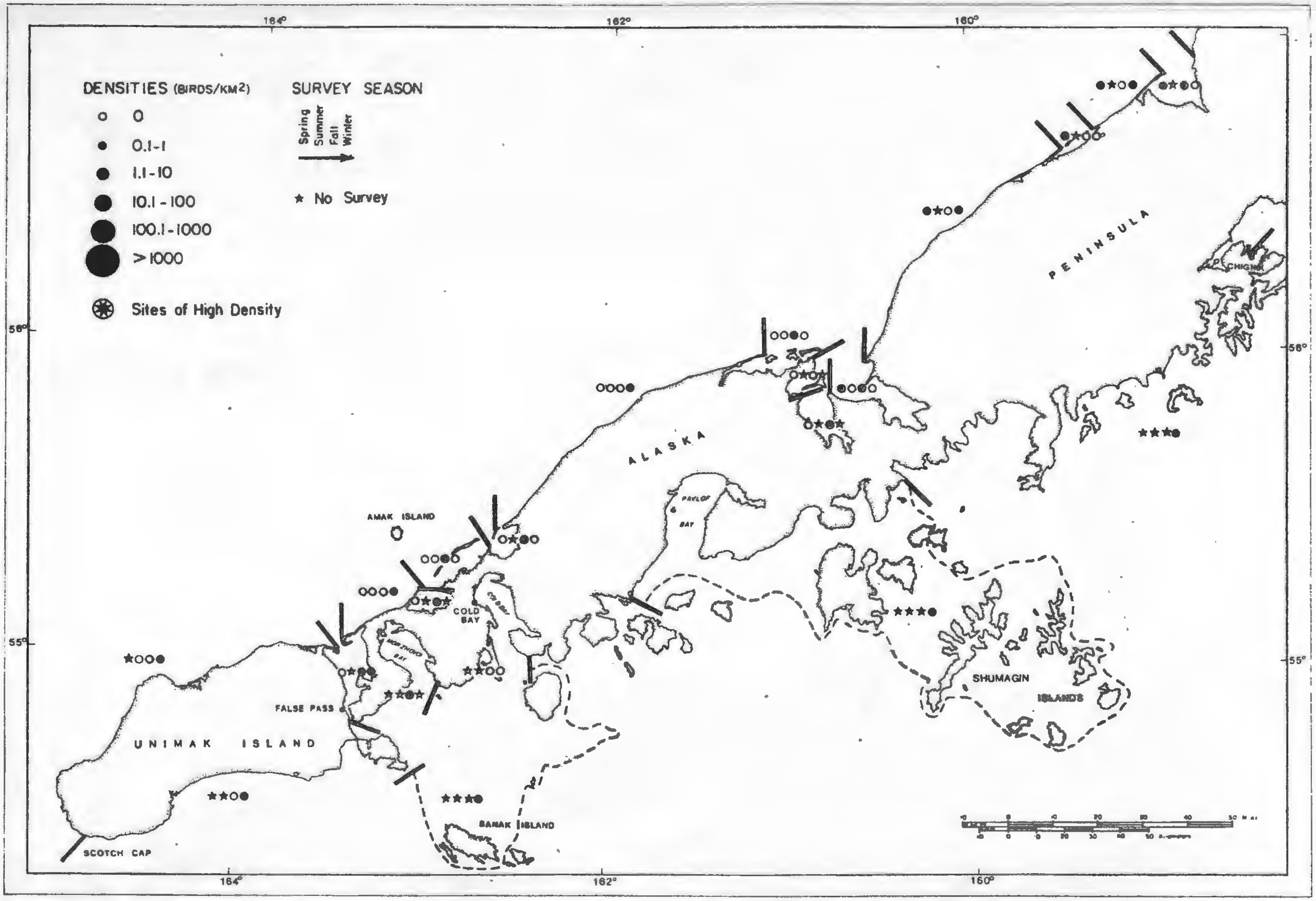


Fig. 108 (cont.). Grebe density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

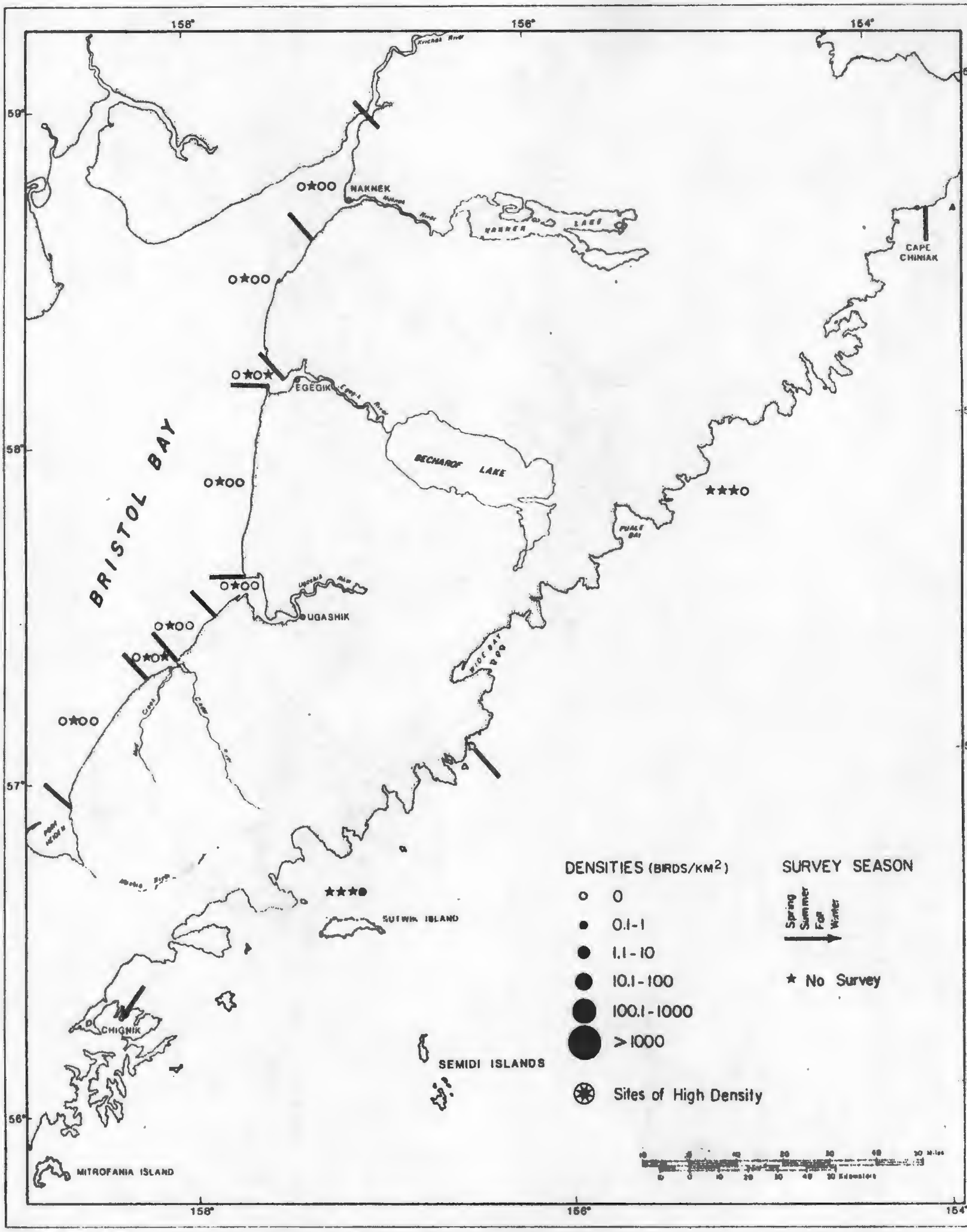


Fig. 109. Tubenose density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

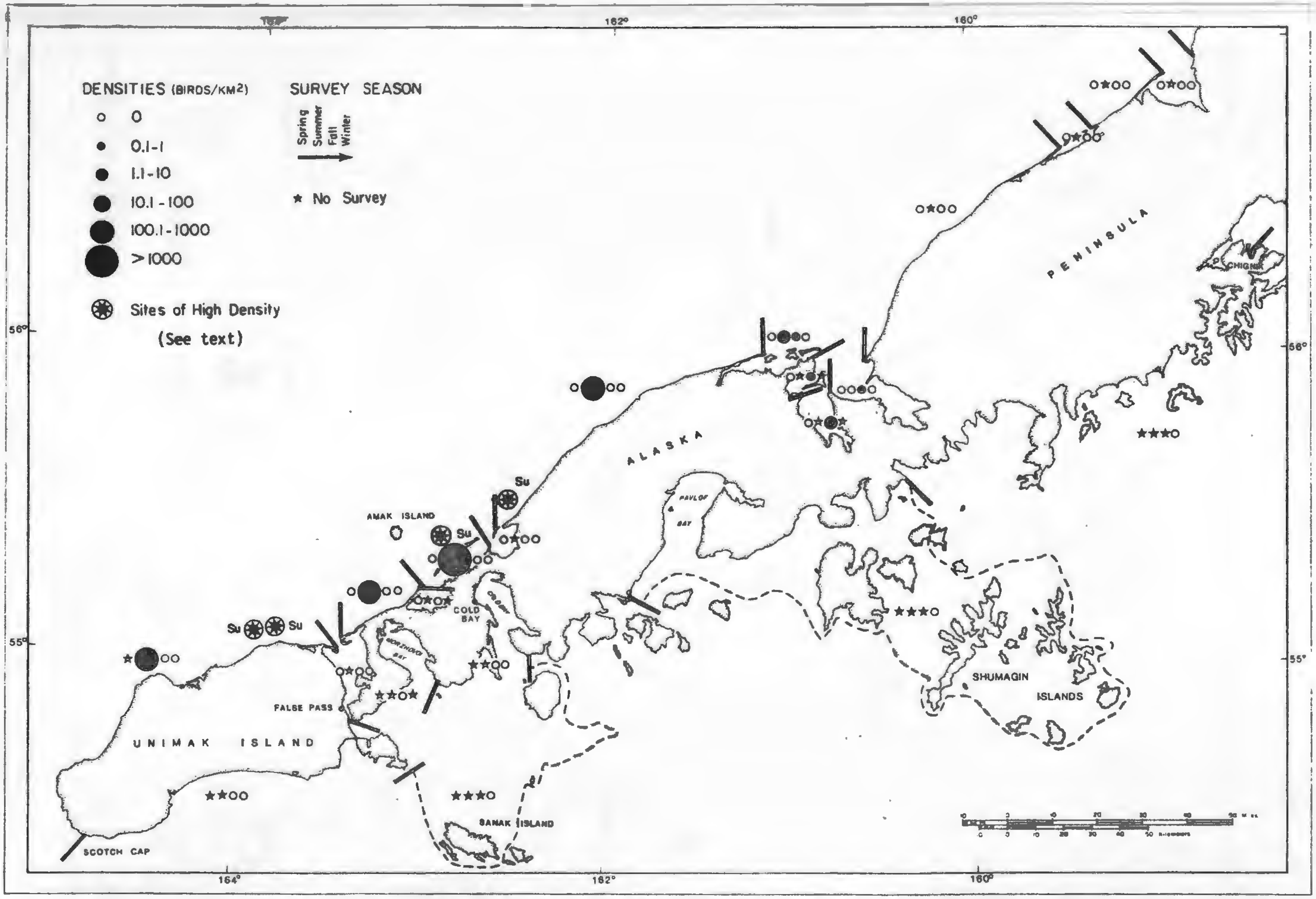


Fig. 109 (cont.). Tubenose density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

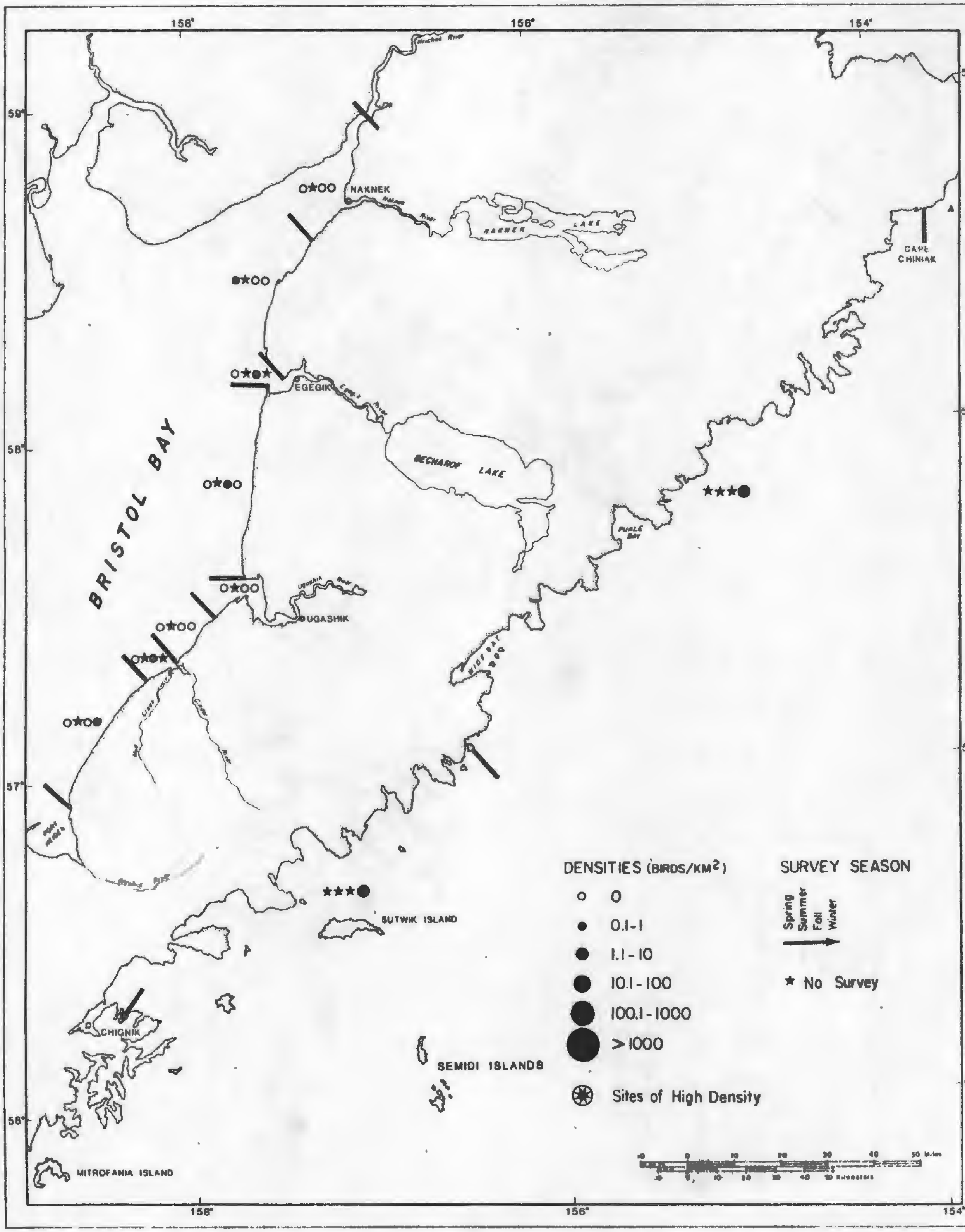


Fig. 110. Cormorant density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

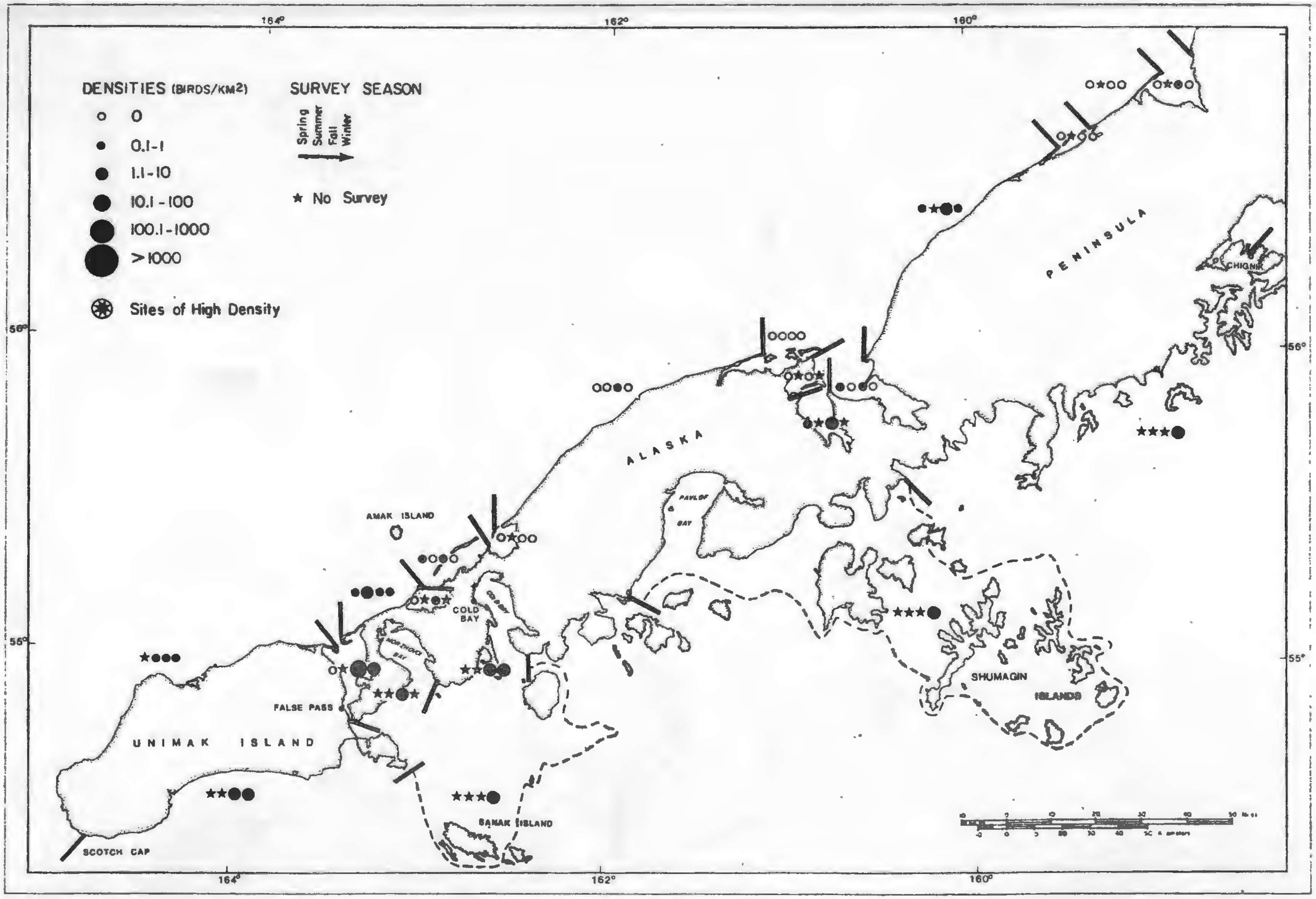


Fig. 110 (cont.). Cormorant density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

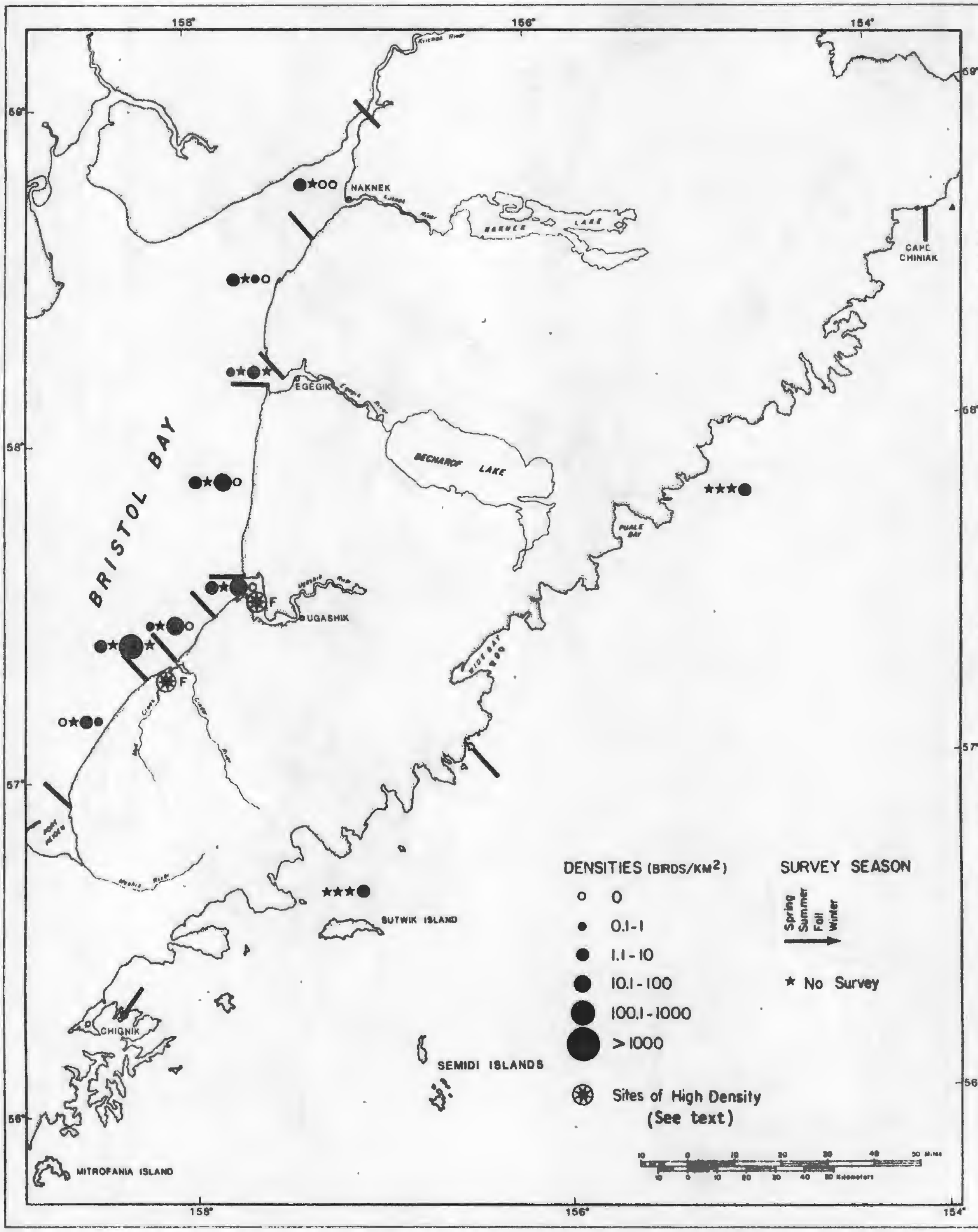


Fig. 111. Goose and swan density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

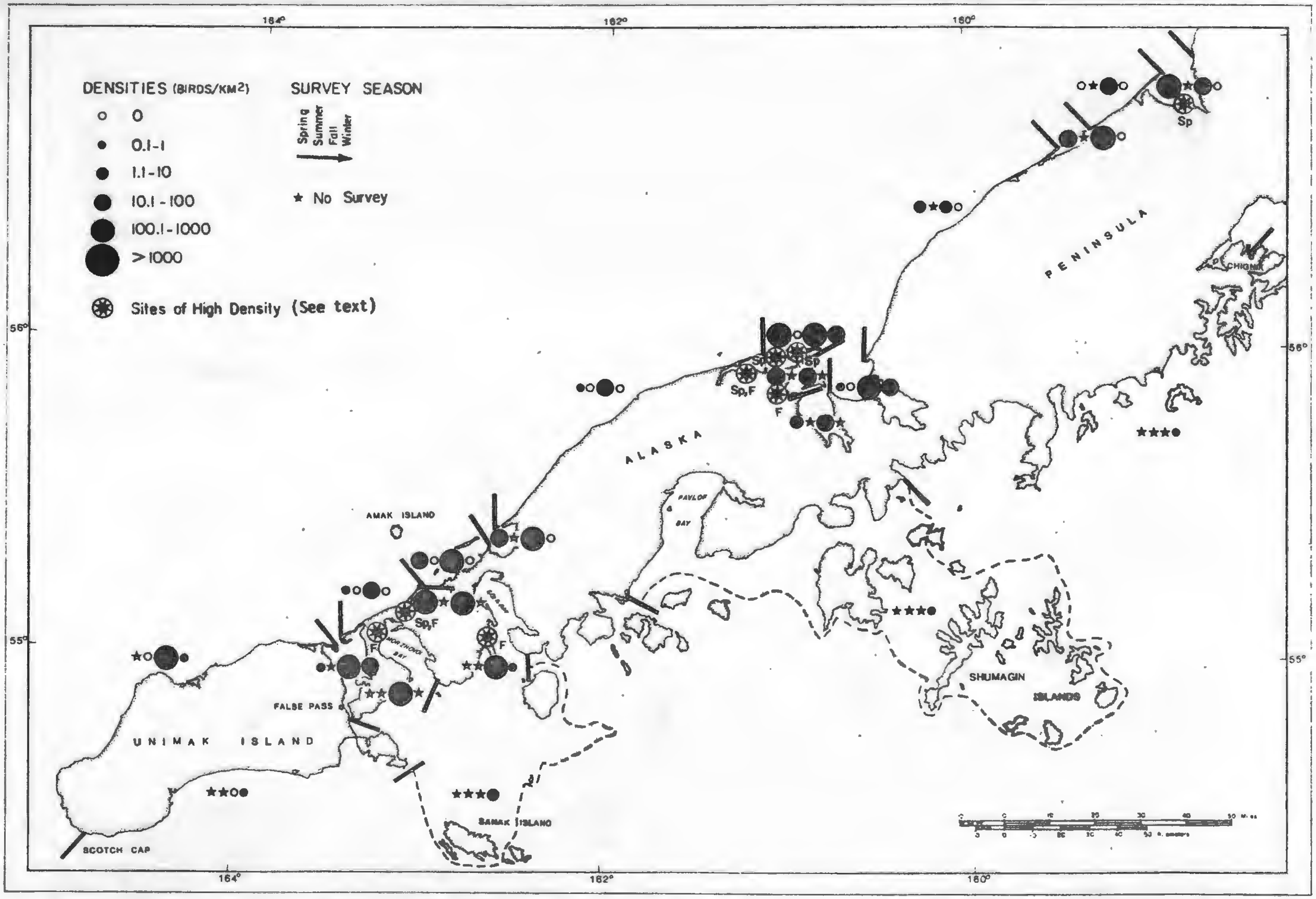


Fig. 111 (cont.). Goose and swan density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

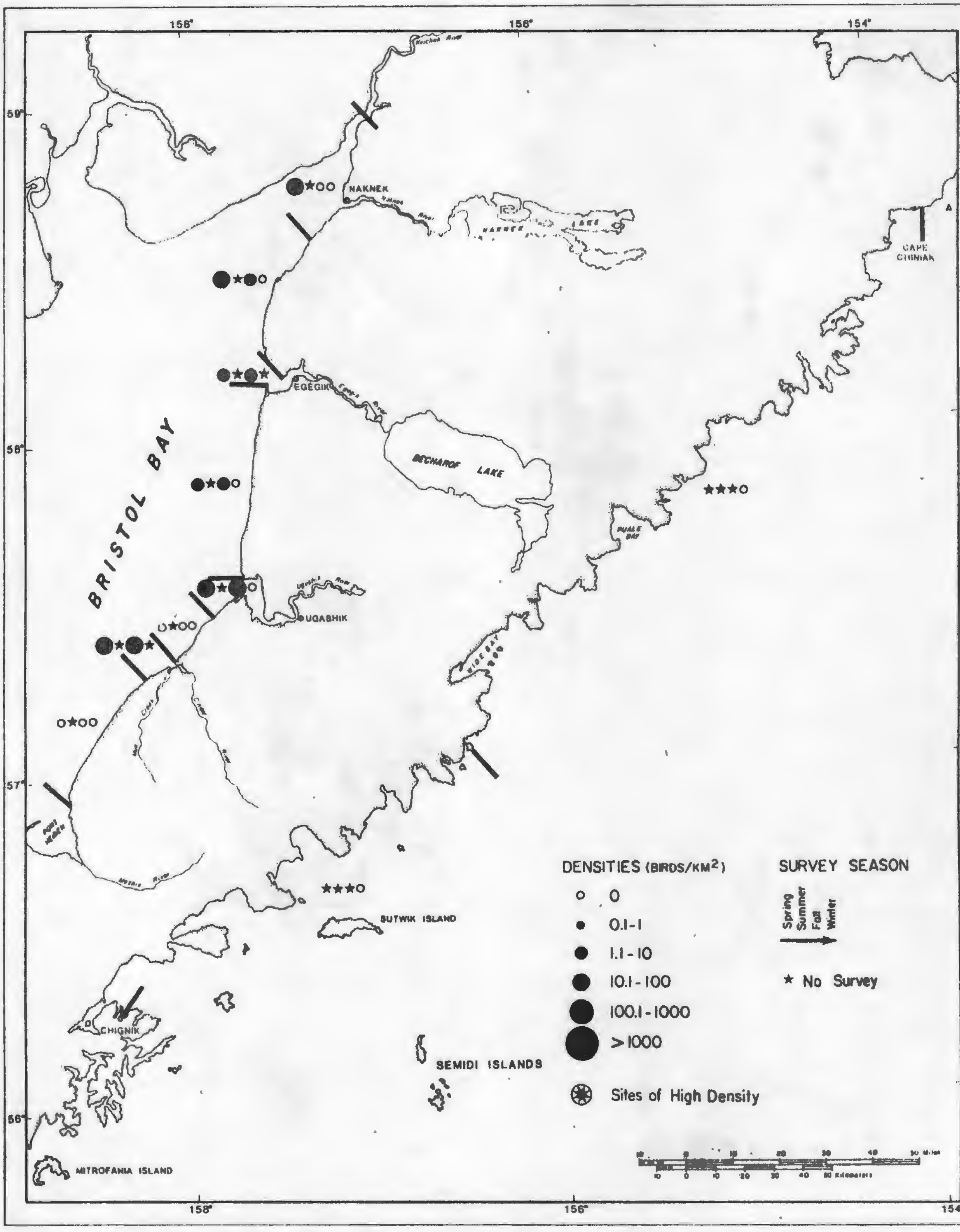


Fig. 112. Dabbling duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

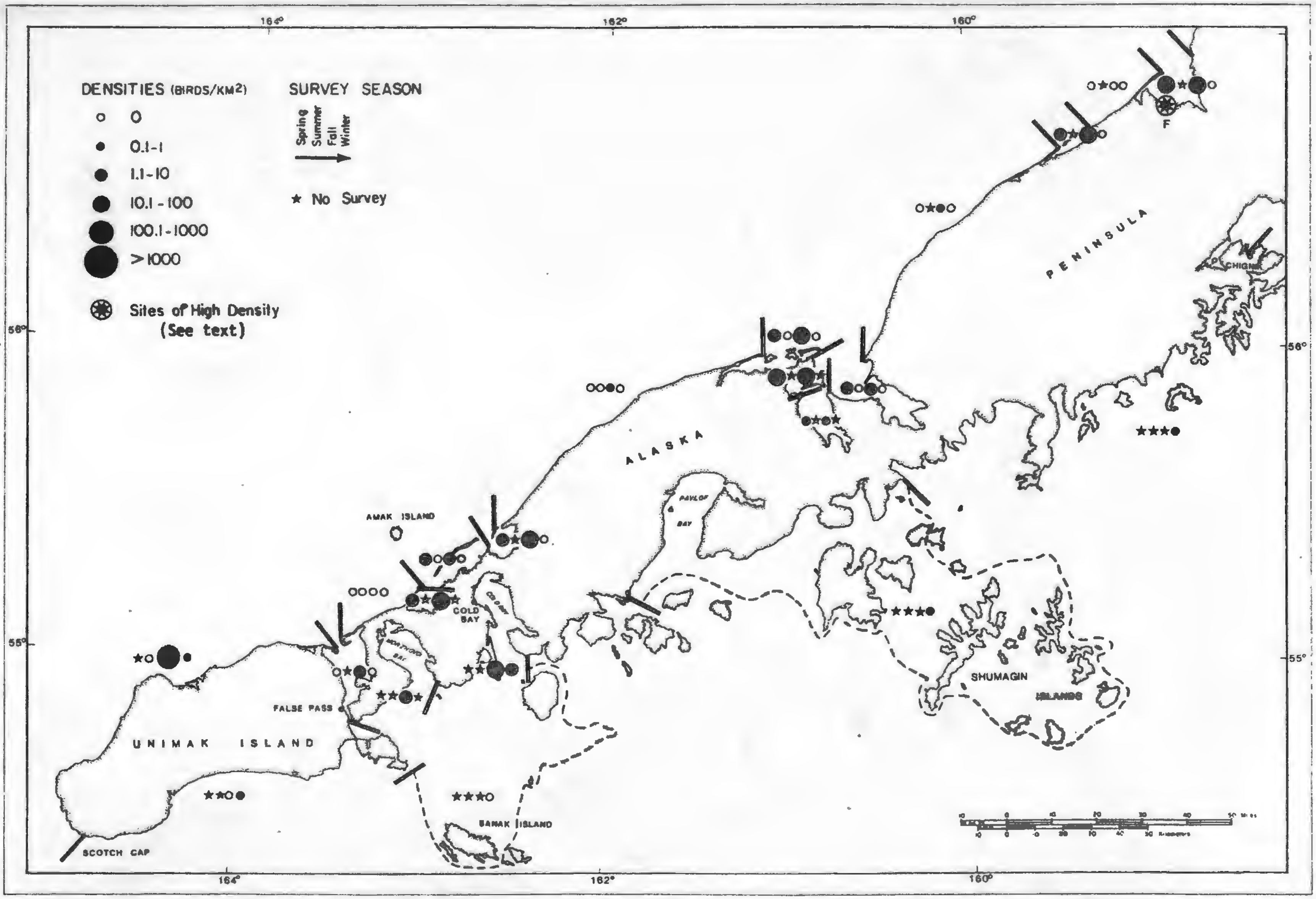


Fig. 112 (cont.). Dabbling duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

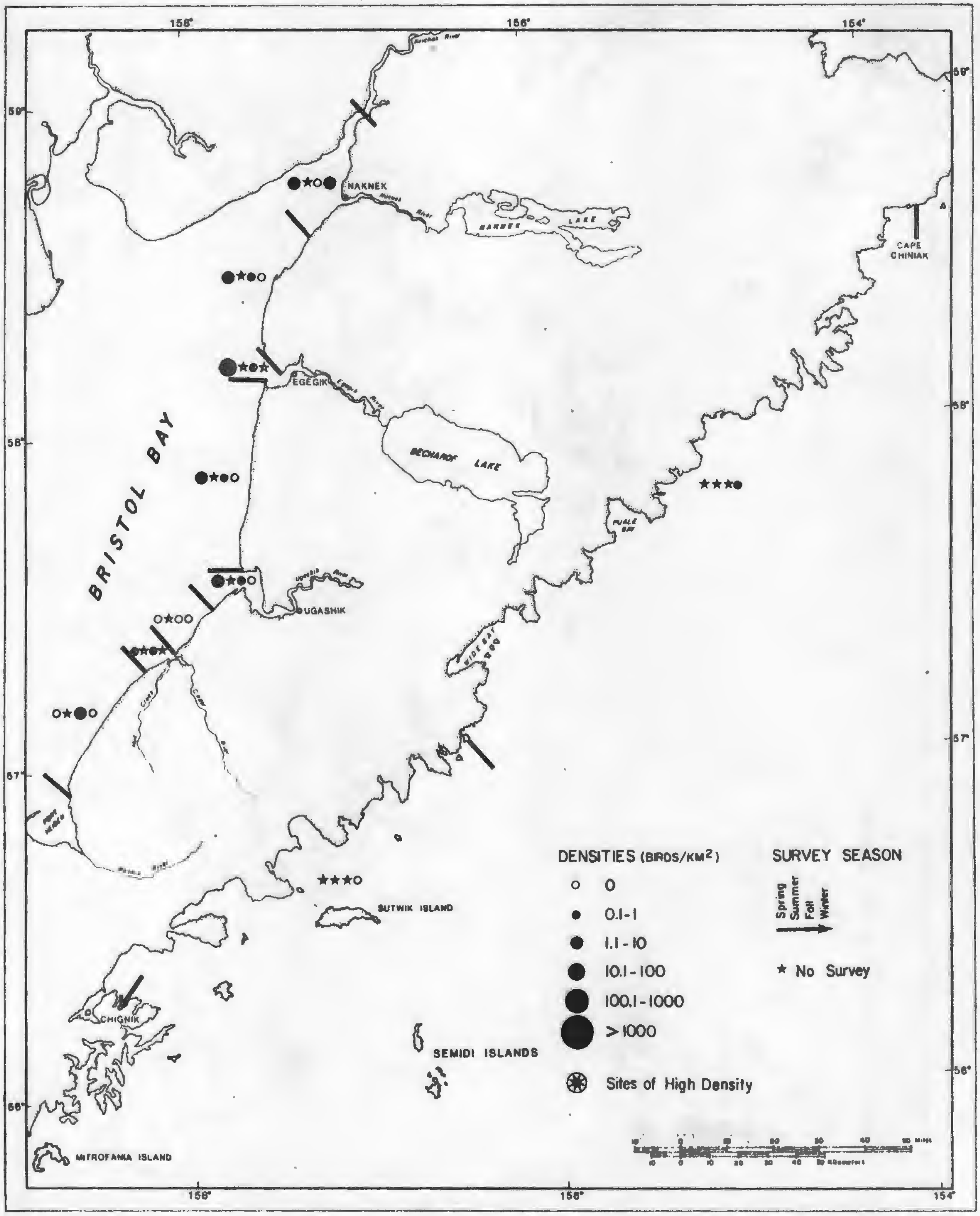


Fig. 113. Diving duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

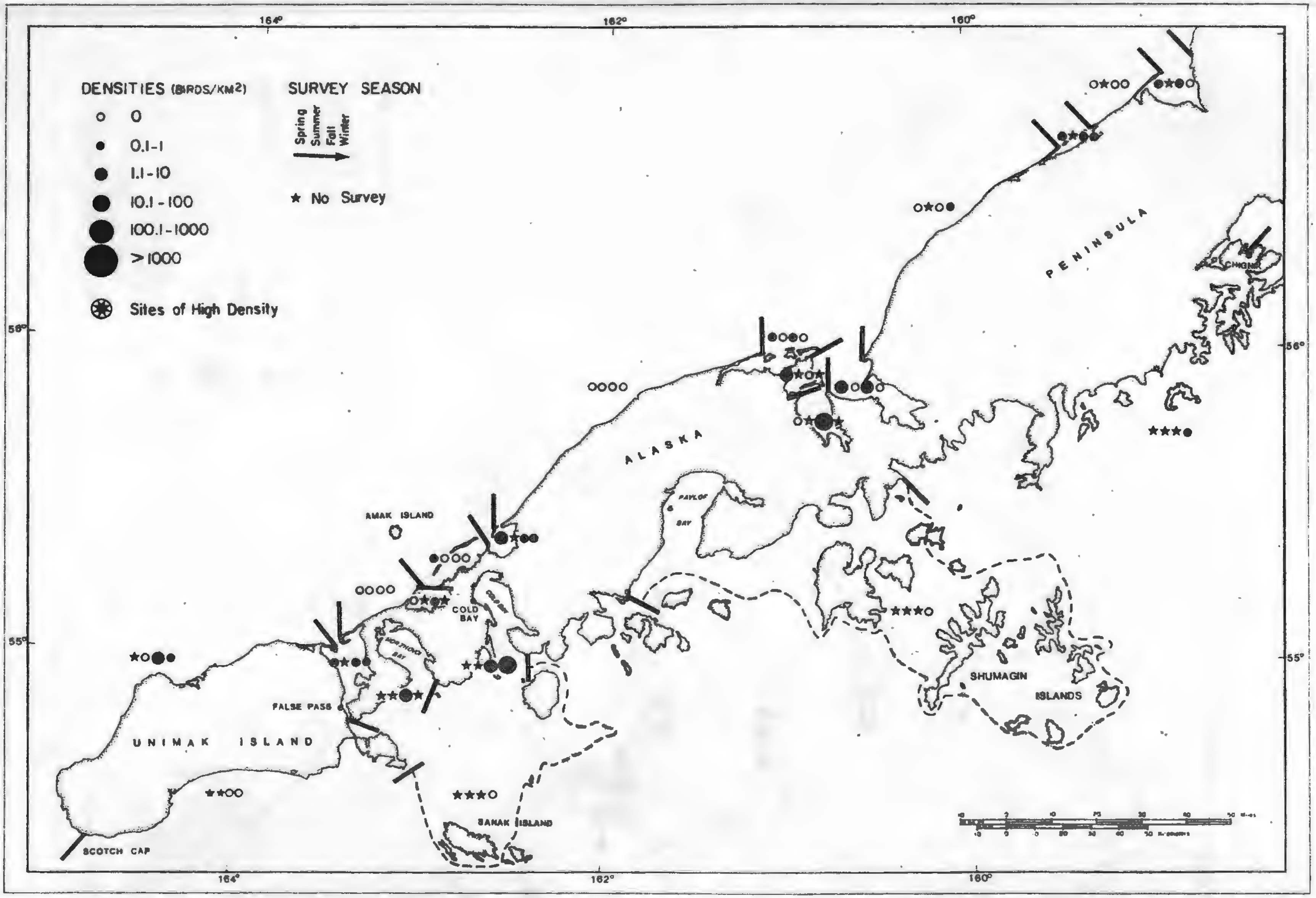


Fig. 113 (cont.). Diving duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

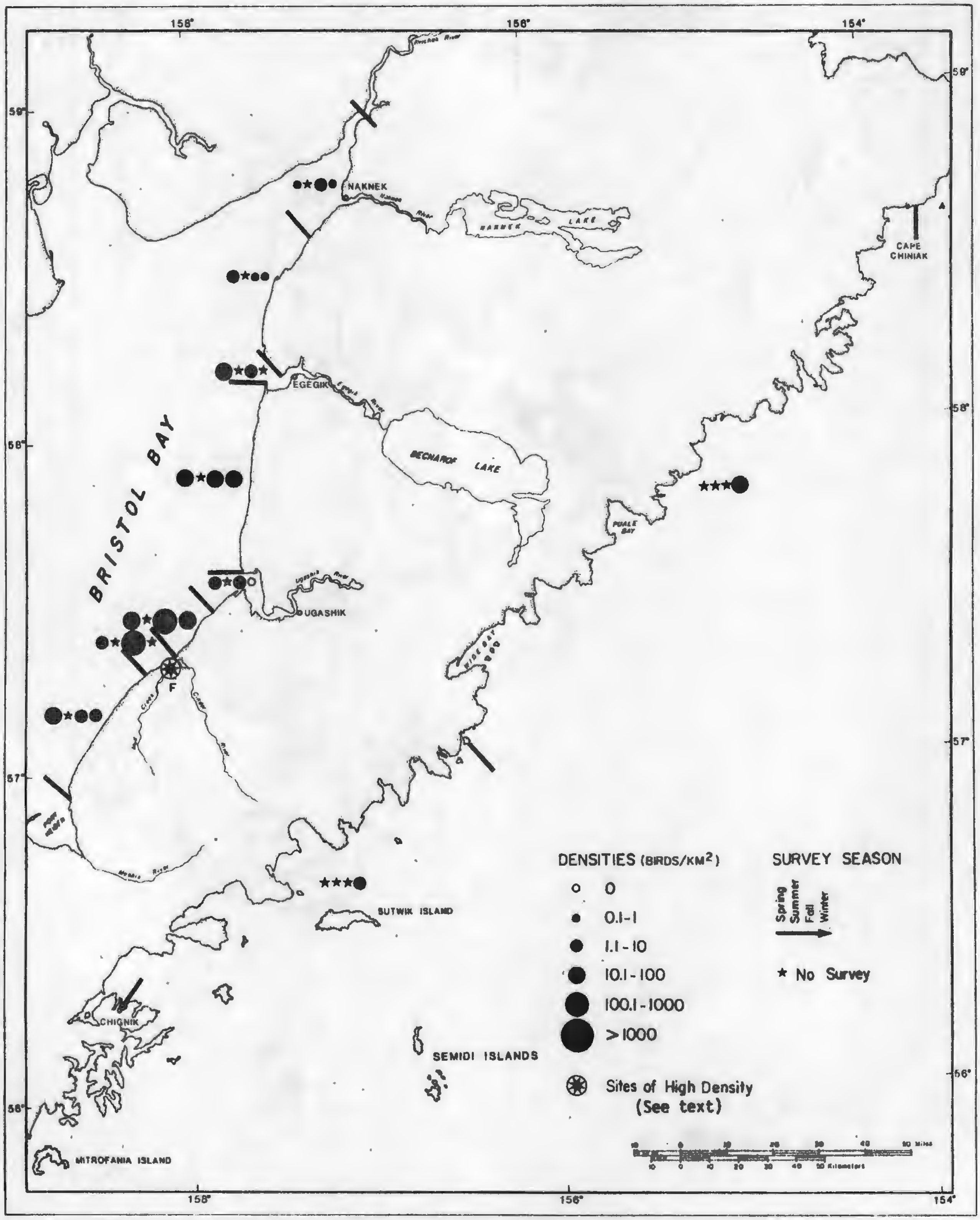


Fig. 114. Sea duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

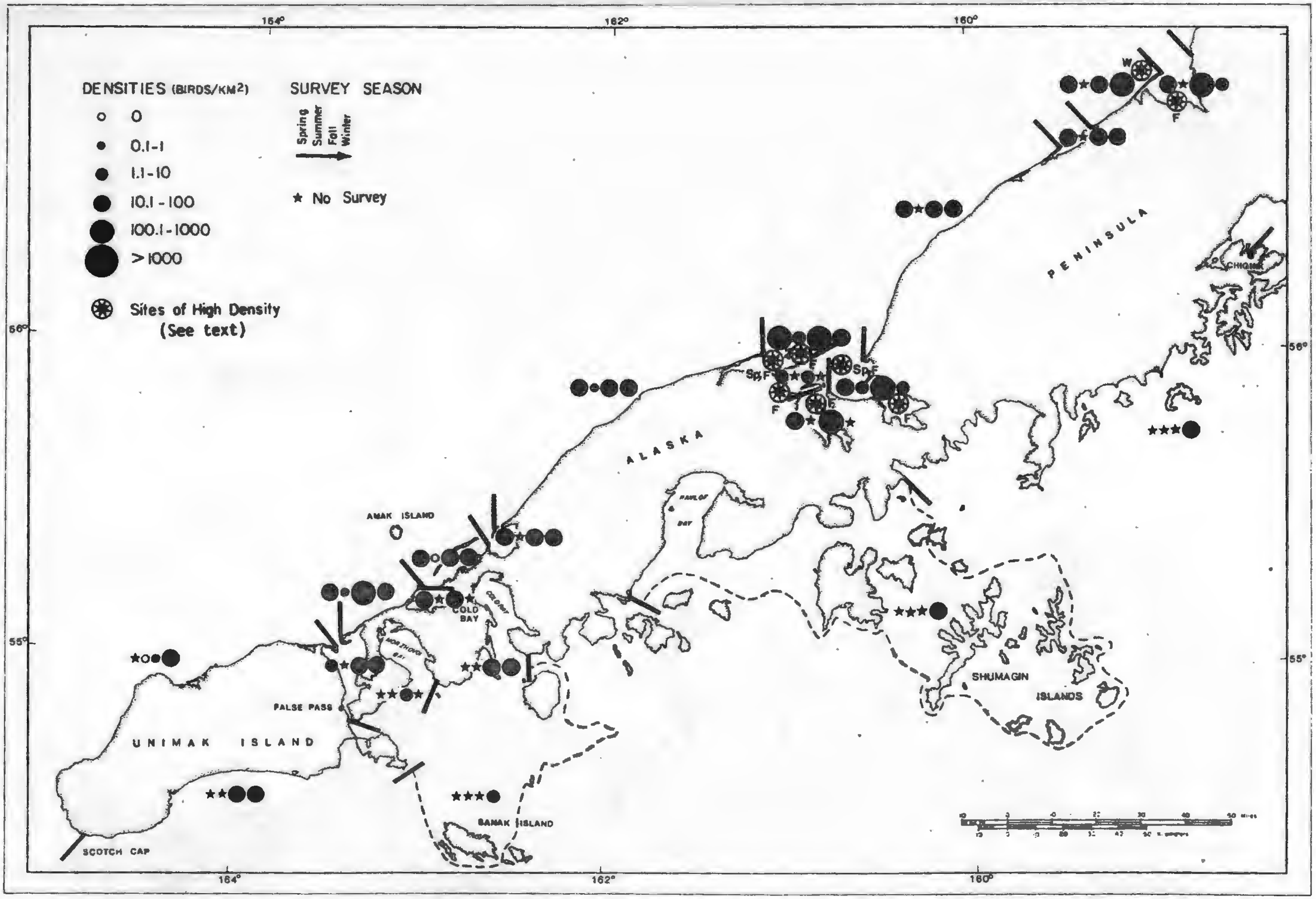


Fig. 114 (cont.). Sea duck density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

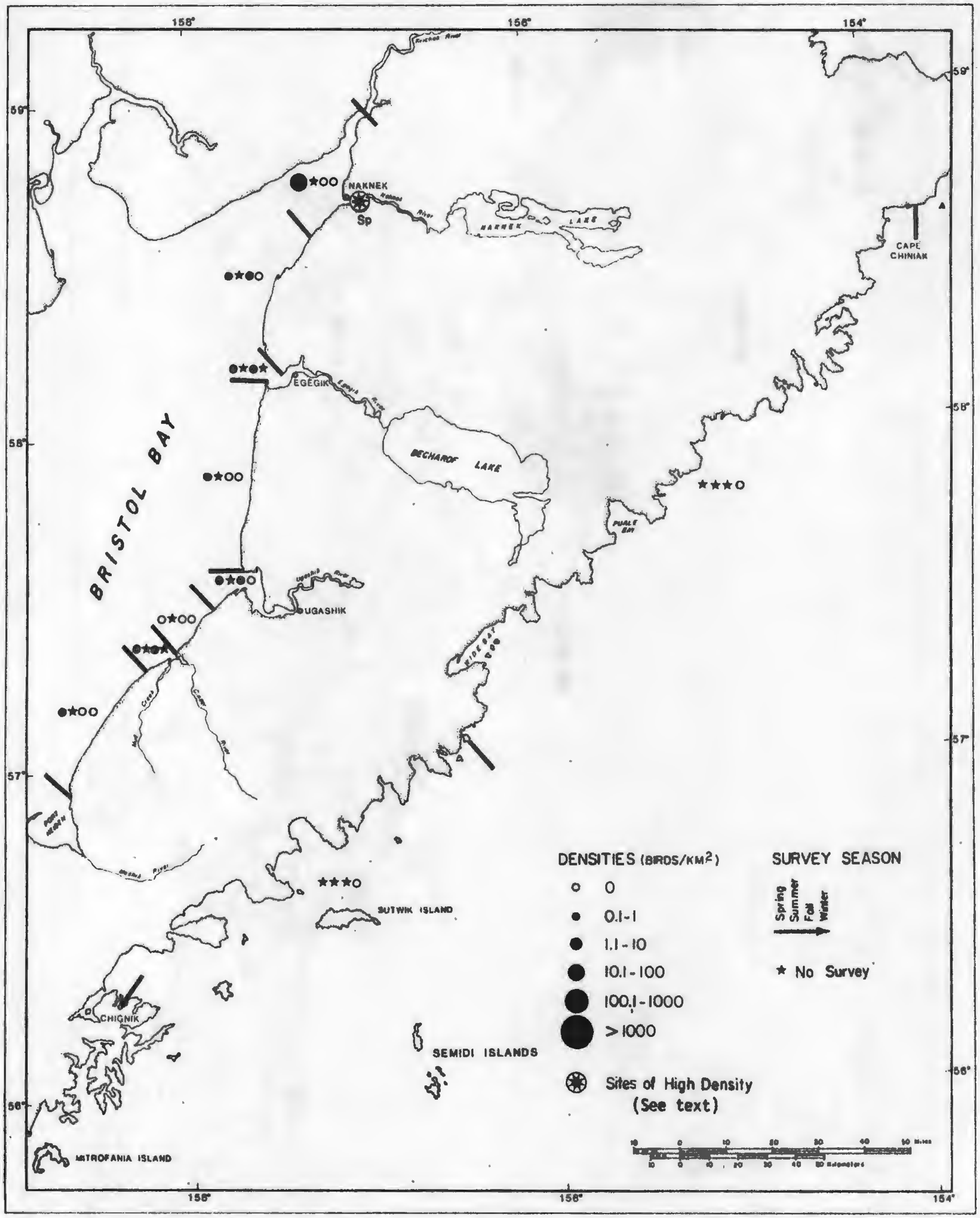


Fig. 115. Merganser density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

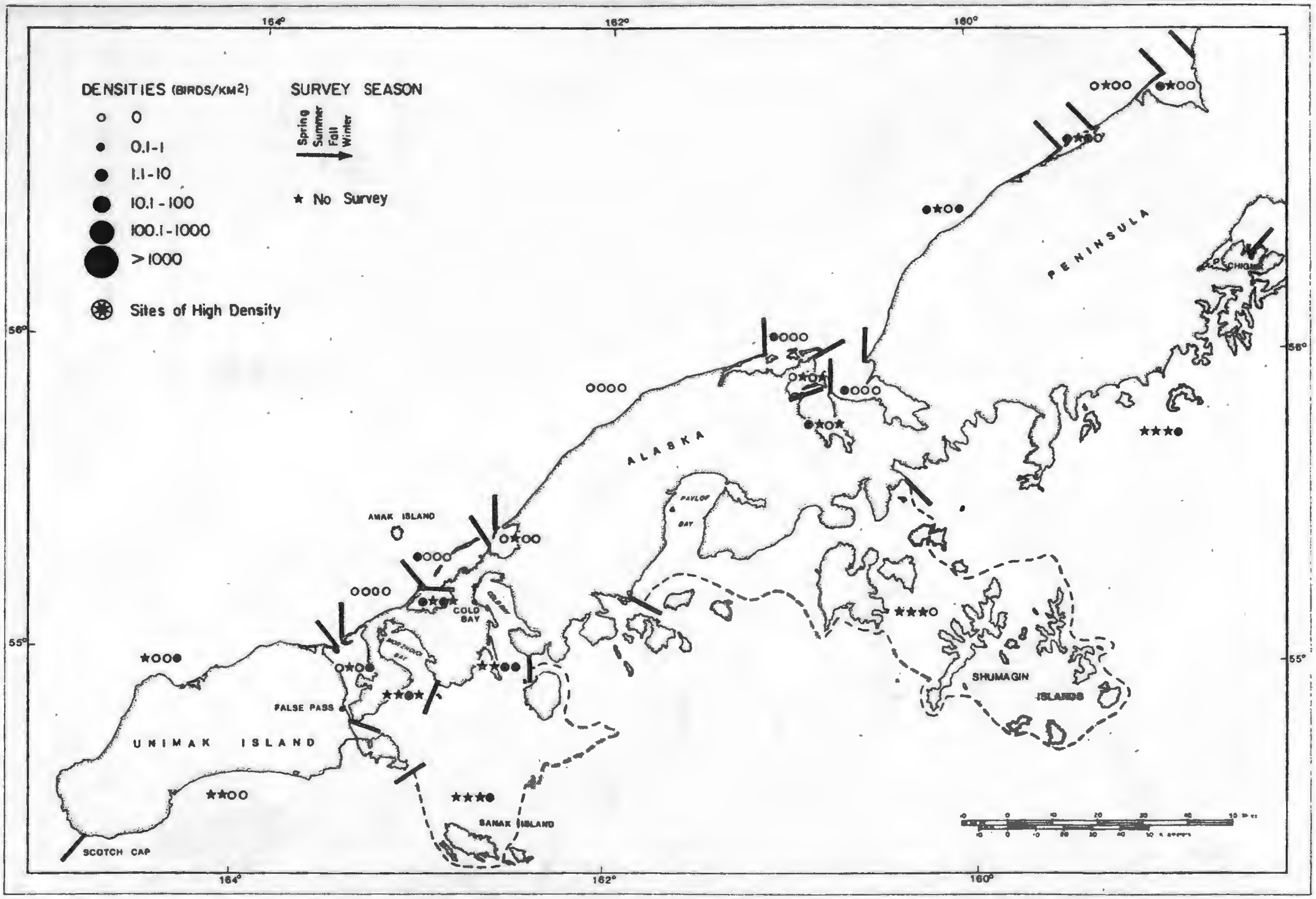


Fig. 115 (cont.). Merganser density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

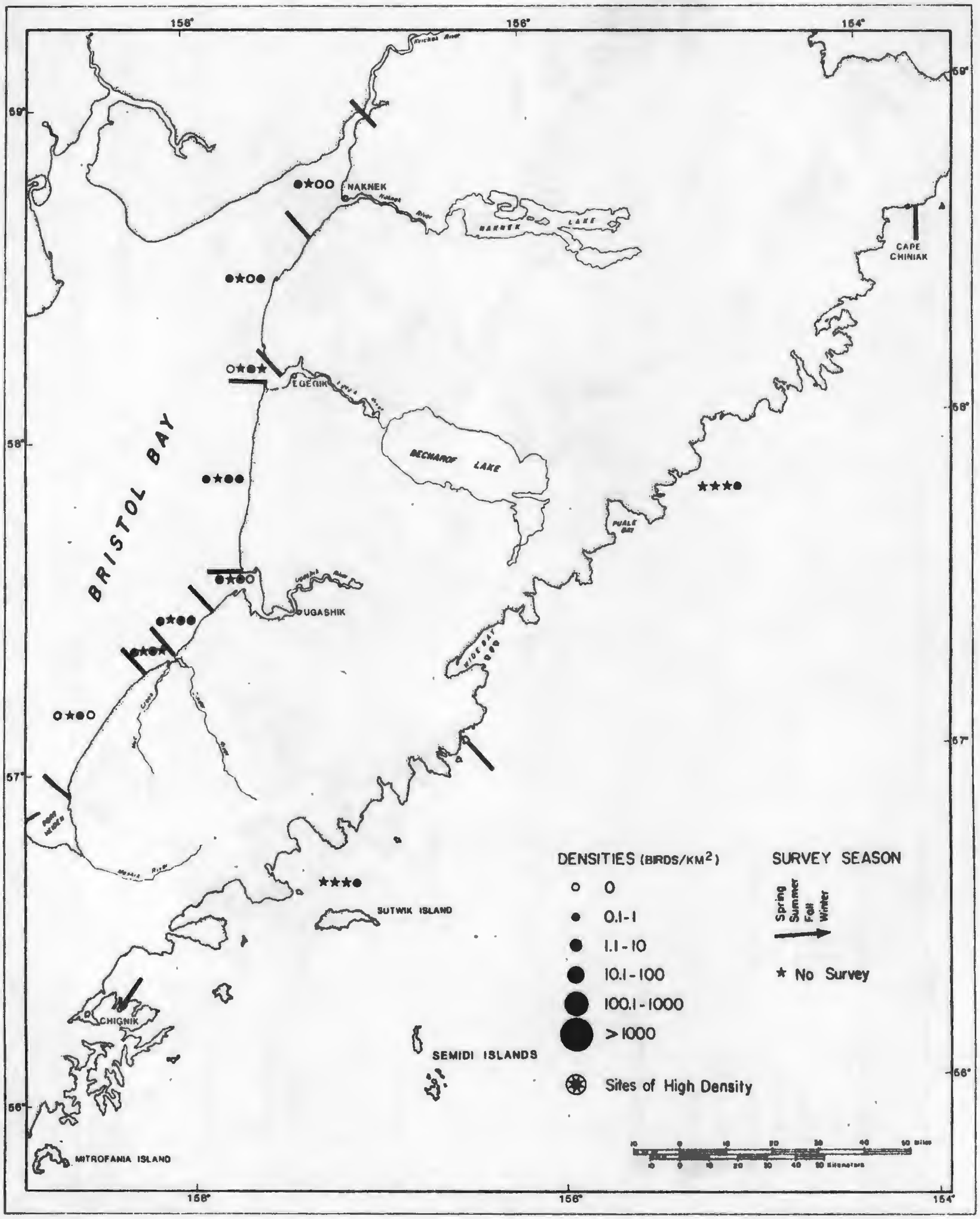


Fig. 116. Raptor density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

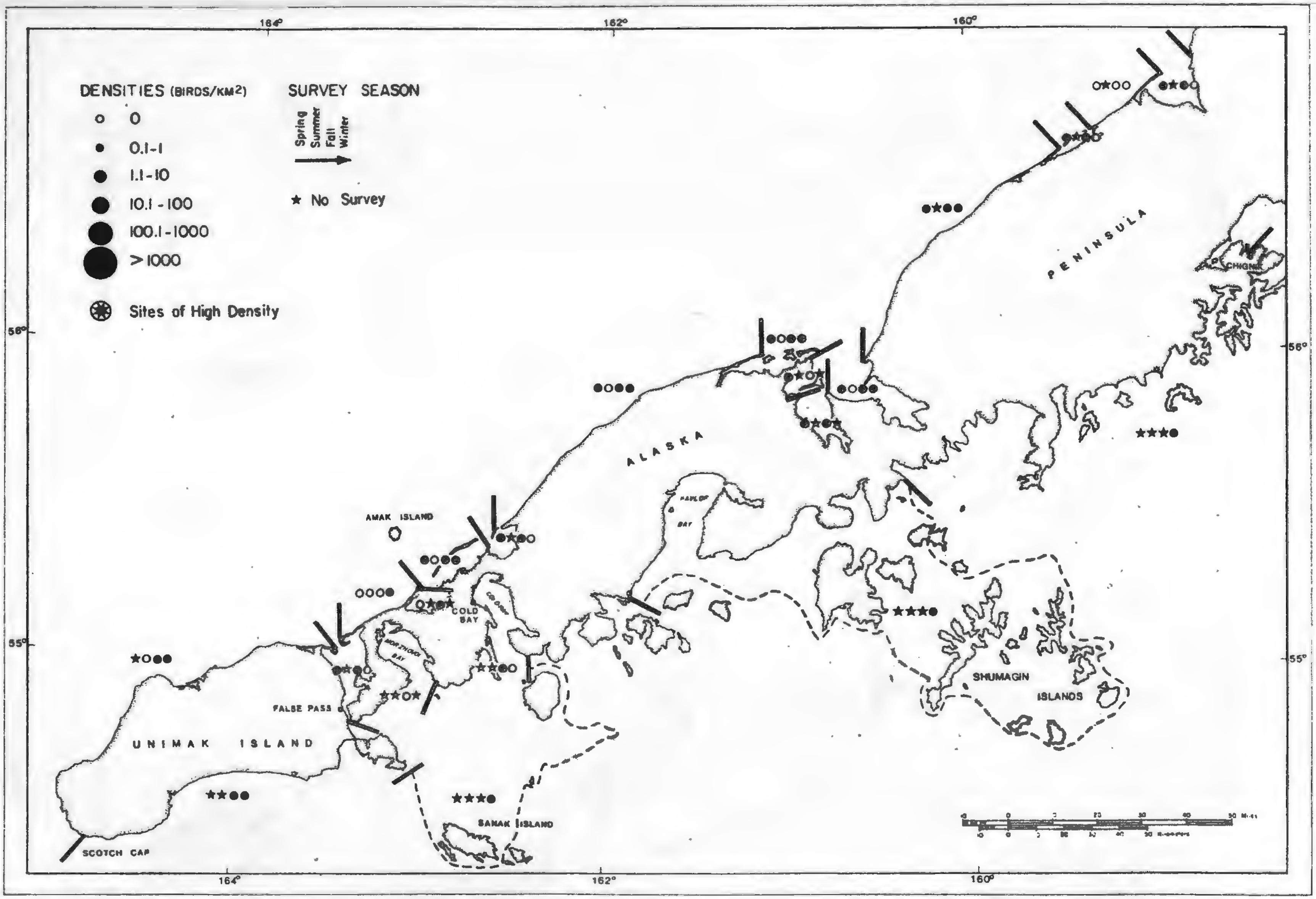


Fig. 116 (cont.). Raptor density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

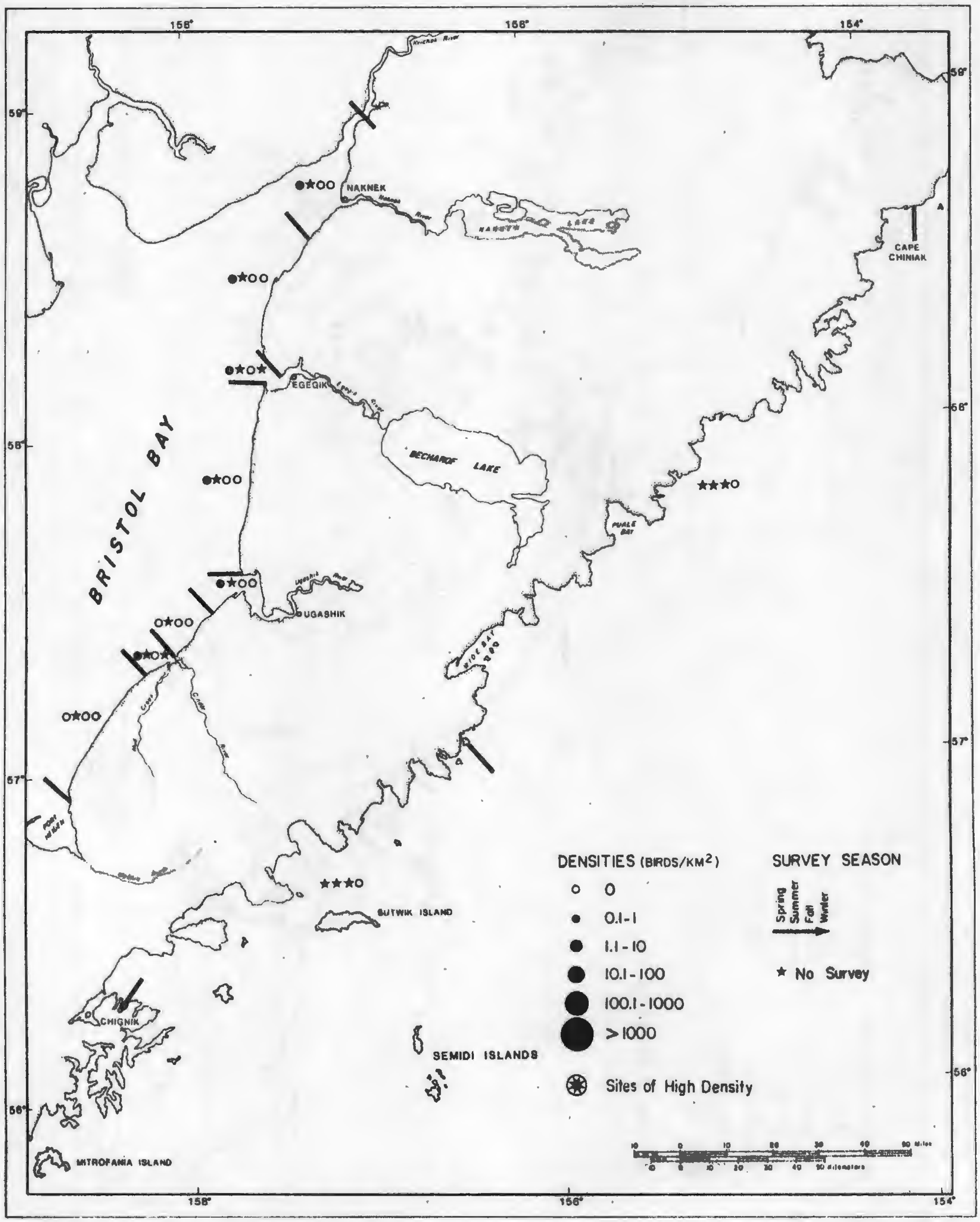


Fig. 117. Crane density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

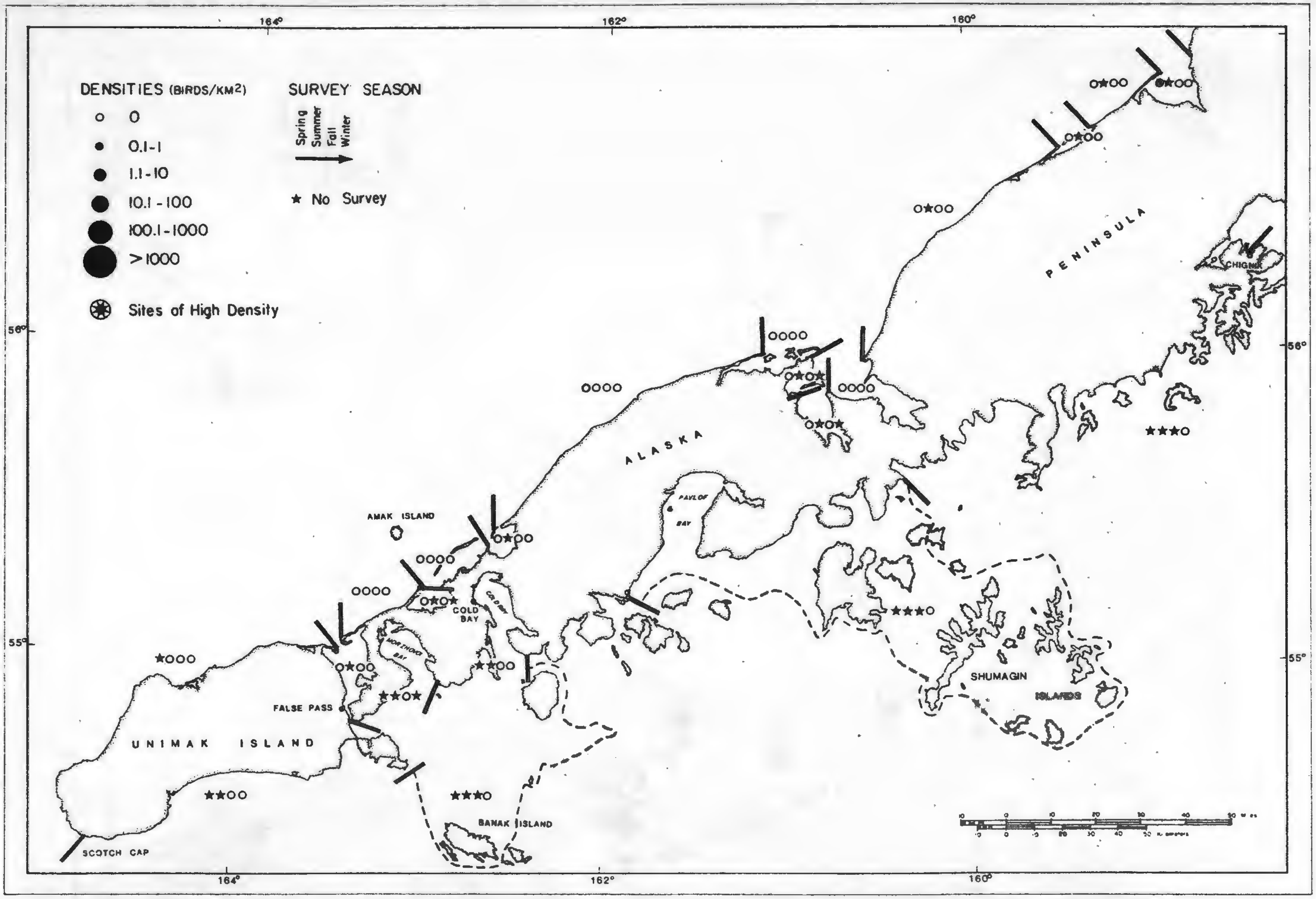


Fig. 117 (cont.). Crane density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

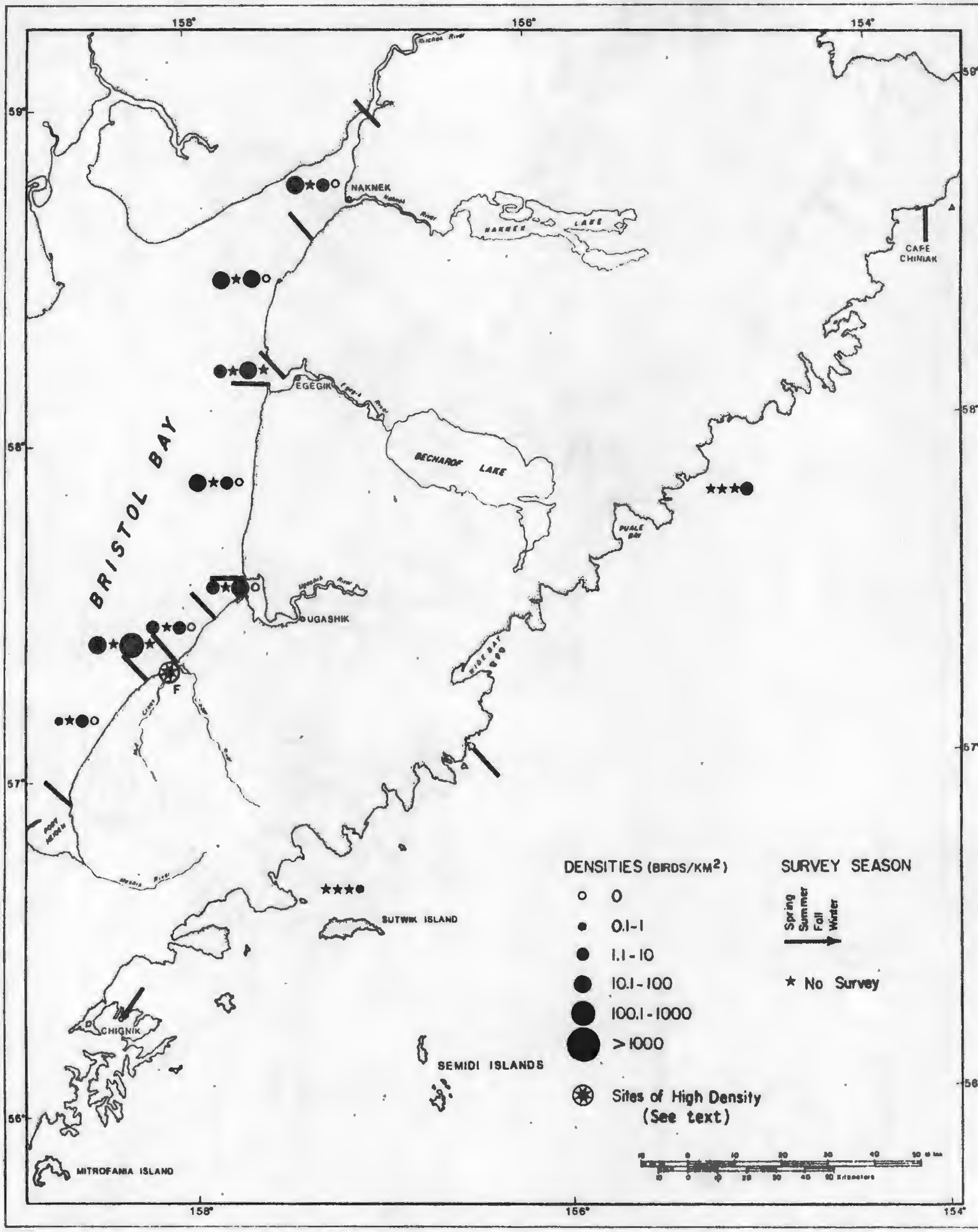


Fig. 118. Shorebird density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

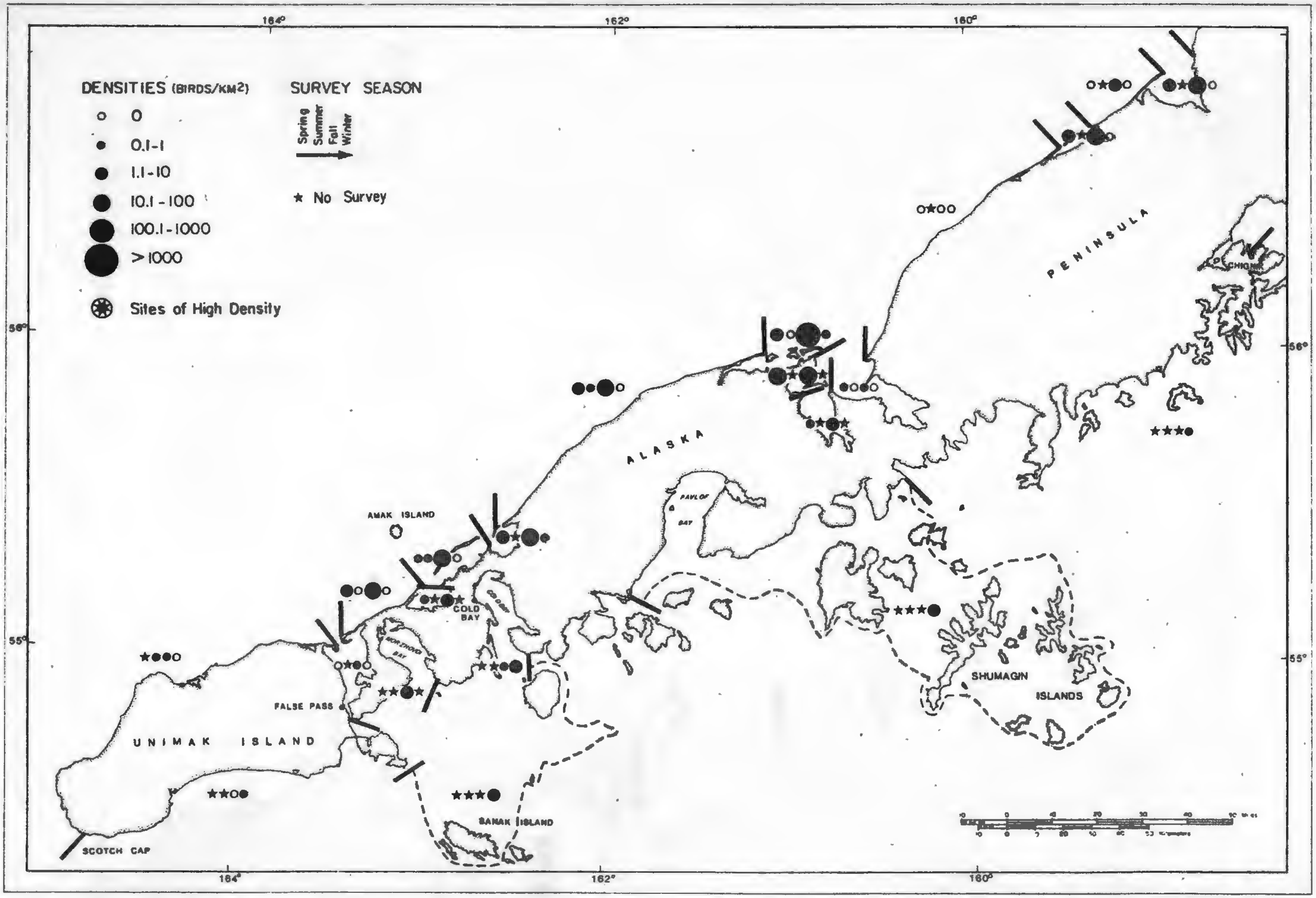


Fig. 118 (cont.). Shorebird density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

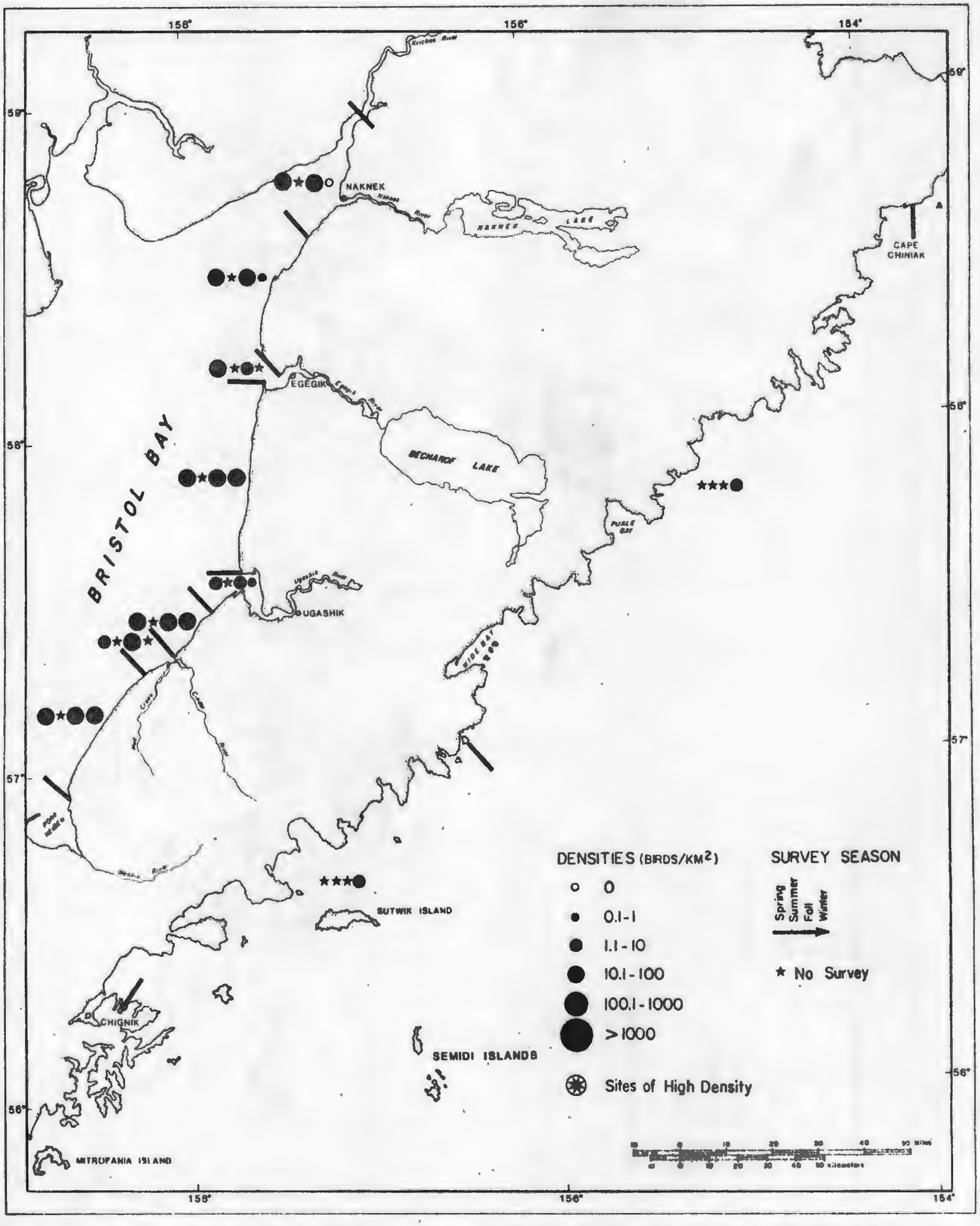


Fig. 119. Gull and jaeger density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

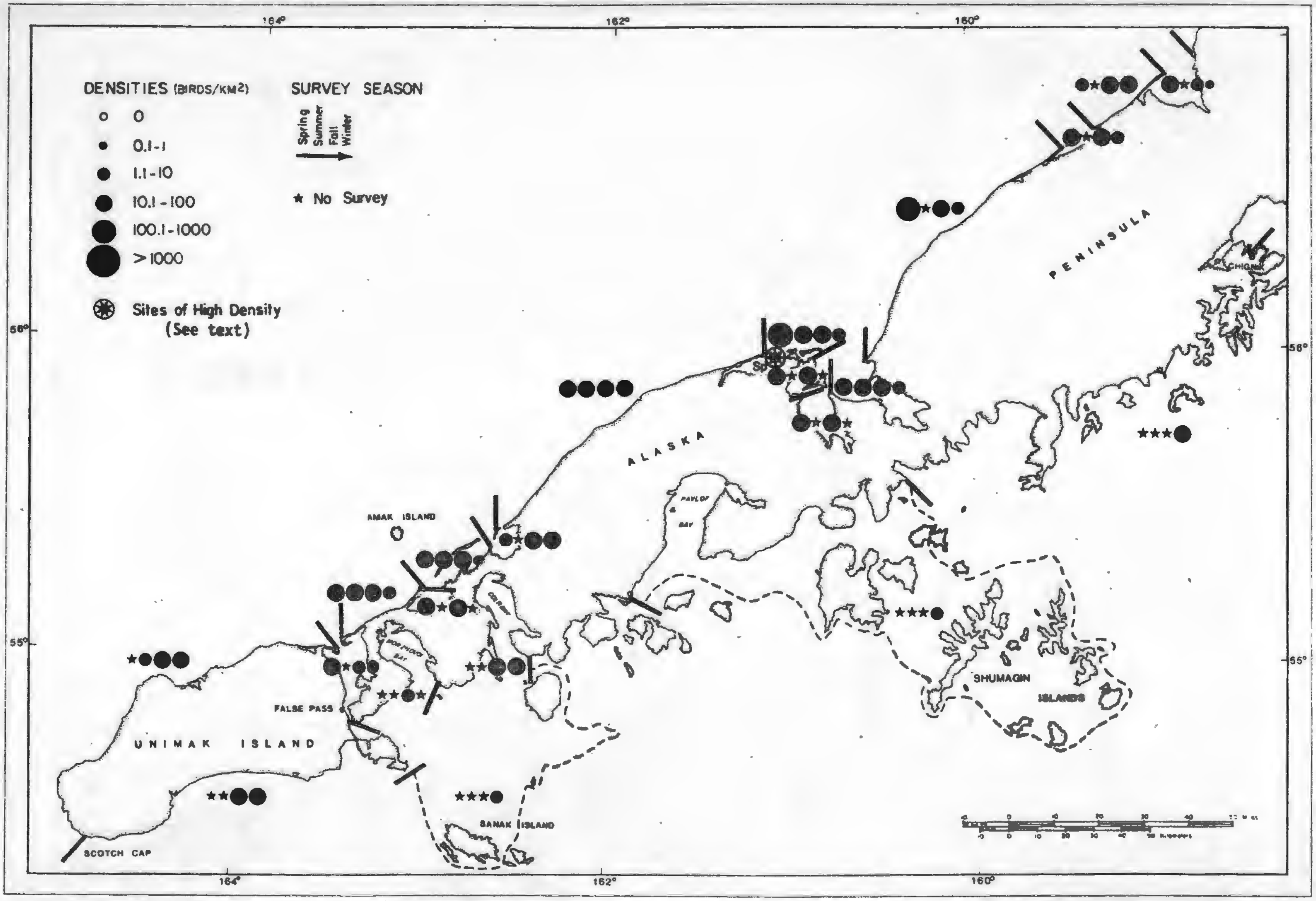


Fig. 119 (cont.). Gull and jaeger density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

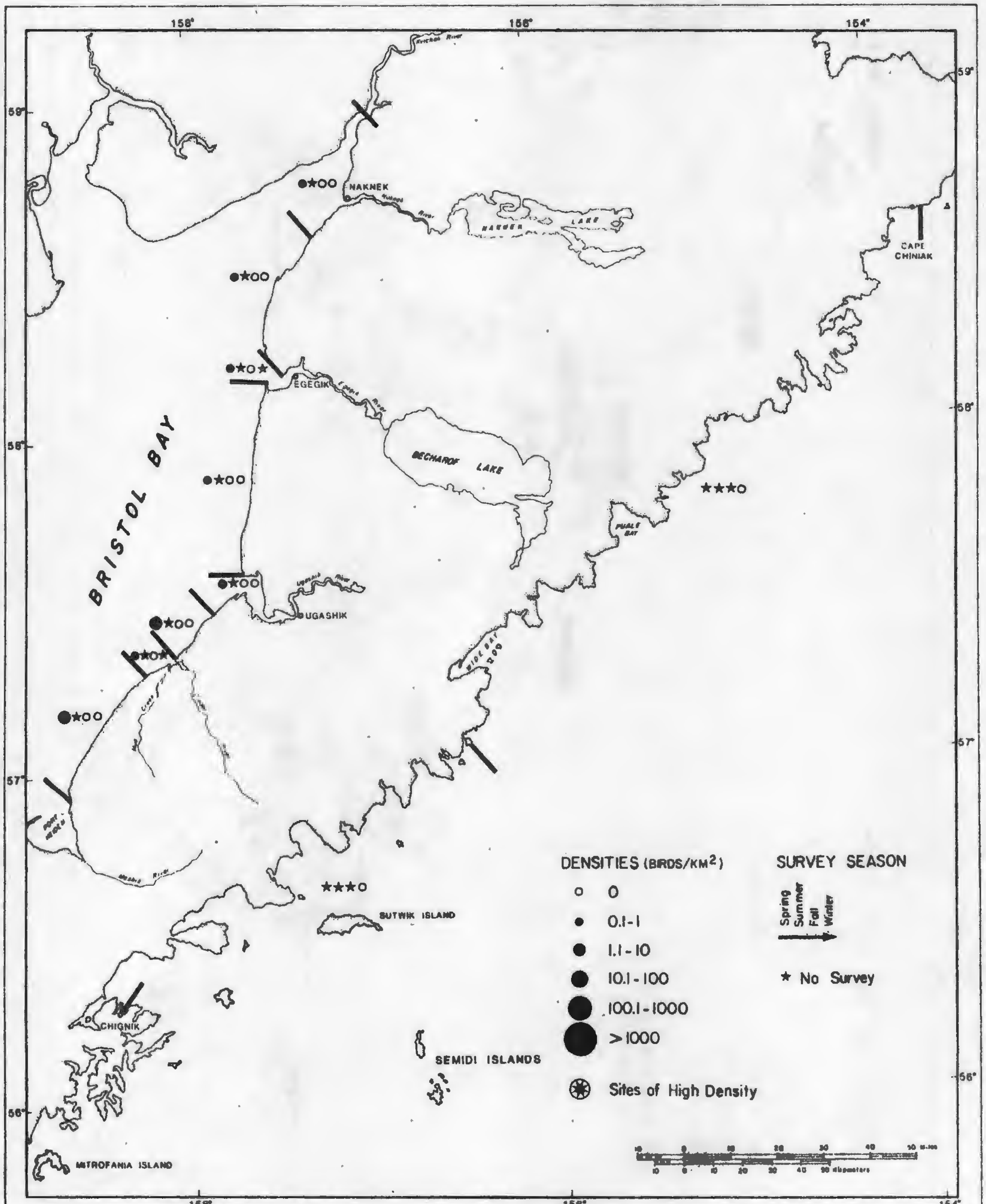


Fig. 120. Tern density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

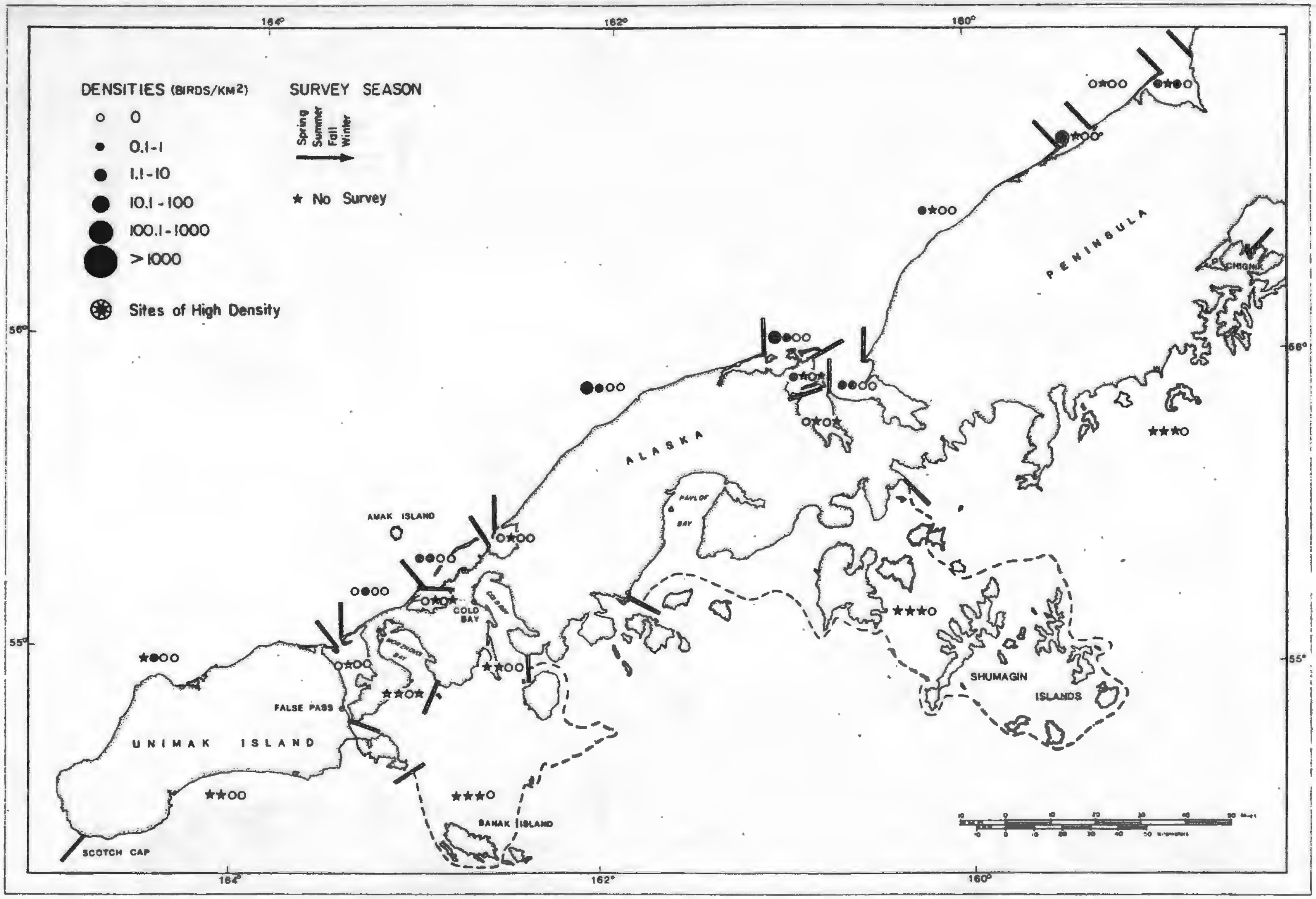


Fig. 120 (cont.). Tern density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

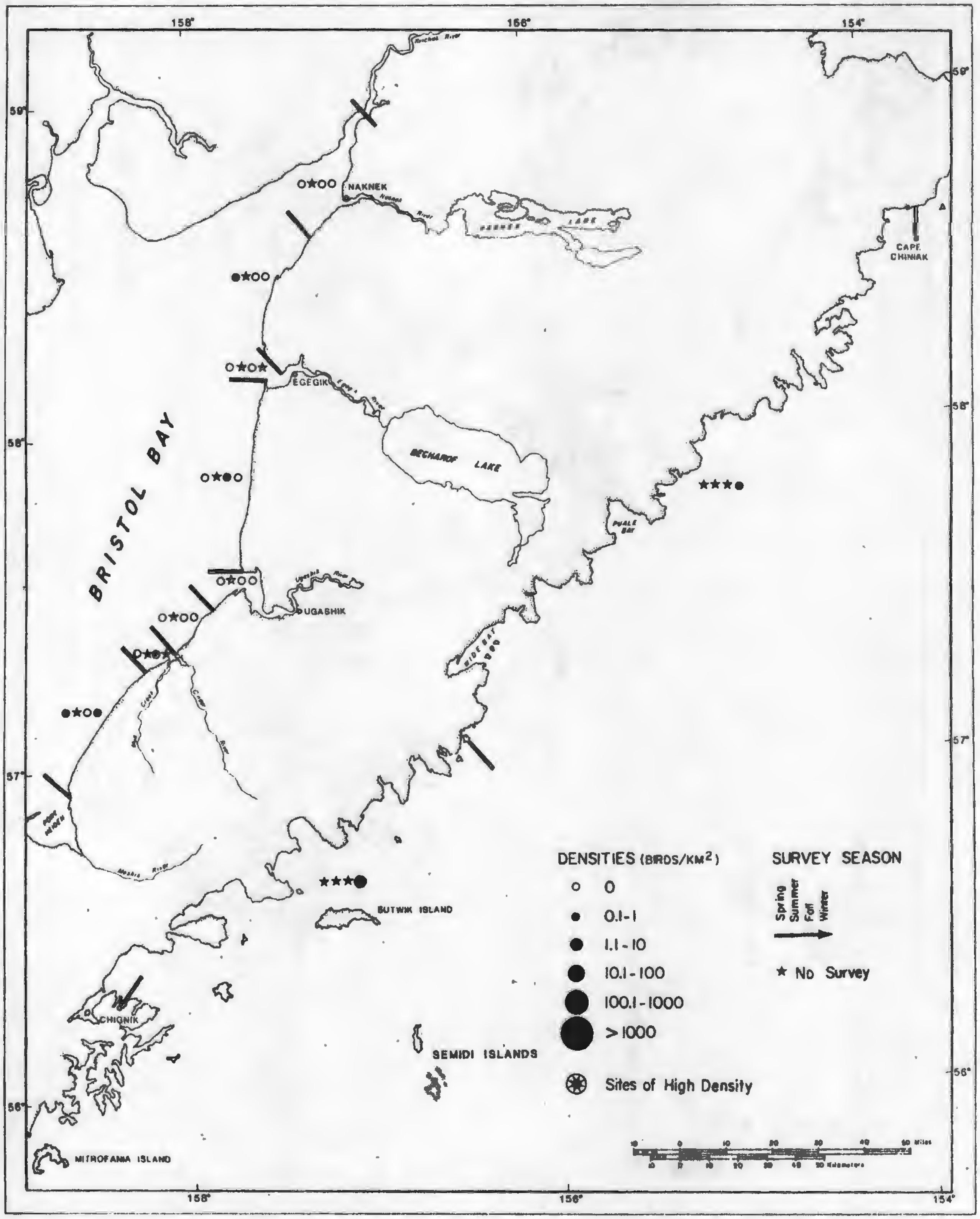


Fig. 121. Alcid density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

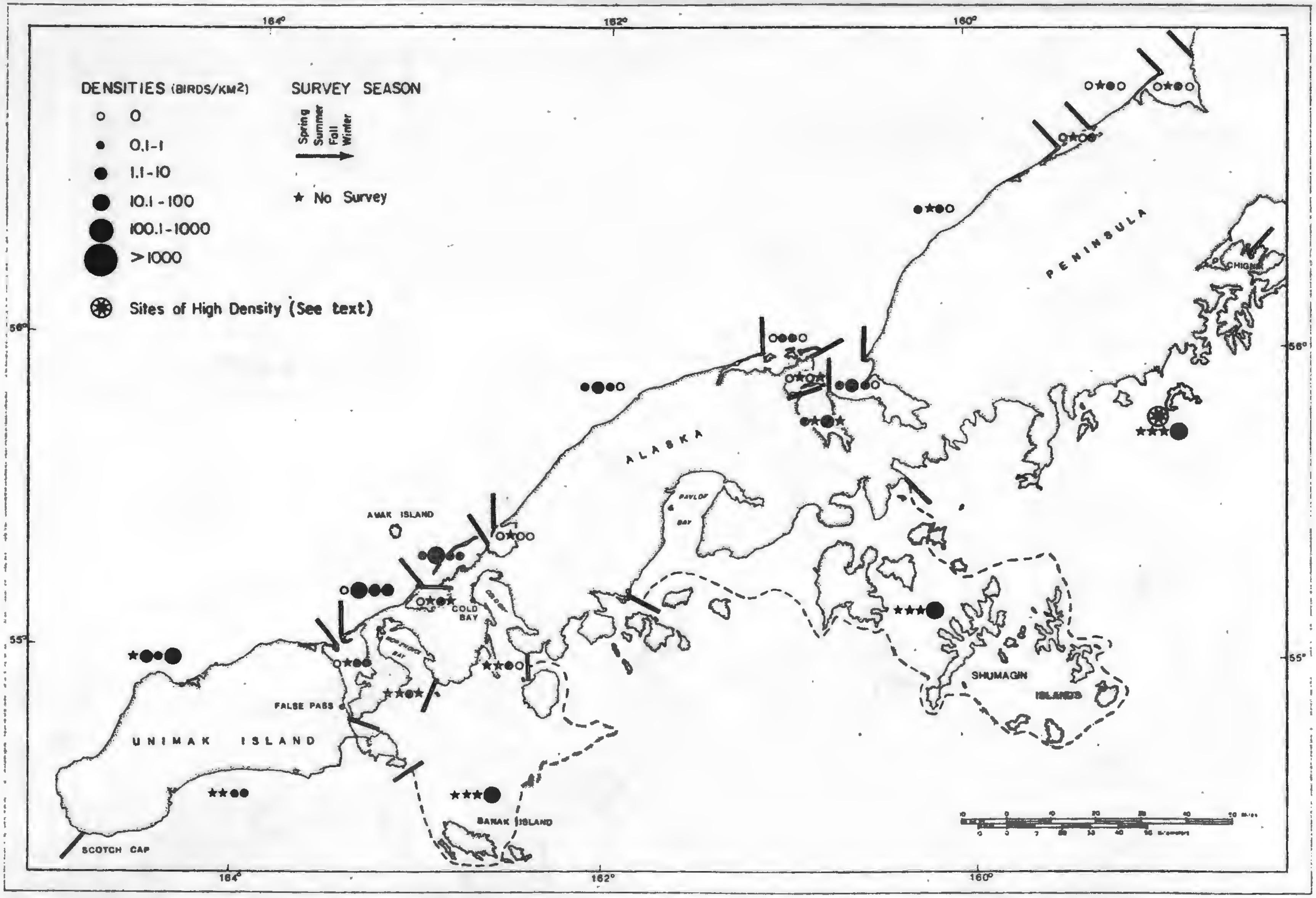


Fig. 121 (cont.). Alcid density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

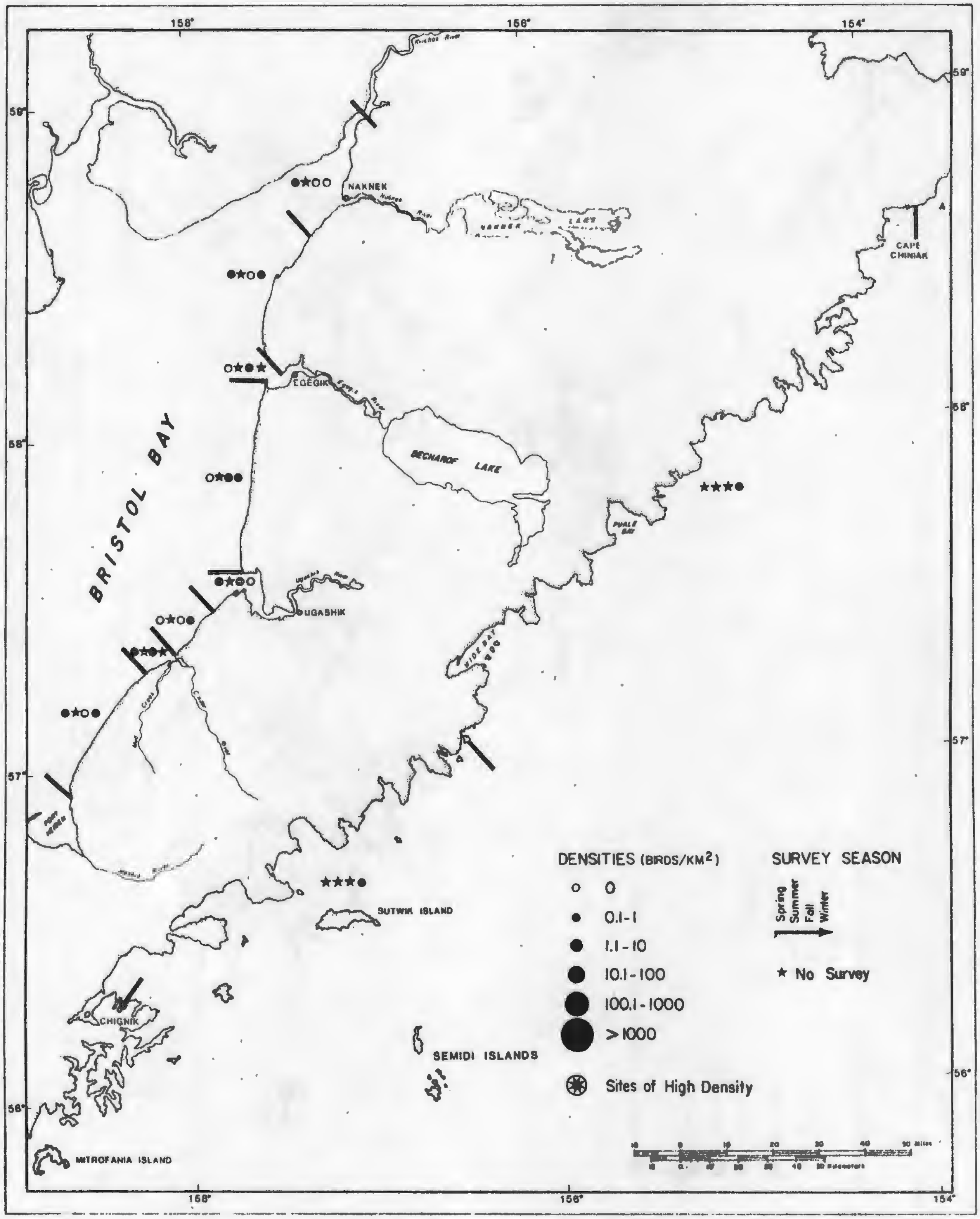


Fig. 122. Corvid density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

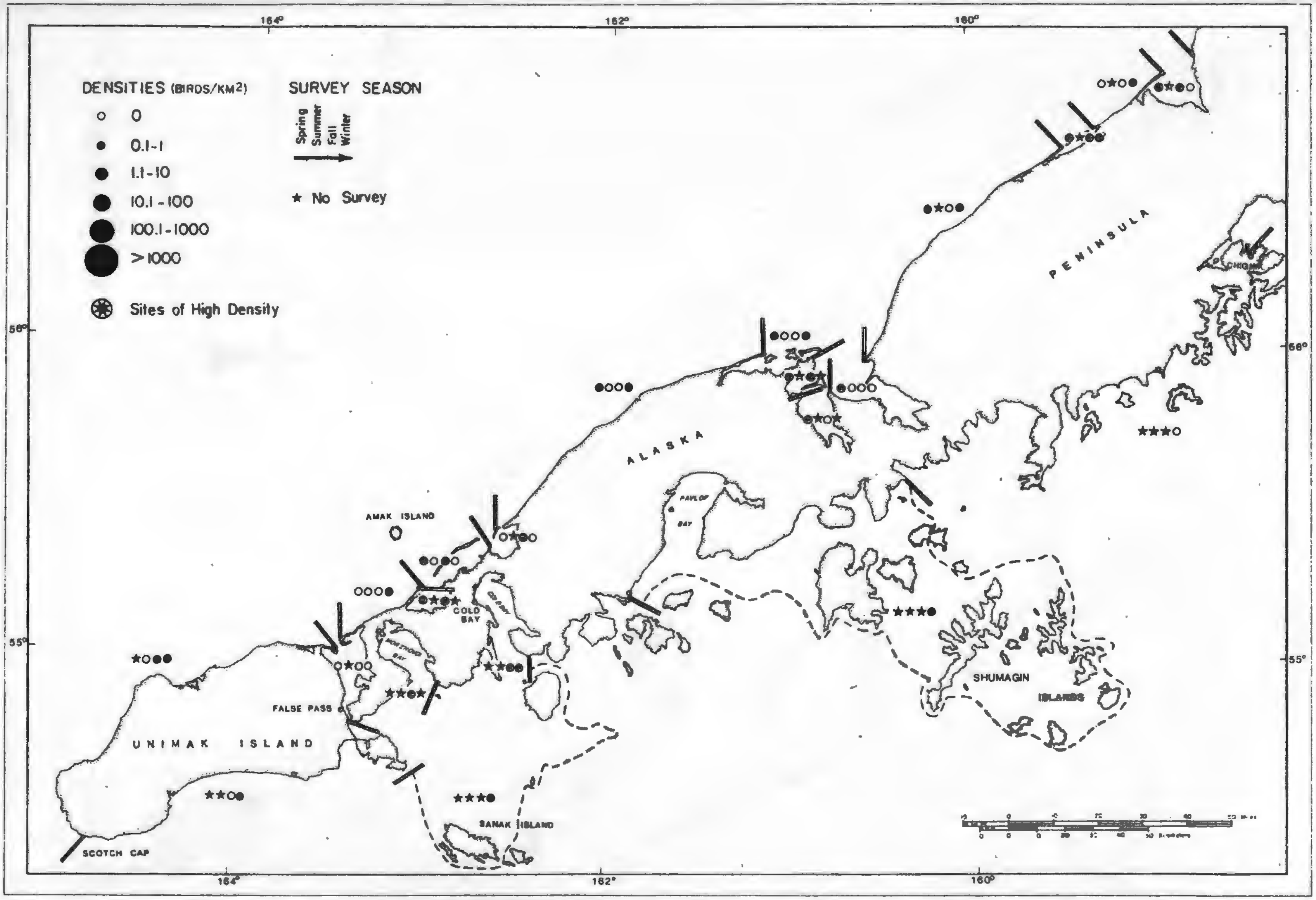


Fig. 122 (cont.). Corvid density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.

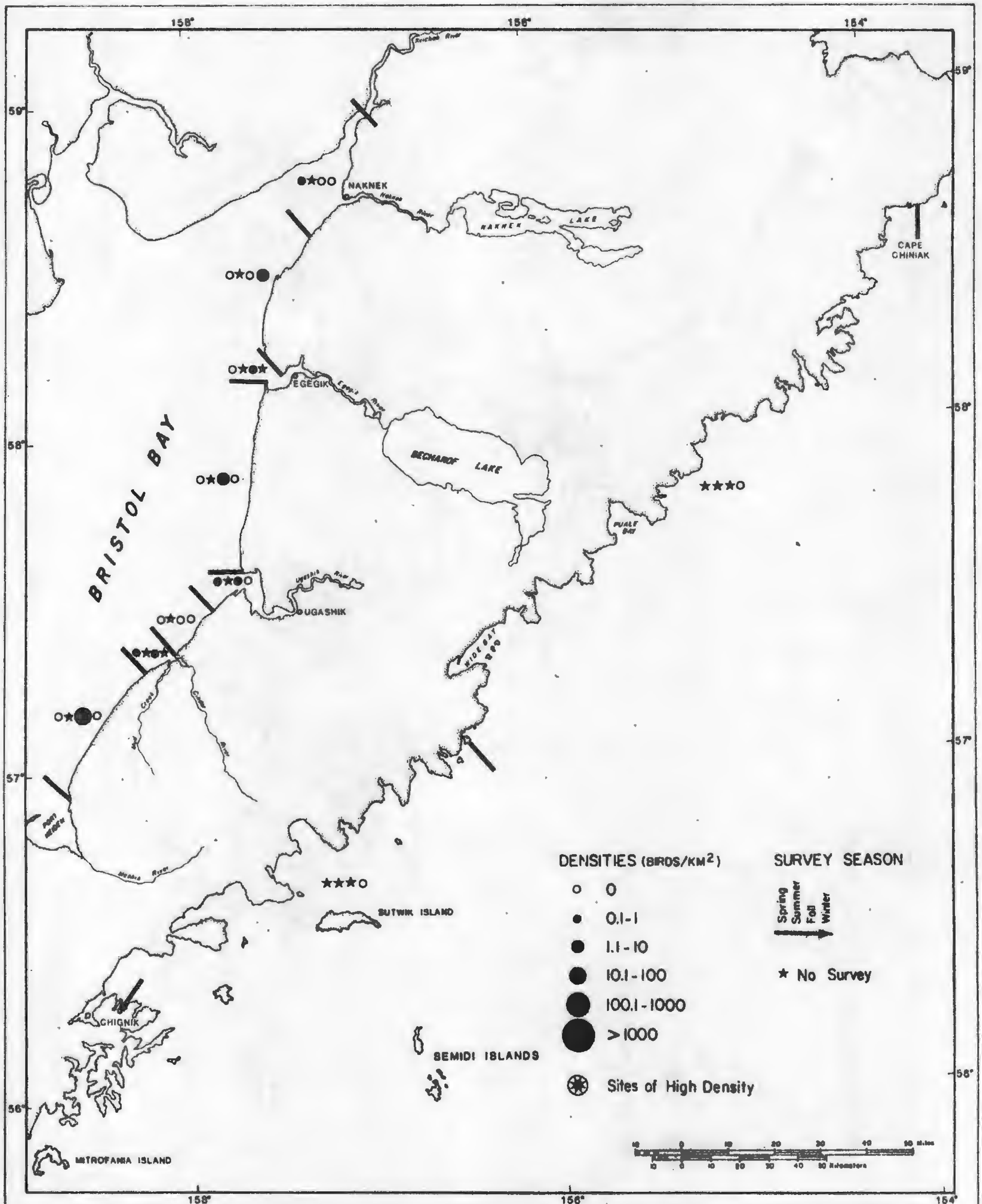


Fig. 123. Passerine (other than corvid) density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic. (Figure continued on next page.)

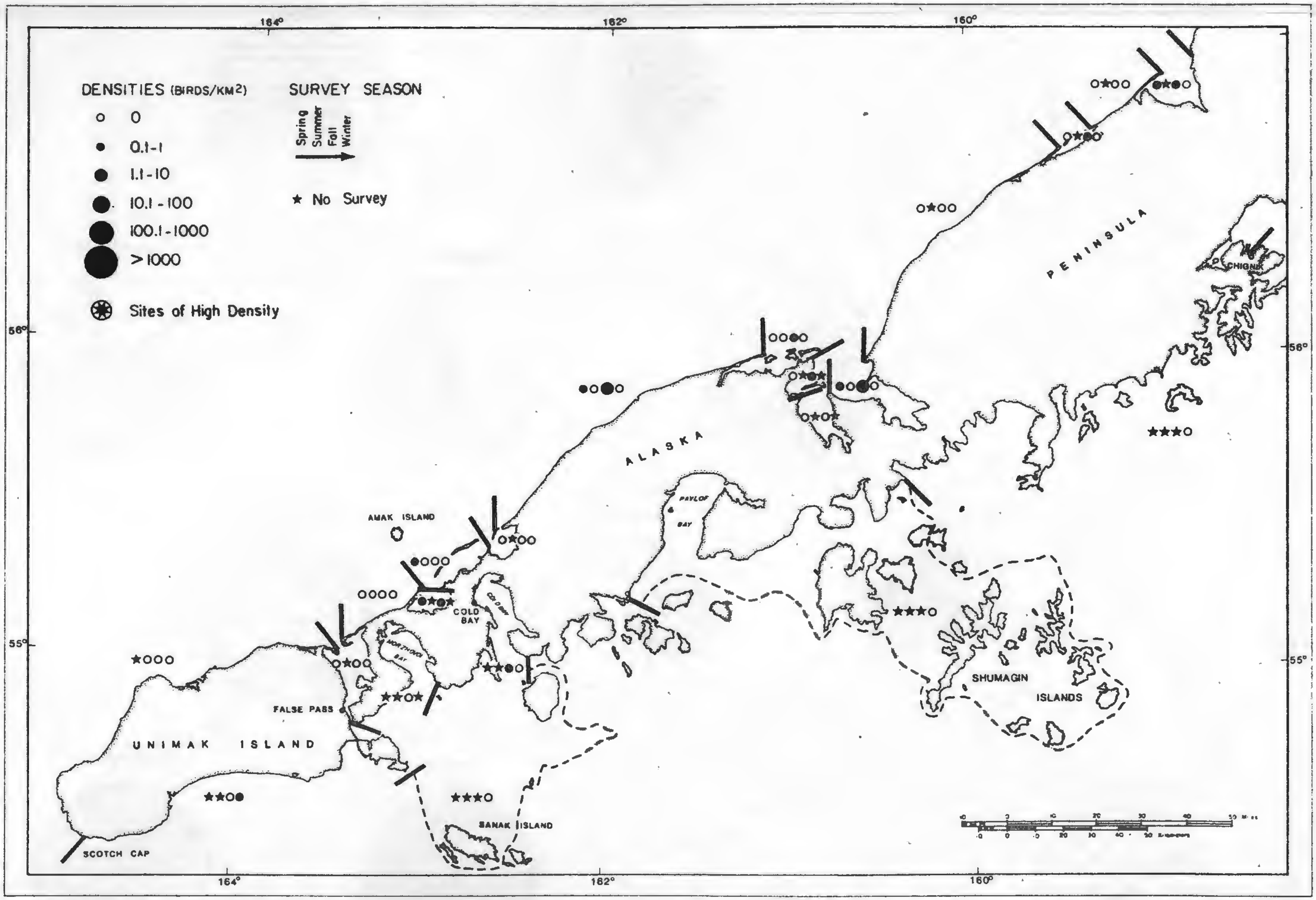
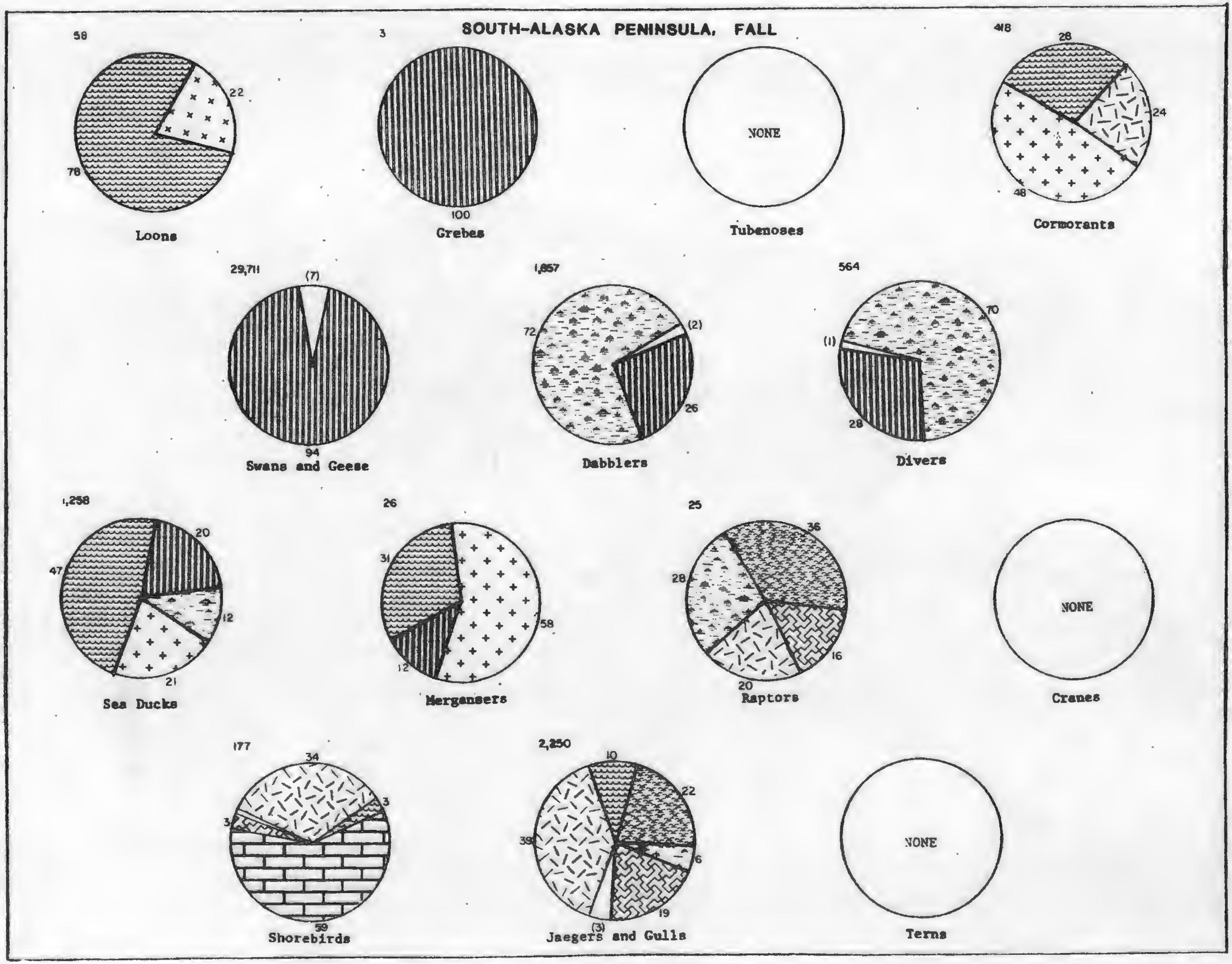


Fig. 123 (cont.). Passerine (other than corvid) density by section along North- and South-Alaska Peninsula during four seasons as determined by aerial surveys. Densities read from left to right: spring, summer, fall, winter. Spring, fall and winter were coastal surveys; summer surveys were pelagic.


SOUTH-ALASKA PENINSULA, FALL
58
22
78
Loons
3
100
Grebes
NONE
Tubenoses
418
28
24
48
Cormorants
29,711
(7)
94
Swans and Geese
1,857
72
(2)
26
Dabblers
564
70
(1)
28
Divers
1,258
20
47
12
21
Sea Ducks
26
31
58
12
Mergansers
25
36
28
16
20
Raptors
NONE
Cranes
177
34
3
3
59
Shorebirds
2,250
10
22
39
6
19
(3)
Jaegers and Gulls
NONE
Terns

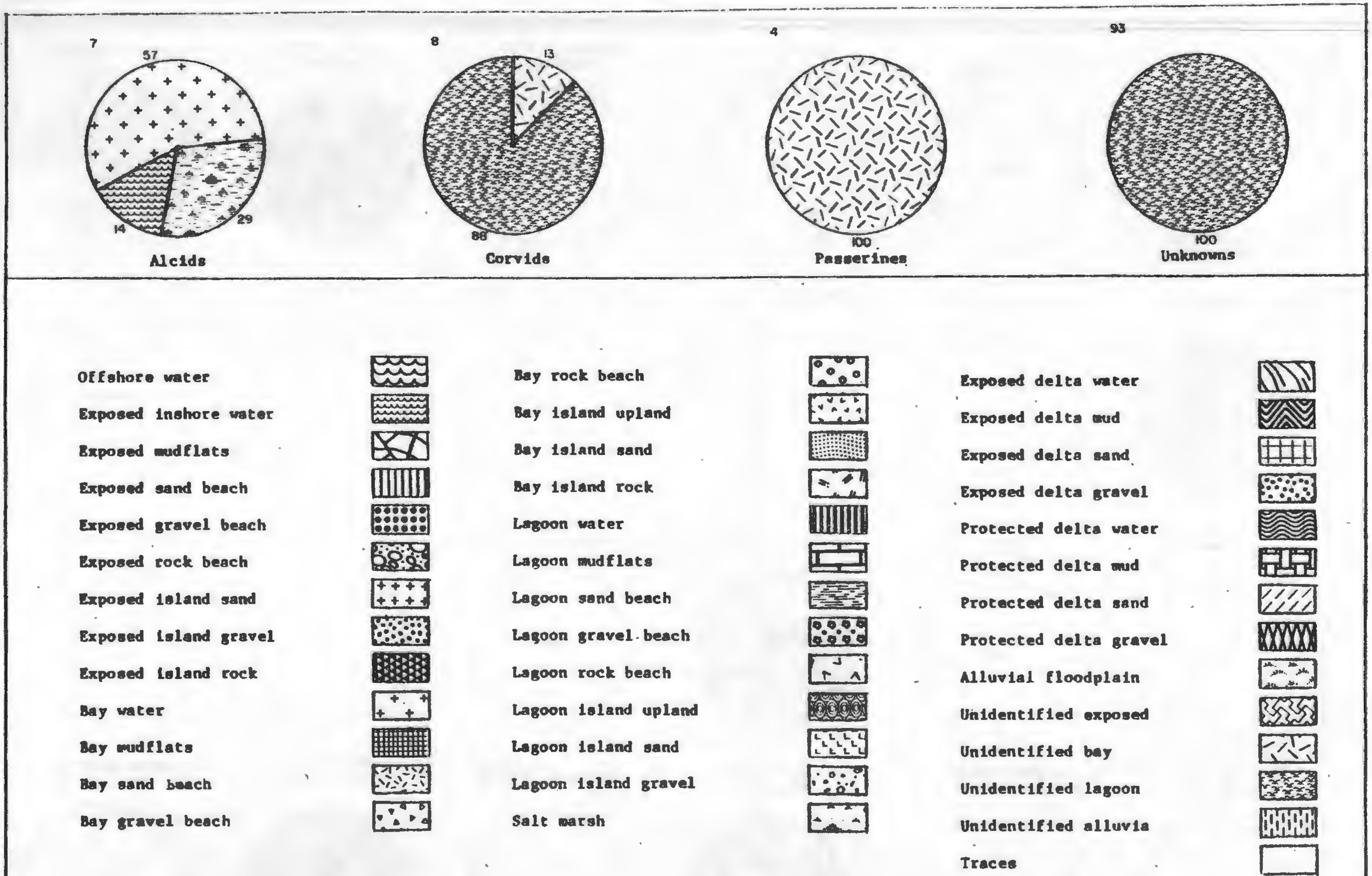
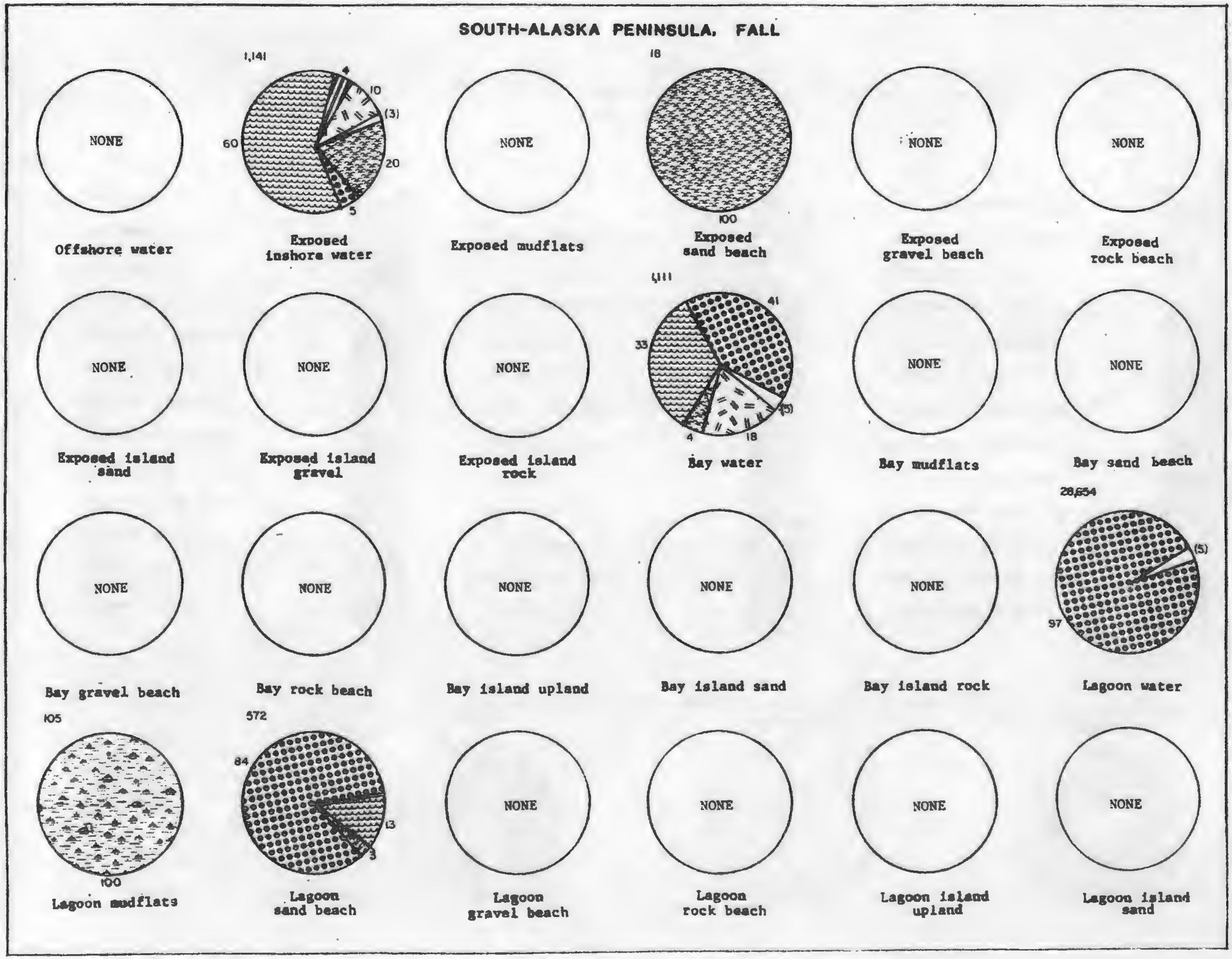


Fig. 124. South-Alaska Peninsula, Fall, 1975. Habitat preference of marine birds as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


SOUTH-ALASKA PENINSULA, FALL
NONE
Offshore water
1,141
4
10
(3)
60
20
5
Exposed inshore water
NONE
Exposed mudflats
18
100
Exposed sand beach
NONE
Exposed gravel beach
NONE
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
1,111
41
33
(5)
4
18
Bay water
NONE
Bay mudflats
NONE
Bay sand beach
NONE
Bay gravel beach
NONE
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
28,654
(5)
97
Lagoon water
105
100
Lagoon mudflats
572
84
13
3
Lagoon sand beach
NONE
Lagoon gravel beach
NONE
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

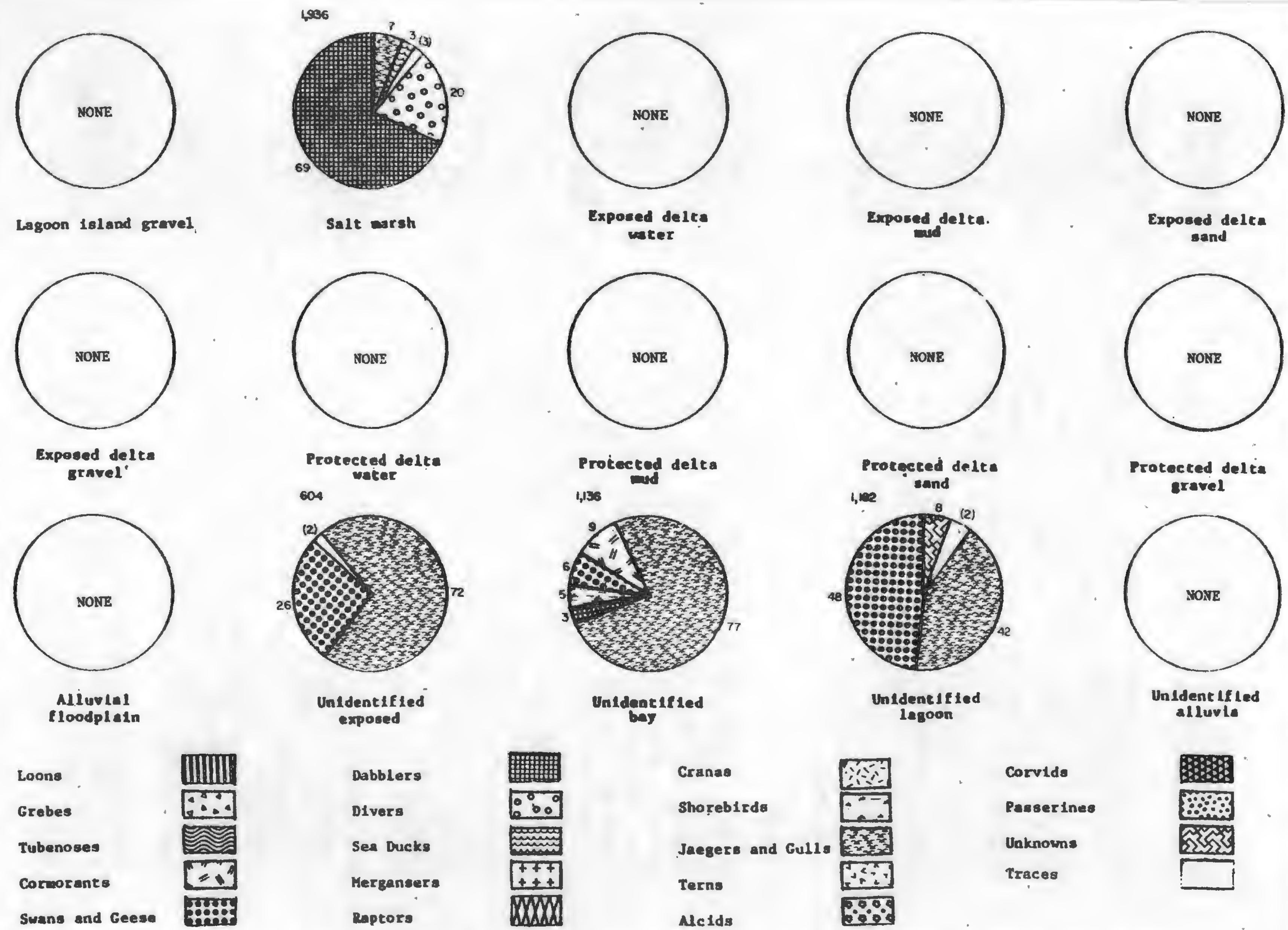


Fig. 125. South-Alaska Peninsula, Fall, 1975. Marine bird usage of habitats as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

percent were geese, 33 percent sea ducks and 18 percent cormorants. Most of the birds on saltmarshes were dabbling ducks (69%) diving ducks (20%) and gulls (7%). Sixty percent of the birds on exposed inshore waters were sea ducks, 20 percent were gulls and 10 percent cormorants.

Habitat preferences of birds are discussed for only those seven groups with sample sizes over 100 individuals. Of 418 cormorants, 72 percent were in bay habitats and the rest (28%) were on exposed inshore waters. Ninety-four percent of the geese used lagoon waters while 72 percent of the dabblers were in saltmarshes and 26 percent on lagoon waters. Similarly, diving ducks mostly used saltmarsh habitats (70%) and lagoon water (28%). Sea ducks were divided among four habitats: 47 percent on exposed inshore water, 21 percent on bay water, 20 percent on lagoon water and 12 percent on saltmarsh. Few shorebirds were seen, but of those recorded 59 percent were on lagoon mudflats and 34 percent on unspecified bay habitats. Most habitats on which gulls were found were not classified to substrate. Forty-one percent were on bay habitats, 30 percent on exposed habitats, 23 percent on lagoon habitats and 6 percent on saltmarsh.

WINTER

<u>Density</u> - Sixty-seven birds/km^2 were found on exposed portions of the south side of the Alaska Peninsula in winter 1977 (Table 13). Alcids comprised 44 percent of the total, sea ducks 26 percent, gulls 14 percent, geese and cormorants 5 percent each and shorebirds 4 percent. Two subdivisions of the trackline (Sections 3 and 4) had over 100 birds/km^2 and one, Section 6, had 99 birds/km^2. Most of the 138 birds/km^2 in Section 3 were alcids (92 birds/km^2). Nearly all were murres near the colony on Spitz Island where 200,000 murres breed in summer months (Sowls et al. 1978). The 90 alcids/km^2 in Section 4 were found mainly in four locations. Rafts of murres containing up to 3,000 birds were found at The Haystacks, Murre Rocks, Chernabura Island and Bird Island (all in the Shumagin Islands). Both sea ducks and gulls had densities of 20 birds/km^2 in Section 3, abd their densities were 18 and 6 birds/km^2, respectively, in Section 4. Other bird groups had similar but lower densities on these two high density sections.

Sea ducks densities were highest (41 birds/km^2) in Section 6, the Cold Bay area, followed by 26 birds/km^2 south of Unimak Island (Section 8). There was a significant increase in densities of sea ducks in Section 6 and 8 between fall and winter (13 and 11 birds/km^2 in fall to 41 and 26 birds/km^2 in winter). Of sea ducks identified at least to genus on South-Alaska Peninsula, 69 percent wete scoters, 12 percent both eiders and Oldsquaw and 6 percent Harlequin Ducks. Over 80 percent of identified scoters were Black, 11 percent were White-winged and 7 percent Surf. Most of the identified eiders were Steller's (57%) and King (32%).

Densities of gulls were highest in Section 6, the Cold Bay area, at 26 birds/km^2. In Section 8 there was a large drop in density between fall and winter (69 to 12 birds/km^2). Geese (all Emperors) reached highest densities in Section 1, the Shelikof Strait area, where 10 birds/km^2

were found. Cormorants were found in almost equal densities (2-4 birds/km^2) in all sections surveyed. Shorebirds and loons were found in all sections; shorebirds in densities up to 7 birds/km^2 and loons only in trace amounts. Dabblers were found in only four of the sections, but 9 birds/km^2 wintered in Section 6. Bald Eagles were regularly seen on small islands offshore but never in high densities.

Habitat Usage - Based on our survey, nothing definite can be said about habitat preferences of birds on South-Alaska Peninsula in winter because of the type of survey conducted. The nature of the survey was to search exposed rocky habitats and, therefore, most birds were found there. Winter habitat usage data are presented in Figs. 126 and 127. Only 16 habitat types were recorded. Eighty-five percent of the birds were on exposed habitats. Most (68% of total) were on exposed water while 7 percent were on exposed island rock and 5 percent on exposed rock beach. On exposed inshore water over one-half (55%) the birds were alcids, 32 percent sea ducks and 9 percent gulls. On exposed island rock, the majority of birds were Emperor Geese, and on rock beaches cormorants predominated. Gulls and shorebirds also were common on rocky habitats.

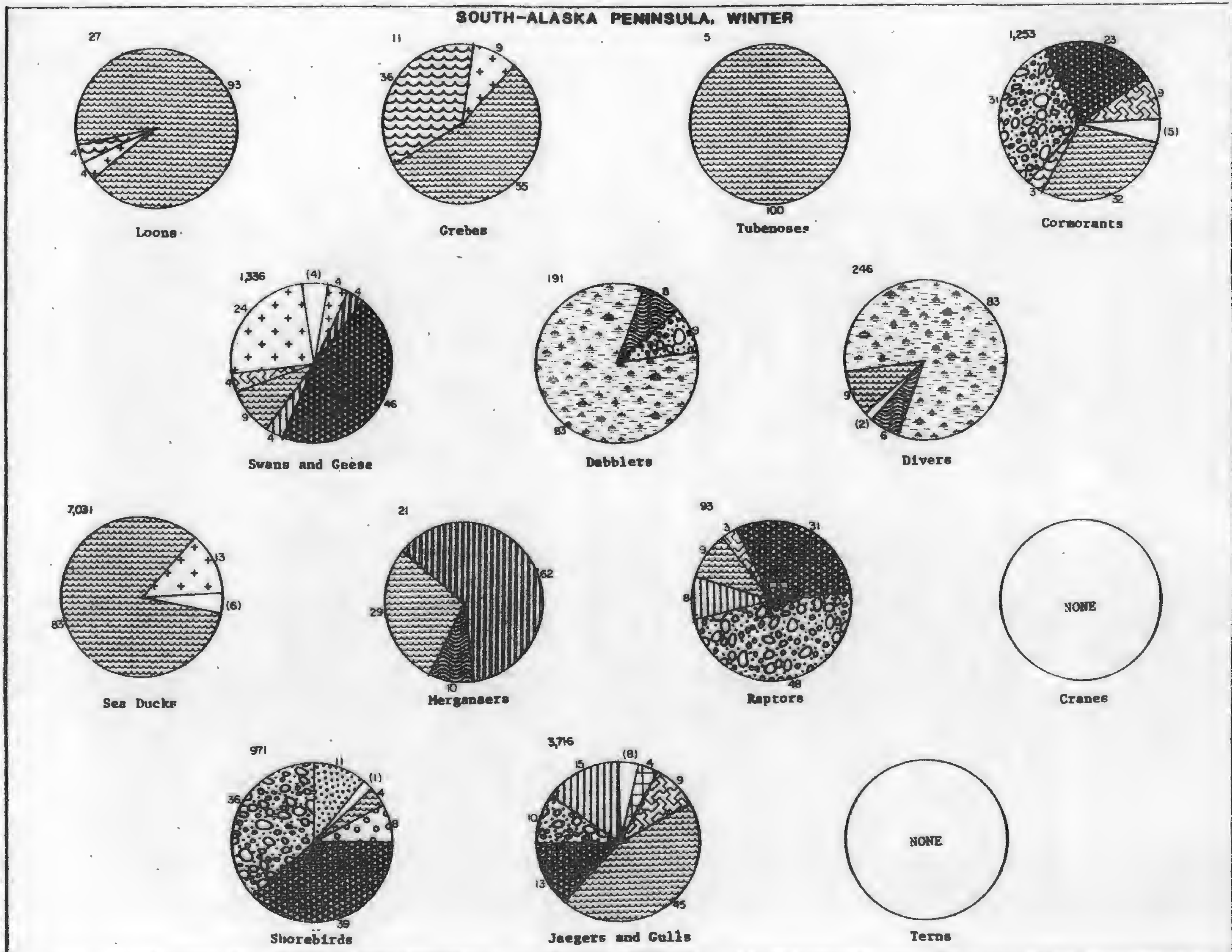
Seven percent of the total birds were on offshore waters, of which 88 percent were alcids and 8 percent sea ducks. The percentage of birds observed on this habitat appeared inordinately low considering the amount of time spent and distance covered in pelagic waters.

On this survey, bay habitats had 5 percent of the birds. Over 70 percent of these birds were sea ducks and over one-fourth were Emperor Geese. Sixty-five percent of the birds on lagoon waters were sea ducks while on saltmarshes most birds were diving and dabbling ducks.

Sample sizes were relatively large for six species groups, and this gave the best indication of habitat selection by these bird groups. Cormorants utilized exposed inshore water (32%) and exposed rock beach (31%) to the same extent, and 23 percent were on exposed island rock. Geese (all Emperors) were mostly on exposed island rock (46%) but also on bay waters (24%) and exposed inshore water (9%). Eighty-three percent of the sea ducks were on exposed inshore waters and 13 percent were on bay water. Shorebirds were found most often on exposed island rock (39% of total) and on exposed rock beach (36%). Eleven habitats were used by gulls, but the majority were on four types: exposed inshore water (45%), exposed sand beach (14%), exposed island rock (13%) and exposed rock beach (10%). Almost 86 percent of the alcids were on exposed inshore water and the remainder were on offshore water.

NORTH - ALASKA PENINSULA

Nine separate surveys were conducted in the North-Alaska Peninsula region, each with varying amounts of coverage and with variable types of habitats searched. Two spring surveys were completed in 1977: the first was an abbreviated survey by helicopter covering only the northwestern 14 stations from Cape Horn to Egegik Bay; the second, by fixed-wing



SOUTH-ALASKA PENINSULA, WINTER
27
93
4
4
Loons
11
9
36
55
Grebes
5
100
Tubenoses
1,253
23
9
31
(5)
3
32
Cormorants
1,336
(4)
4
4
24
4
9
4
46
Swans and Geese
191
8
9
83
Dabblers
246
83
9
(2)
6
Divers
7,031
13
(6)
83
Sea Ducks
21
62
29
10
Mergansers
93
3
31
9
8
48
Raptors
NONE
Cranes
971
11
(1)
4
8
36
39
Shorebirds
3,716
15
(8)
4
9
10
13
45
Jaegers and Gulls
NONE
Terns

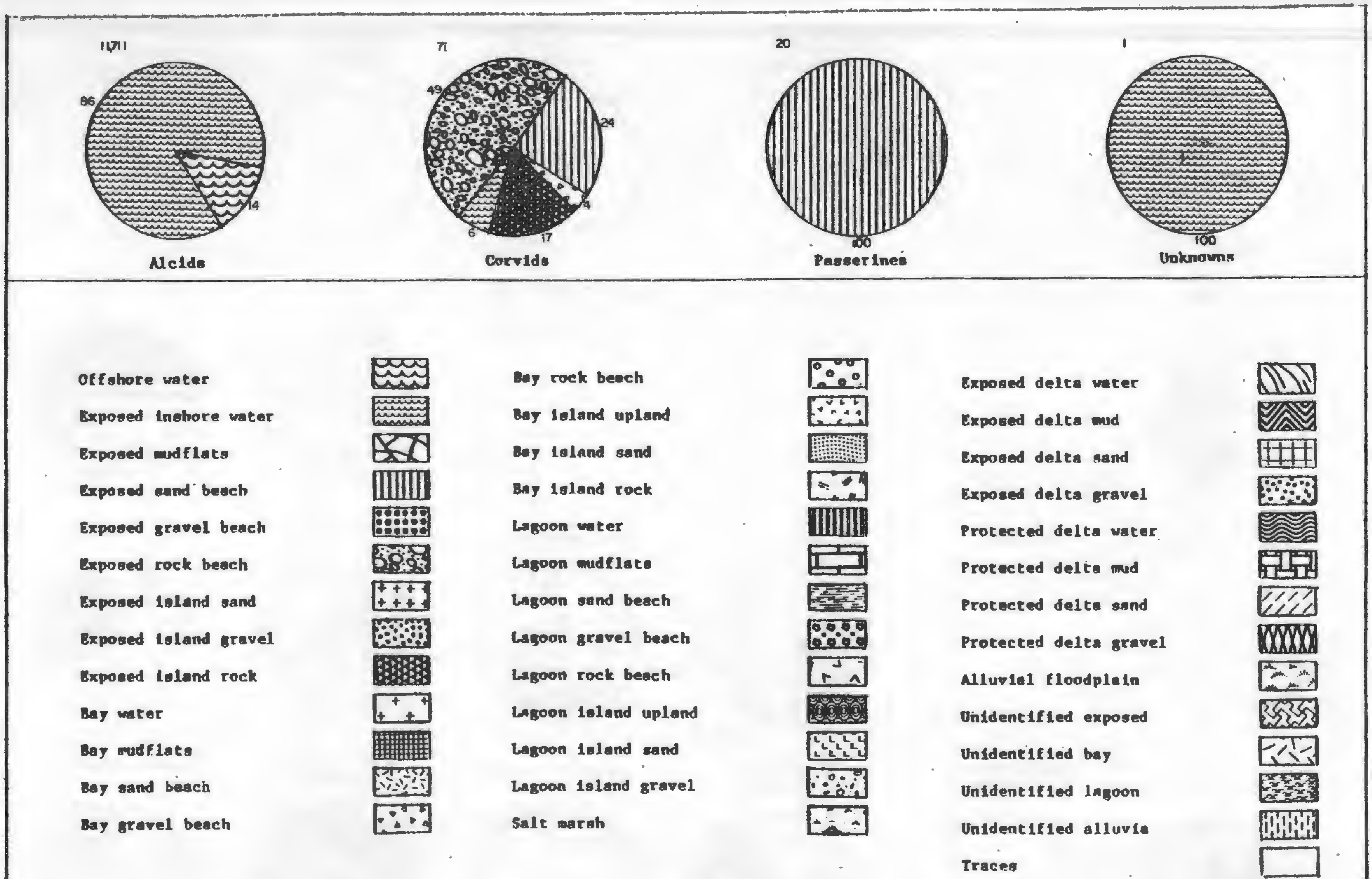
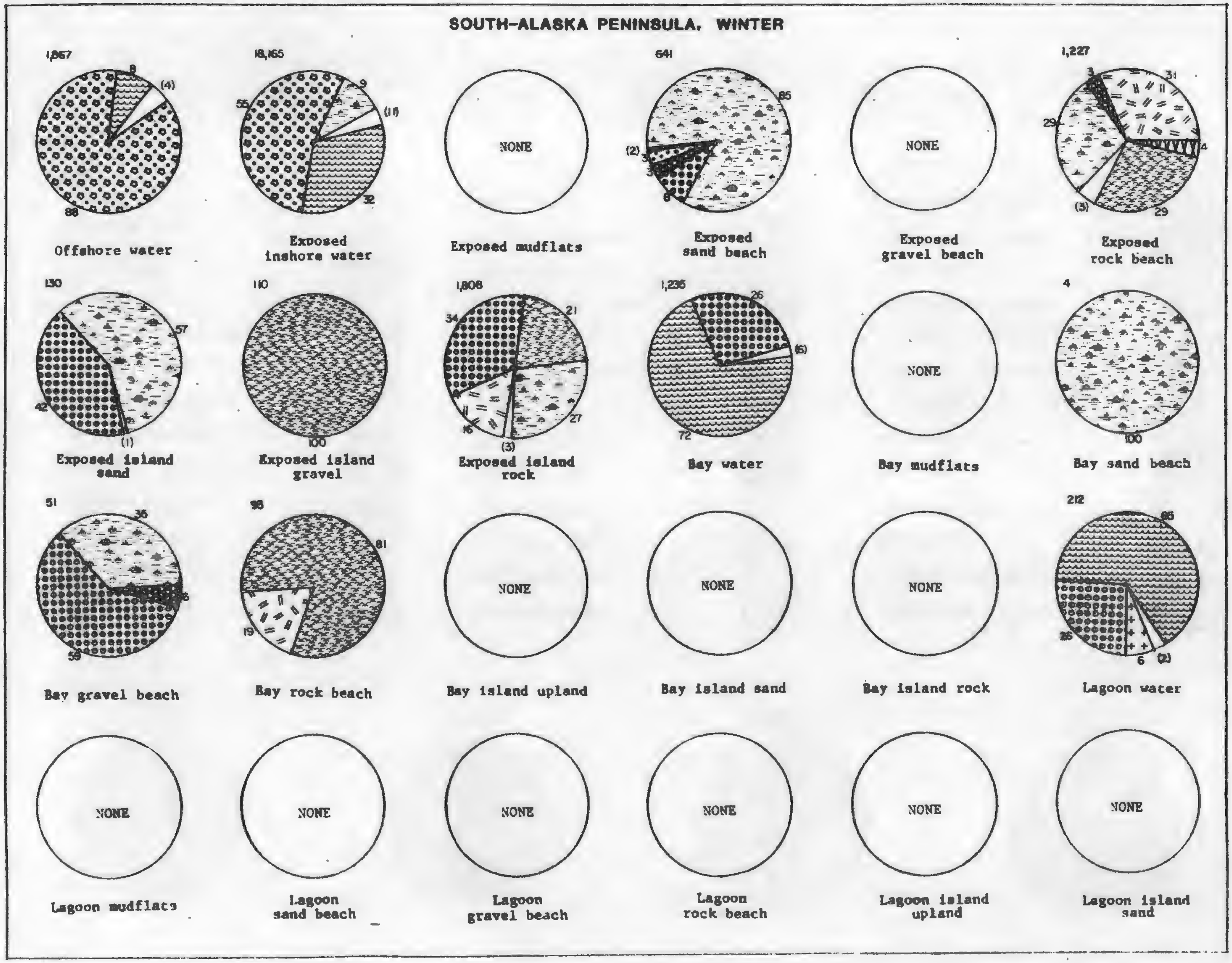


Fig. 126. South-Alaska Peninsula, Winter, 1977. Habitat preference of marine birds as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


SOUTH-ALASKA PENINSULA. WINTER
1,867
8
(4)
88
Offshore water
18,165
9
55
(11)
32
Exposed inshore water
NONE
Exposed mudflats
641
85
(2)
3
3
8
Exposed sand beach
NONE
Exposed gravel beach
1,227
3
31
29
4
(3)
29
Exposed rock beach
130
57
42
(1)
Exposed island sand
110
100
Exposed island gravel
1,808
34
21
16
27
(3)
Exposed island rock
1,235
26
(6)
72
Bay water
NONE
Bay mudflats
4
100
Bay sand beach
51
35
6
59
Bay gravel beach
98
81
19
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
212
65
26
6
(2)
Lagoon water
NONE
Lagoon mudflats
NONE
Lagoon sand beach
NONE
Lagoon gravel beach
NONE
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

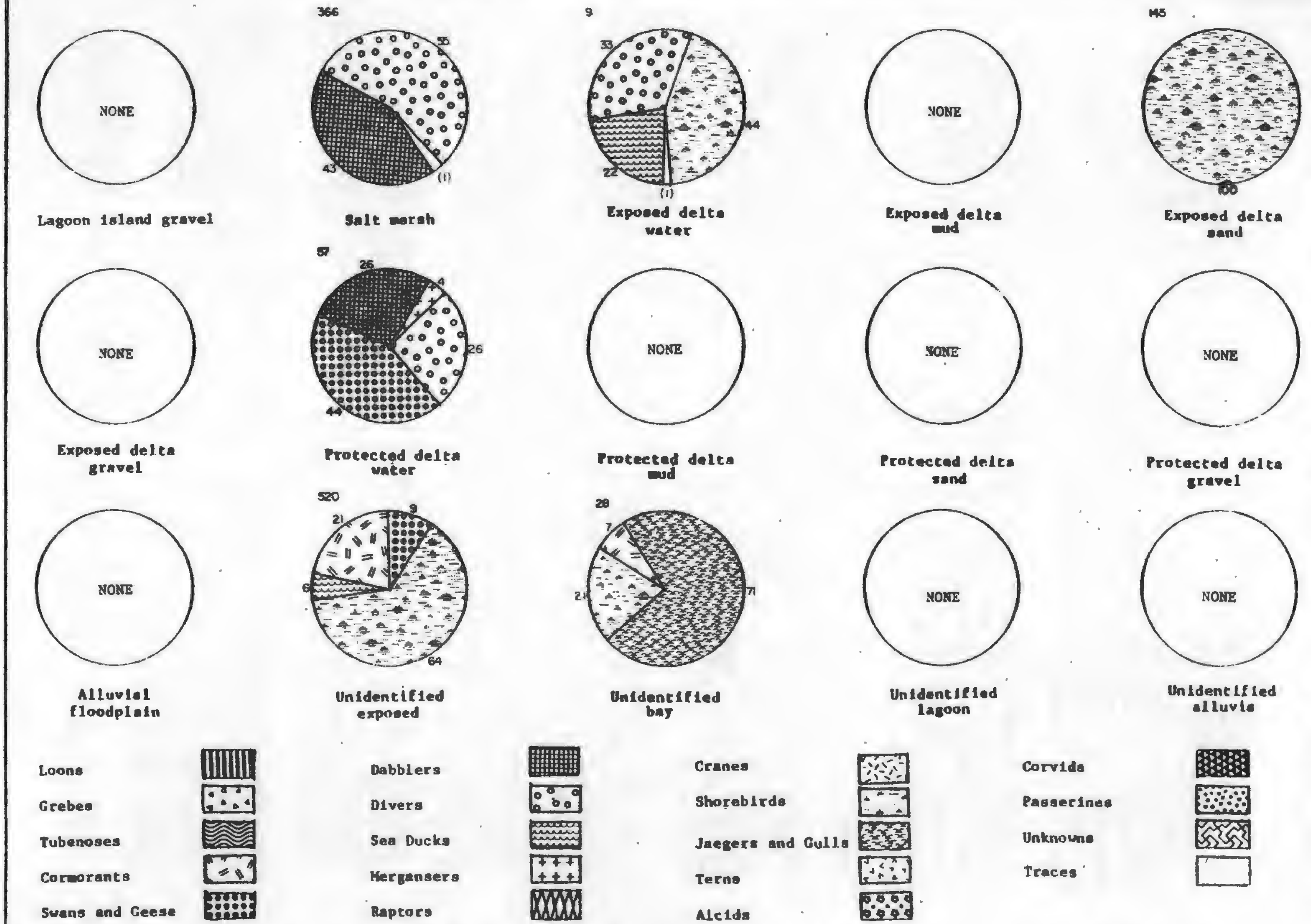


Fig. 127. South-Alaska Peninsula, Winter, 1977. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

aircraft, covered the entire shoreline to St. Catherine Cove in Bechevin Bay. Both summer surveys were pelagic and both were conducted in conjunction with marine mammal surveys. In fall, two surveys were conducted, one in October 1975 and one in October 1976. The first covered most of the coast from Naknek River to Otter Point on Unimak Island including the estuaries. On the second survey, estuaries were covered from Egegik to Bechevin Bay. Three partial winter surveys were conducted and, in general, only coastal areas and not estuaries were searched for birds. Some offshore water was surveyed on one winter survey.

For data summary, the coast from Cape Horn in the Kvichak River to Scotch Cap on Unimak Island was subdivided into 23 sections (Fig. 105). Section boundaries changed when there was a major change in physiographic features. In general, sections denoted exposed coast and various types of estuaries. Bird density data for all seasons are shown by section in Figs. 106-123.

SPRING

Density - The mean density for North-Alaska Peninsula in spring was 141 birds/km^2 (Table 14). Highest density (849 birds/km^2) was in Section 16, Nelson Lagoon followed distantly by Section 20, Applegate Cove of Izembek Lagoon, with 358 birds/km^2. Eleven sections had densities over 100 birds/km^2. The lowest section (No. 22) had a density of 44 birds/km^2. Section 23 was not surveyed in spring.

Geese had the highest overall density - 60 birds/km^2. Next were gulls (31 birds/km^2) and sea ducks (26 birds/km^2), both of which were observed in all sections. Dabblers numberd 11 birds/km^2, shorebirds 9 birds/km^2 and the rest were 2 birds/km^2 or less. Only tubenoses were not observed.

Nelson Lagoon had the highest densities for three bird groups: geese (388 birds/km^2), sea ducks (233 birds/km^2) and gulls (208 birds/km^2). All geese were Emperors and sea duck species composition was 88 percent Steller's Eider, 9 percent Black Scoter and 3 percent Common Eider.

Applegate Cove in southwestern Izembek Lagoon had a goose density of 319 birds/km^2; however, almost 100 percent were Brant and a trace were Emperors. Section 9, Port Heiden, was the only other area with goose densities over 100 birds/km^2 at 118 birds/km^2. Emperor Geese made up 98 percent, Canada Geese 1 percent and Brant 1 percent of these birds.

Dabbling ducks densities were highest at Port Heiden (Section 9) at 40 birds/km^2 and in Section 1 at the mouth of Kvichak River with 34 birds/km^2. Ugashik Bay (Section 5) and Mud Bay (Section 15) were next highest with 24 and 22 dabblers/km^2, respectively. Pintails comprised 91 percent of the total identified dabblers. Diving ducks were most common on the north end of the region.

Densities of shorebirds were greatest on four sections. Sections 1, 3, 7 and 15 had 26, 33, 23 and 20 birds/km^2, respectively. A rapid change

Table 14. Bird density by section of coastline in North-Alaska Peninsula, spring 1977. See Figure 105 for section boundaries. (T=trace).

	Spring Densities (birds/km^2)																							
	Section of Coastline																							
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Loon	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T	T							T
Grebe	T	T	T	T	T				T	T	T	T	T											T
Tubenose																								0
Cormorant		T										1	T	T					T		1			T
Goose and Swan	8	2	T	2	3	T	8		118		45	3	1	5	62	388	1	16	78	319	T	1		60
Dabbler	34	12	3	9	24		15		40		8		2	1	22	6		2	2	2				11
Diver	10	3	11	6	2		1		1		T		3		2	1		2	T			T		2
Sea Duck	1	7	20	19	4	33	3	30	13	59	24	53	73	28	5	233	25	50	20	26	28	5		26
Merganser	12	1	T	1	T		T	1	T		T	T	T	T		T			T	T				1
Raptor	T	T		T	T	T	T		T		T	T	T	T	T	T	T	T	T			T		T
Crane	1	T	T	T	T		T		T															T
Shorebird	26	33	6	16	7	4	23	T	10		5		1	T	20	8	8	3	1	T	3			9
Gull and Jaeger	30	45	12	14	8	39	8	13	20	7	38	167	76	31	31	208	48	5	22	11	87	38		31
Tern	T	T	T	1	1	6	1	9	1		2	1	T		T	5	4		1					1
Alcid		T						T				1	T	T			T		T					T
Corvid	T	T			T		T	T	T		T	T	T	T	T	T	T		T	T				T
Other Passerine	T				T		T		1				T				T		T	T				T
Other Bird	1	T	T	1	1		T		T		T		T					T						T
TOTAL	123	103	53	69	49	82	60	53	205	66	124	227	155	66	143	849	86	79	124	358	119	44	*	141

* No survey.

in species composition was noted between the helicopter and fixed-wing surveys that were only days apart. Black-bellied plovers (*Pluvialis squatarola*), common on 6 May 1977, were absent on 10 May 1977. Few shorebirds were seen on 10 May in the stations duplicating the 6 May survey.

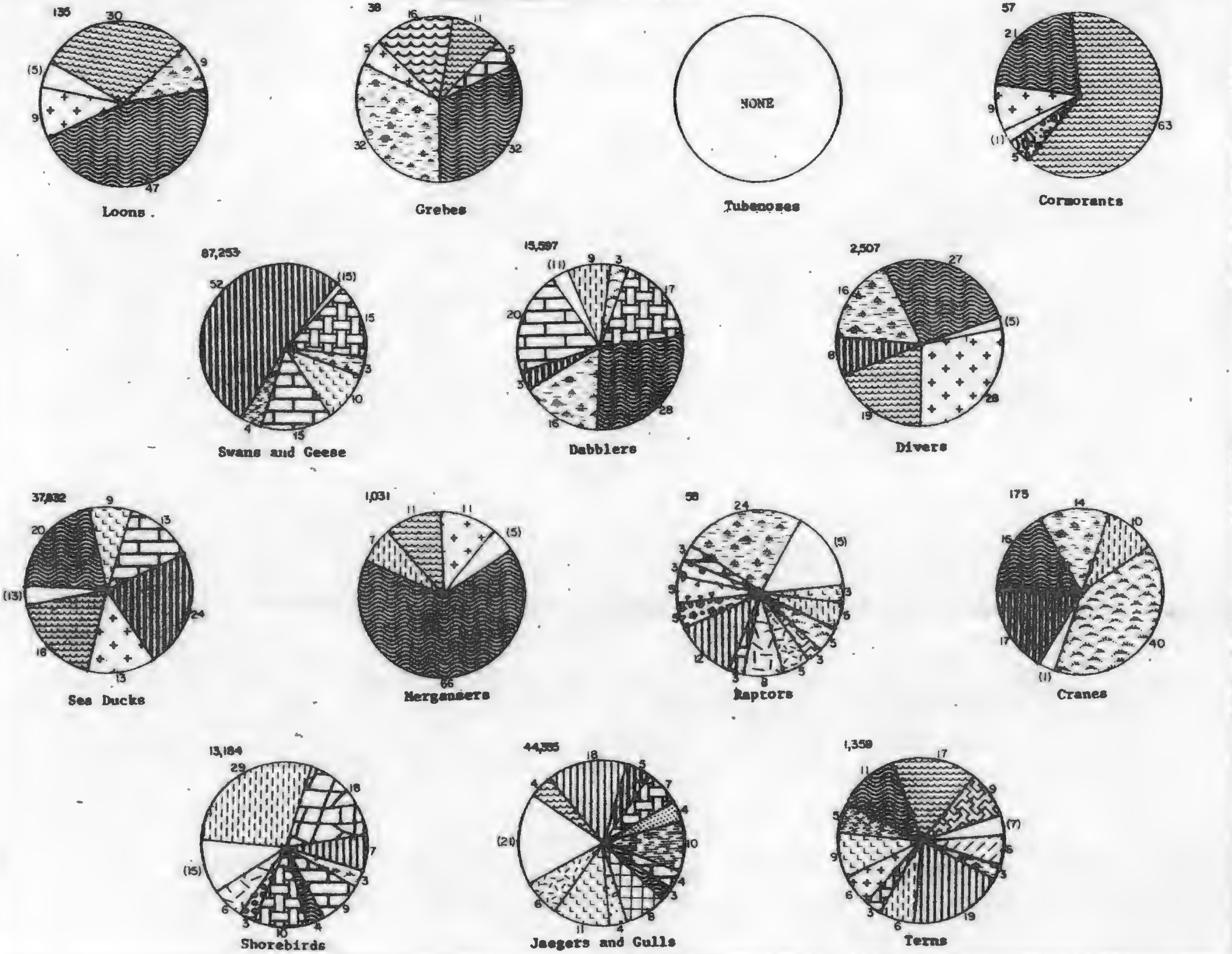
Other than at Nelson Lagoon, gulls were abundant only in Section 12 where 167 birds/km^2 were found. Many of these were kittiwakes at Cape Seniavin. In most cases, higher gull densities occurred on sections with exposed beaches rather than protected estuaries. Tern migration was just beginning an upswing and highest recorded densities were 9, 6, 5 and 4 birds/km^2 in Sections 8, 6, 16 and 17, respectively.

Loons, Bald Eagles and Common Ravens were observed in most sections but only in trace densities. Sandhill Cranes were found only on the northern half of the region, and with measurable amounts (1 bird/km^2) only in Section 1.

Habitat Usage - Birds on North-Alaska Peninsula during spring were distributed on a variety of habitats. Information on habitat usage by birds in spring is presented in Figs. 128 and 129. Of the 30 identified habitats on which birds were found in spring, nine habitats had 5,000 or more birds. The most used habitat was lagoon water where 28 percent of the birds were found. Almost 80 percent of the birds on this habitat were geese and most of the remainder (16%) were sea ducks. Lagoon mudflats were the next most used areas, and 12 percent of the birds were found there. Fifty-four percent of the birds on lagoon mudflats were geese, 20 percent sea ducks, 13 percent dabblers, 7 percent gulls and 5 percent shorebirds. Protected delta mudflats, used by 10 percent of the birds, supported mostly geese (65%), plus many gulls (15%) and dabblers (14%). Lagoon island sand, fourth in percent usage with 8 percent, was used most commonly by geese (49%). Additionally, 29 percent of the birds were gulls and 20 percent sea ducks on this habitat. The fifth most used habitat at just under 8 percent of the total, protected delta water, was used most by sea ducks (47%), dabblers (27%) and gulls (10%). Exposed inshore water and exposed sand beach each had 5 percent of the birds. On exposed water 69 percent of the birds were sea ducks and 19 percent gulls. On sand 86 percent were gulls and 9 percent shorebirds. Three percent of the birds were on bay water, most were sea ducks (73%) plus 10 percent each for diving ducks and gulls.

Of the over 200,000 birds recorded on spring surveys in the region, only eight species groups numbered over 1,000. Geese comprised 43 percent of the total and were found on principally four habitats. Over half (52%) were on lagoon water, 15 percent on lagoon mudflats, 15% on protected delta mud and 10 percent on lagoon island sand. Dabblers were most commonly found on protected delta water (28%), lagoon mud (20%), protected delta mud (17%) and saltmarsh (16%). Twenty-eight percent of diving ducks were on bay water, 27 percent on protected delta water, 19 percent on exposed inshore water and 16 percent on saltmarsh. Sea ducks also were found on a variety of habitats: 24 percent on lagoon water, 20

NORTH-ALASKA PENINSULA, SPRING



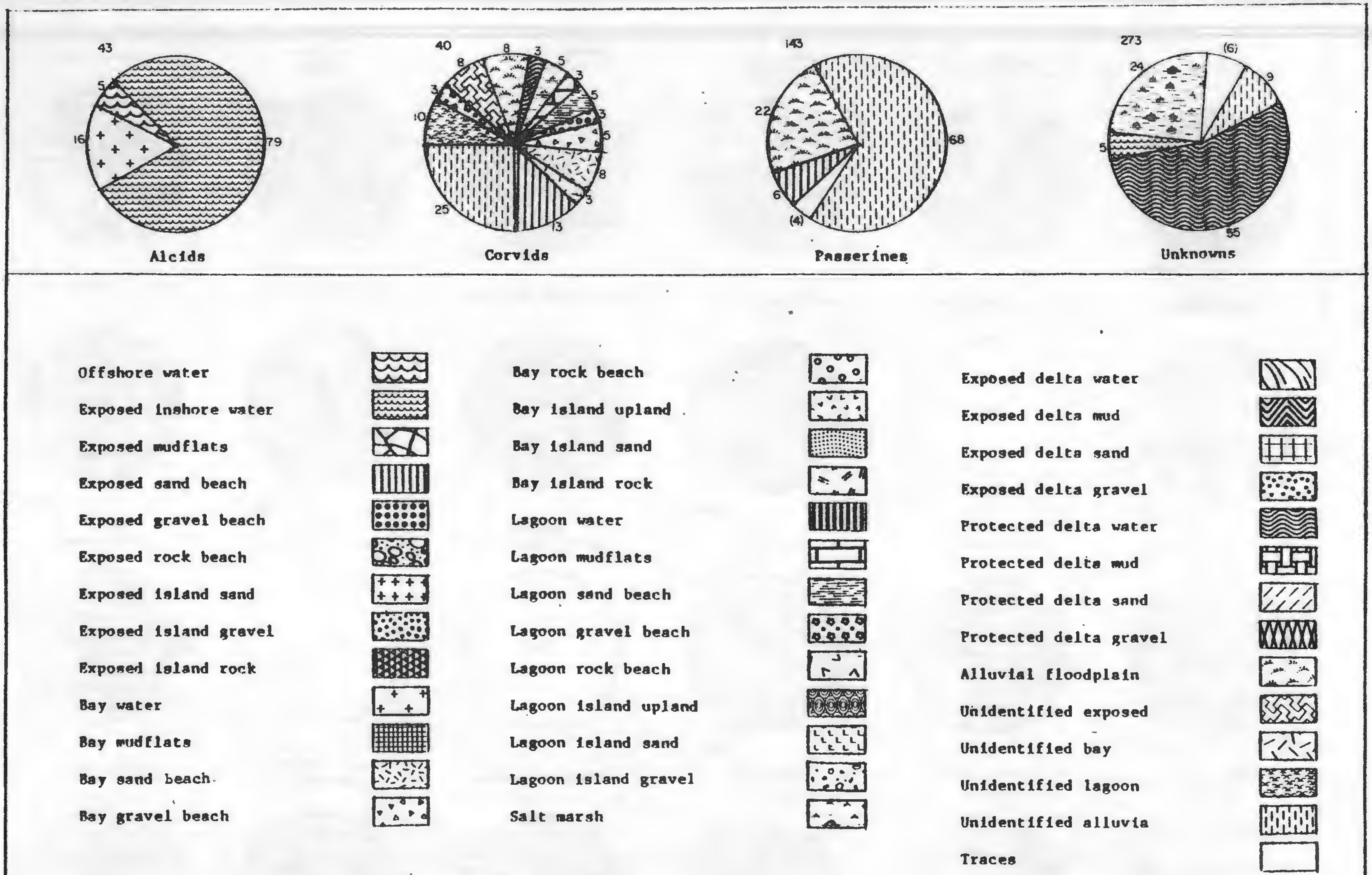
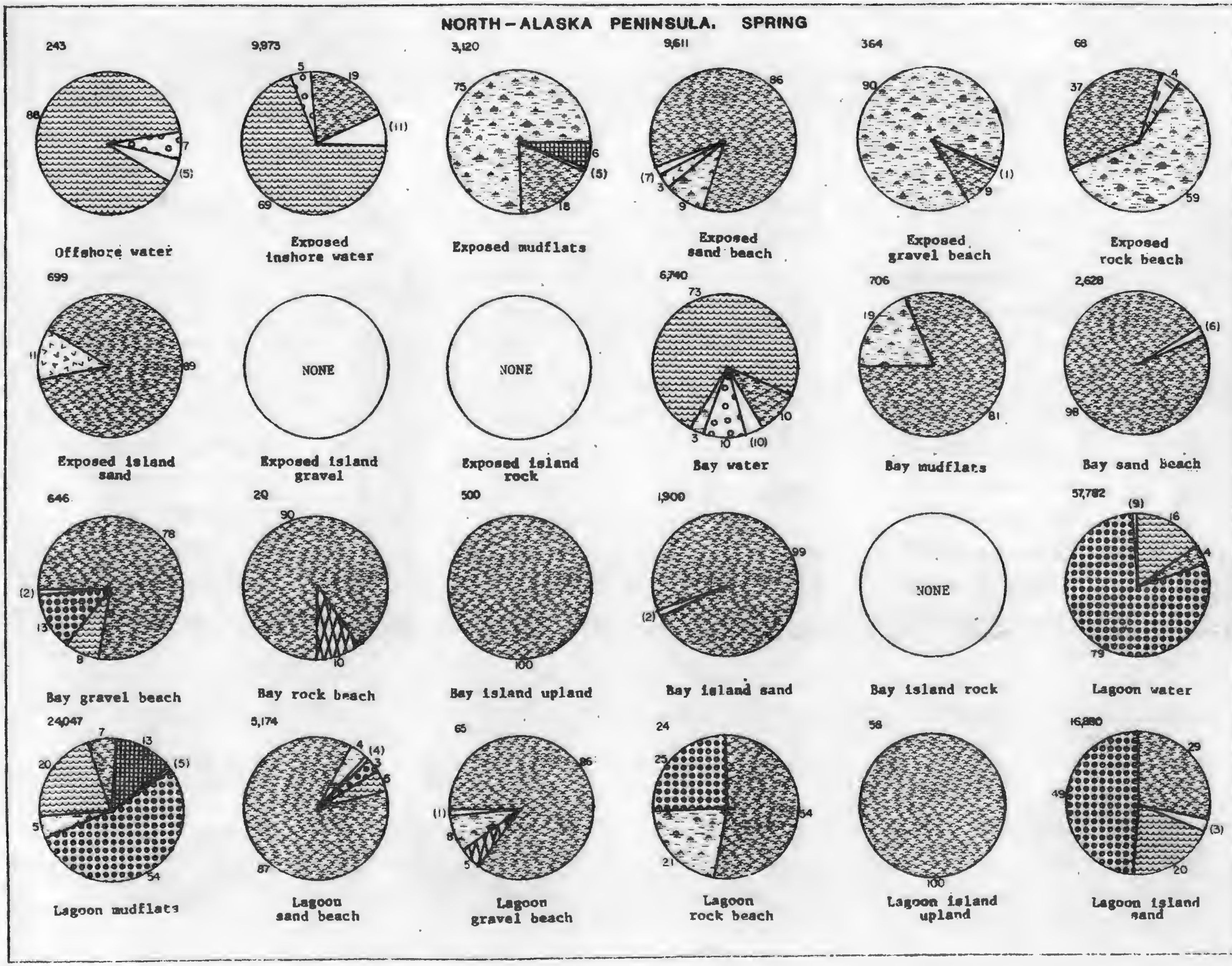


Fig. 128. North-Alaska Peninsula, Spring, 1977. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


NORTH-ALASKA PENINSULA. SPRING
243
88
7
(5)
69
Offshore water
9,973
5
19
(11)
69
Exposed inshore water
3,120
75
6
(5)
18
Exposed mudflats
9,611
86
(7)
3
9
Exposed sand beach
364
90
(1)
9
Exposed gravel beach
68
4
37
59
Exposed rock beach
699
11
89
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
6,740
73
10
3
10
(10)
Bay water
706
19
81
Bay mudflats
2,628
(6)
98
Bay sand beach
646
78
(2)
13
8
Bay gravel beach
20
90
10
Bay rock beach
500
100
Bay island upland
1,900
99
(2)
Bay island sand
NONE
Bay island rock
57,782
(9)
16
4
79
Lagoon water
24,047
7
13
20
(5)
5
54
Lagoon mudflats
5,174
4
(4)
3
6
87
Lagoon sand beach
65
86
(1)
8
5
Lagoon gravel beach
24
25
54
21
Lagoon rock beach
58
100
Lagoon island upland
16,880
29
49
(3)
20
Lagoon island sand

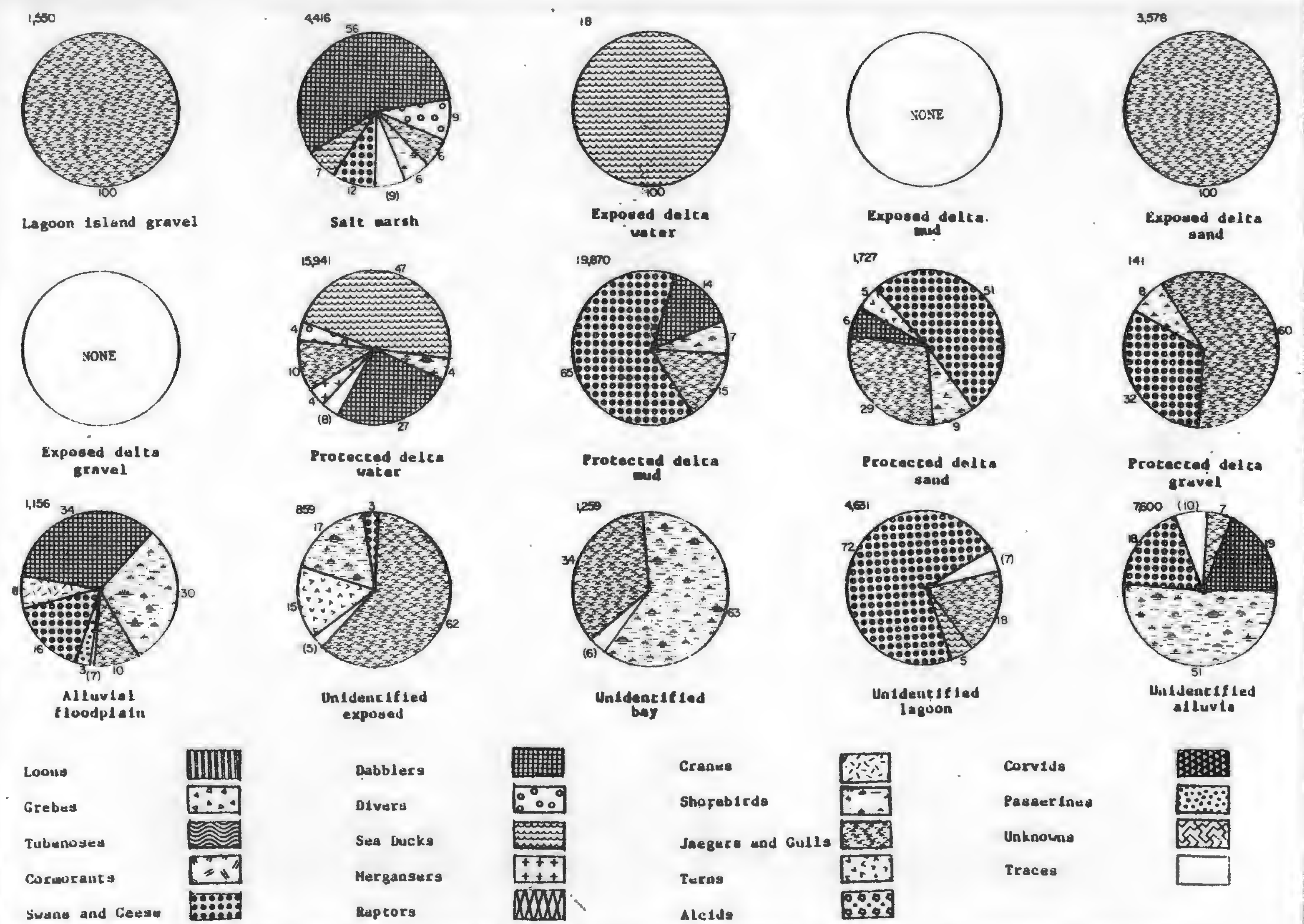


Fig. 129. North-Alaska Peninsula, Spring, 1977. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

percent on protected delta water, 18 percent on exposed inshore water, 13 percent on each of bay water and lagoon mudflats and 9 percent on lagoon island sand. Sixty-six percent of the mergansers were on protected delta water plus 11 percent each on exposed inshore and bay water.

Shorebirds and gulls were found in small percentages on the greatest diversity of habitats. Shorebirds were found in twenty habitats but most often used protected delta areas (48% of the birds). Gulls were found in 30 of 31 habitats, with exposed sand beach being the predominant habitat (19% of the birds on it) followed by lagoon island sand (11%) and lagoon sand beach (10%). In all, 60% of the gulls were recorded on sand substrate in exposed and protected areas. Nineteen percent of the terns were also on, or flying over, exposed sand beaches. The second most frequently used habitat by terns was exposed inshore water (17%), followed by protected delta water (11%) and lagoon island sand (9%).

Overall, birds selected lagoon habitats 54 percent of the time, protected deltas 23 percent, exposed habitats 12 percent, bays 7 percent, and both saltmarshes and exposed delta habitats 2 percent.

SUMMER

Pelagic Density - The brief survey in June 1976 covered only seven stations offshore from Section 17, and the 39 pelagic transects in July were nearest the six exposed sections from Port Moller to Unimak Pass. The overall summer bird density in these waters was 432 birds/km^2 (Table 15). Over 90 percent of the birds, or 402 birds/km^2, were shearwaters. At the time of the survey in late July, the waters northeast and southwest of Amak Island supported scattered, large flocks of these birds. A small percentage of the total population was enumerated in the transect width, and it was assumed that several million shearwaters were present. Sectional breakdown of shearwater densities was likely not a true indicator of bird distribution, but pelagic waters off Section 19 (on the east side of Amak Island) had 1375 shearwaters/km^2. Numbers of shearwaters dropped off as we proceeded up the coast from Moffett Lagoon.

Gulls were the next most abundant group with 16 birds/km^2. The high density area was just north of Nelson Lagoon with 65 birds/km^2. Large gulls predominated in Section 16, whereas farther south kittiwakes were as abundant as Glaucous-winged Gulls. Murres were the predominant alcid and the greatest density occurred southwest of Amak Island at 33 birds/km^2. Sea duck densities were highest near Port Moller but only 4 and 5 birds/km^2 were recorded for the two sections 13 and 16, respectively. Terns were observed in all sections but only in trace amounts.

Habitat Usage - Except for a few birds on the inshore portion of the transects, all birds were in offshore waters.

Table 15. Pelagic densities of birds by section of coastline in North-Alaska Peninsula, summer 1976. See Figure 105 for section boundaries. (T=trace).

	Summer Densities (birds/km^2)						
	Section of Coastline						
Bird Group	13	16	17	19	21	23	Total
Loon			T				T
Grebe							0
Tubenose		4	133	1375	431	426	402
Cormorant					2	T	T
Goose and Swan							0
Dabbler							0
Diver							0
Sea Duck	4	5	1		T		1
Merganser							0
Raptor							0
Crane							0
Shorebird			T	T		T	T
Gull and Jaeger	13	65	17	11	20	6	16
Tern	1	T	T	T	T	T	T
Alcid	5	1	7	11	33	9	12
Corvid							0
Other Passerine							0
Other Bird							0
TOTAL	22	76	158	1397	486	442	432

FALL

Density - The north side of the Alaska Peninsula, in fall, provided ideal staging habitat for waterfowl and other bird groups. The mean fall density was 453 birds/km^2 and of that number 268 birds/km^2 were geese (Table 16). Over one-half of the geese were Brant (59%), 23 percent Canada Geese and 17 percent Emperor Geese. Only a trace of Snow Geese and no White-fronted Geese were seen on the October surveys. Mean densities for sea ducks were 97 birds/km^2, shorebirds 41 birds/km^2, dabblers 23 birds/km^2 and gulls 19 birds/km^2. Remaining bird groups had densities of 1 bird/km^2 or less.

Seventeen sections had densities of over 100 birds/km^2, and on one, densities exceeded 1,000 birds/km^2. The latter section was No. 20, the Applegate Cove portion of Izembek Lagoon. Geese (mostly Brant) accounted for 932 of 1044 birds/km^2 in Section 20.

On the first survey in October 1975, it was found that Brant were difficult to census because they frequently flushed upon approach of the aircraft and flew to areas not yet counted, potentially being counted repeatedly. For that reason, Brant numbers from the first survey may be exaggerated to some extent but this did not greatly affect mean densities when lumped with such large numbers. Section 20 would still remain the one with the highest bird density in the region. In Applegate Cove 76 percent of the geese were Brant, 20 percent Canada Geese and 4 percent Emperor Geese. Almost all of the sea ducks (66 birds/km^2) in Section 20 were Steller's Eiders.

The section with the second highest bird density was Nelson Lagoon (No. 16) with a density of 746 birds/km^2. In this area sea ducks were the most abundant bird group at 420 birds/km^2. Species composition was 55 percent Steller's Eiders, 2 percent large eiders (King and Common) and 42 percent scoters (99% Black). The goose density was 168 birds/km^2 with almost all Emperors and only a trace of Canadas. High shorebird densities were also noted, 100 birds/km^2. In October, most of the shorebirds were likely Rock Sandpipers. Section 13, Port Moller, had a bird density of 618 birds/km^2, the majority of which were sea ducks (360 birds/km^2). However, 156 geese/km^2 were observed (most of which were Emperors), and the highest gull density (86 birds/km^2) for fall in the region was recorded in Section 13.

Three other sections supported bird densities over 400 birds/km^2. Section 6, 7 and 14 had densities of 428, 499 and 451 birds/km^2, respectively. In Sections 6 and 14 sea ducks were the predominant bird group with 369 and 321 birds/km^2, respectively. In Section 7, three groups comprised the largest percentages of the total: shorebirds (164 birds/km^2), geese (156 birds/km^2) and sea ducks (113 birds/km^2).

Second highest goose densities were found in Section 19, the central portion of Izembek Lagoon, with 256 birds/km^2. Next was Section 23 with 198 geese/km^2. One-hundred dabblers/km^2 were also found in Section 23, but densities of both geese and dabblers largely represent Swanson

Table 16. Bird density by section of coastline in North-Alaska Peninsula, fall 1975, 1976. See Figure 105 for section boundaries. (T=trace).

	Fall Densities (birds/km^2)																							
	Section of Coastline																							
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Loon		T	T	T	T		T	T	T		T	T	T	1		T	T	T	T	T		T		T
Grebe		T	T	T	T		T		T				T	T		T		T	T	T		T		T
Tubenose													T	3	T	T								T
Cormorant			T	T			T		T			7	1	4			T		T	T	1	20	T	1
Goose and Swan		T	10	15	95	33	156	3	39	26	149	3	156	35	62	168	17	113	256	932	47	143	198	268
Dabbler		9	8	7	41		38		30		49	T	3	1	13	17	T	11	5	25		6	100	23
Diver		1	T	T	1		1	2	T		T		5	15		T		1		1		T	5	1
Sea Duck	2	1	7	42	8	369	113	5	111	23	37	38	360	321	5	420	49	45	45	66	123	28	1	97
Merganser		T	1		T		T				T									T				T
Raptor			T	T	T	T	T	T	T		T	T	T	T		T	T	T	T	T		T	T	T
Crane																								0
Shorebird	3	53	85	2	15	4	164	5	39	2	52		T	4	45	110	71	46	24	7	11	1	T	41
Gull and Jaeger	81	47	6	22	6	21	19	14	5	46	37	16	86	65	14	31	19	32	13	13	64	10	26	19
Tern									T															T
Alcid				T			T		T	T		T	1	3		T	T		T	T	2	T	T	T
Corvid			T	T	T		T		T		T				T			T	T	T			T	T
Other Passerine			T	4	T		1	11	T		T		7		T	T	2			T				1
Other Bird	T	1	1	1	3		7			T	1				T	1			5	T		T		1
TOTAL	86	111	119	96	171	428	499	39	225	96	327	65	618	451	139	746	160	249	348	1044	247	209	332	453

Lagoon densities because the trackline did not go beyond Otter Point on Unimak Island. Other high dabbler densities were found in Section 11, Seal Islands, with 49 birds/km^2 and Section 5, Ugashik Bay, with 41 birds/km^2. Diving ducks were abundant only in Section 14, Herendeen Bay, at a density of 15 birds/km^2.

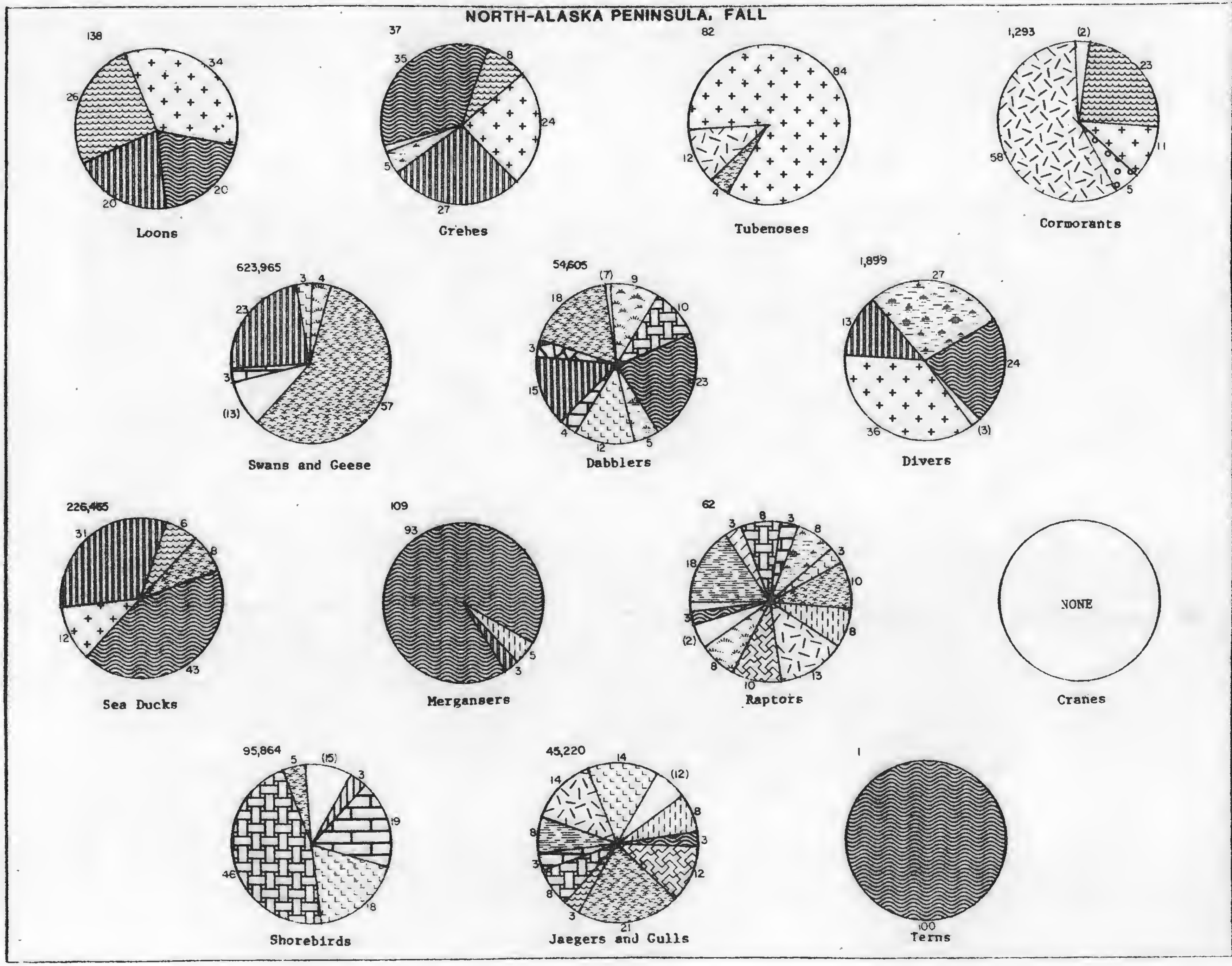
About the only birds in Section 1 were gulls, and the second highest density for that bird group was found there (81 birds/km^2). Other high gull densities were recorded in Sections 14 and 21 with 65 and 64 birds/km^2, respectively. Of the identified gulls in fall, the majority were Glaucous-winged (93%). Low percentages of kittiwakes (4%) and Mew Gulls (2%) were recorded. During a mapping flight in October 1976, while I was not specifically recording bird numbers, 11,500 gulls (both kittiwakes and large gulls) were observed in Bechevin Bay and Isantoski Straits of Section 22.

Section 8 had the lowest fall density with 39 birds/km^2. The bird group, Other Passerines, had its highest density in that section - 11 birds/km^2. Most passerines on the coast in fall were Snow Buntings (*Plectrophenax nivalis*) which fed in beach rye (*Elymus* sp.) along sand beaches.

Loons were found in most sections, but only occurred in a measurable amount (1 bird/km^2) in Section 14. Tubenoses were only found in the Port Moller complex (Sections 13-16), and were measurable only in Section 14 (3 birds/km^2). Cormorants were widely scattered but reached a density of 20 birds/km^2 in Section 22, Bechevin Bay. Raptors were recorded in almost all sections but only in trace amounts. Bald Eagles were the most common raptor but Gyrfalcons (*Falco rusticolus*), Marsh Hawks and Short-eared Owls were also observed. Alcids were recorded in 14 sections and reached their highest density (3 birds/km^2) in Section 14.

Habitat Usage - Because the second fall survey of North-Alaska Peninsula primarily covered estuarine habitats, 70 percent of the total birds were found on lagoon habitats, 21 percent on protected delta habitats and 5 percent in bays. Only 3 percent were on exposed habitats and 2 percent on saltmarshes. On the October 1975 survey, most habitat delineations had not been finalized, and therefore, a large percentage of birds were recorded as using unidentified habitats. Almost 90 percent of the 400,000 birds in unidentified lagoon habitats were geese. Most of these geese were found in Izembek Lagoon, but at the time of the survey a substrate was not specified, and, therefore, they were put into an unidentified category. Information on fall habitat usage by birds is diagrammed in Figs. 130 and 131.

Lagoon water was the most used habitat identified. Twenty-one percent of the birds were found there; 62 percent were geese and 31 percent sea ducks. Brant remained over water at all times and fed on eelgrass (*Zostera marina*). Canada Geese roosted on lagoon water but frequently fed on nearby tundra. Lagoon water also was used by Emperor Geese for roosting when disturbed from their usual beach habitats. Large rafts of feeding and roosting sea ducks were often observed on the lagoon/embayment water just inside sand/gravel spits.


NORTH-ALASKA PENINSULA, FALL
138
34
26
20
20
Loons
37
35
8
24
5
27
Grebes
82
84
12
4
Tubenoses
1,293
(2)
23
11
58
5
Cormorants
623,965
3
4
23
3
(13)
57
Swans and Geese
54,605
(7)
9
18
10
3
23
15
4
12
5
Dabblers
1,899
27
13
24
36
(3)
Divers
226,465
31
6
8
12
43
Sea Ducks
109
93
5
3
Mergansers
62
3
8
3
8
3
18
10
3
(2)
8
8
10
13
Raptors
NONE
Cranes
95,864
5
(15)
3
19
46
18
Shorebirds
45,220
14
14
(12)
8
8
3
3
12
8
3
21
Jaegers and Gulls
1
100
Terns

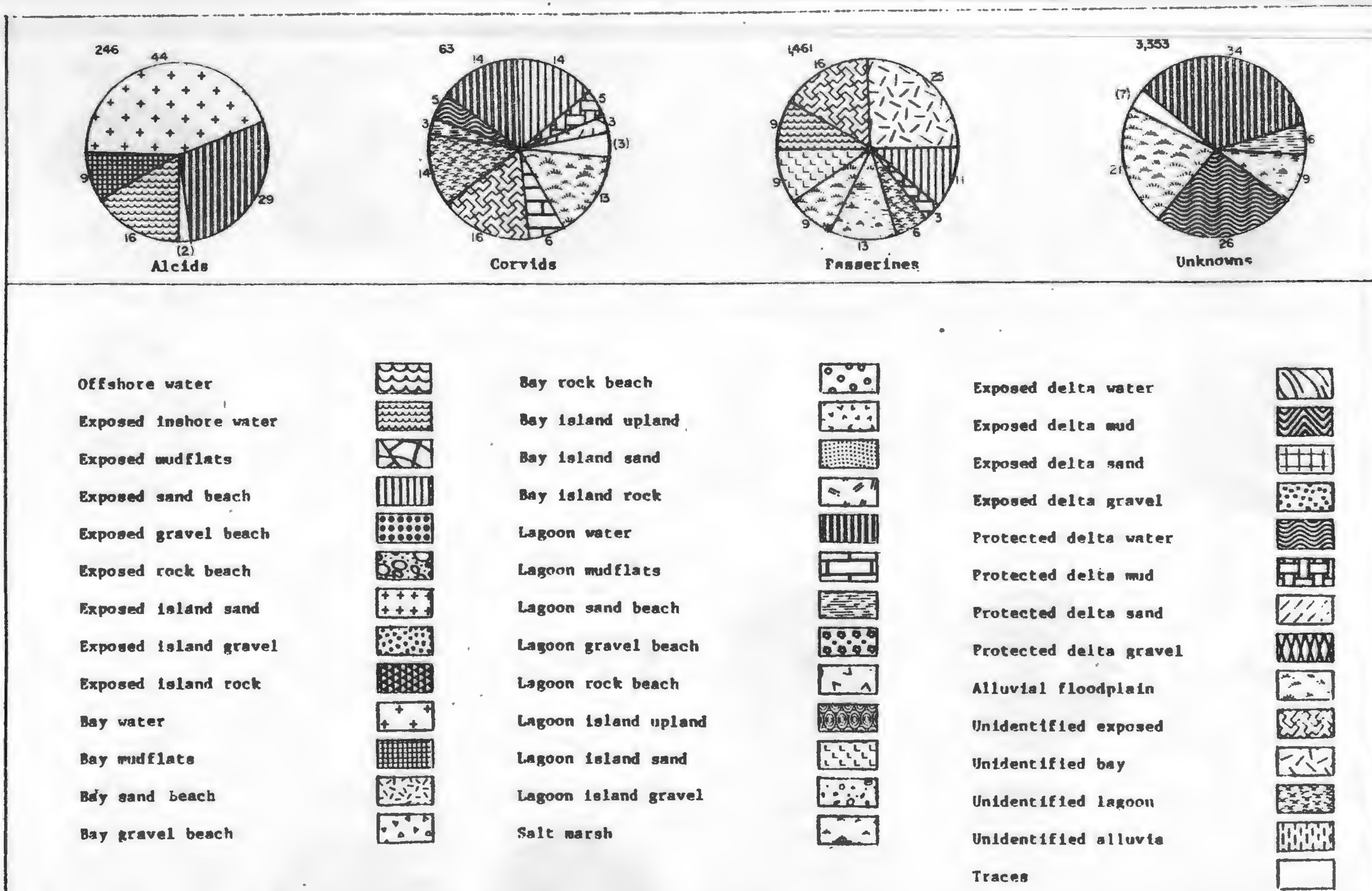
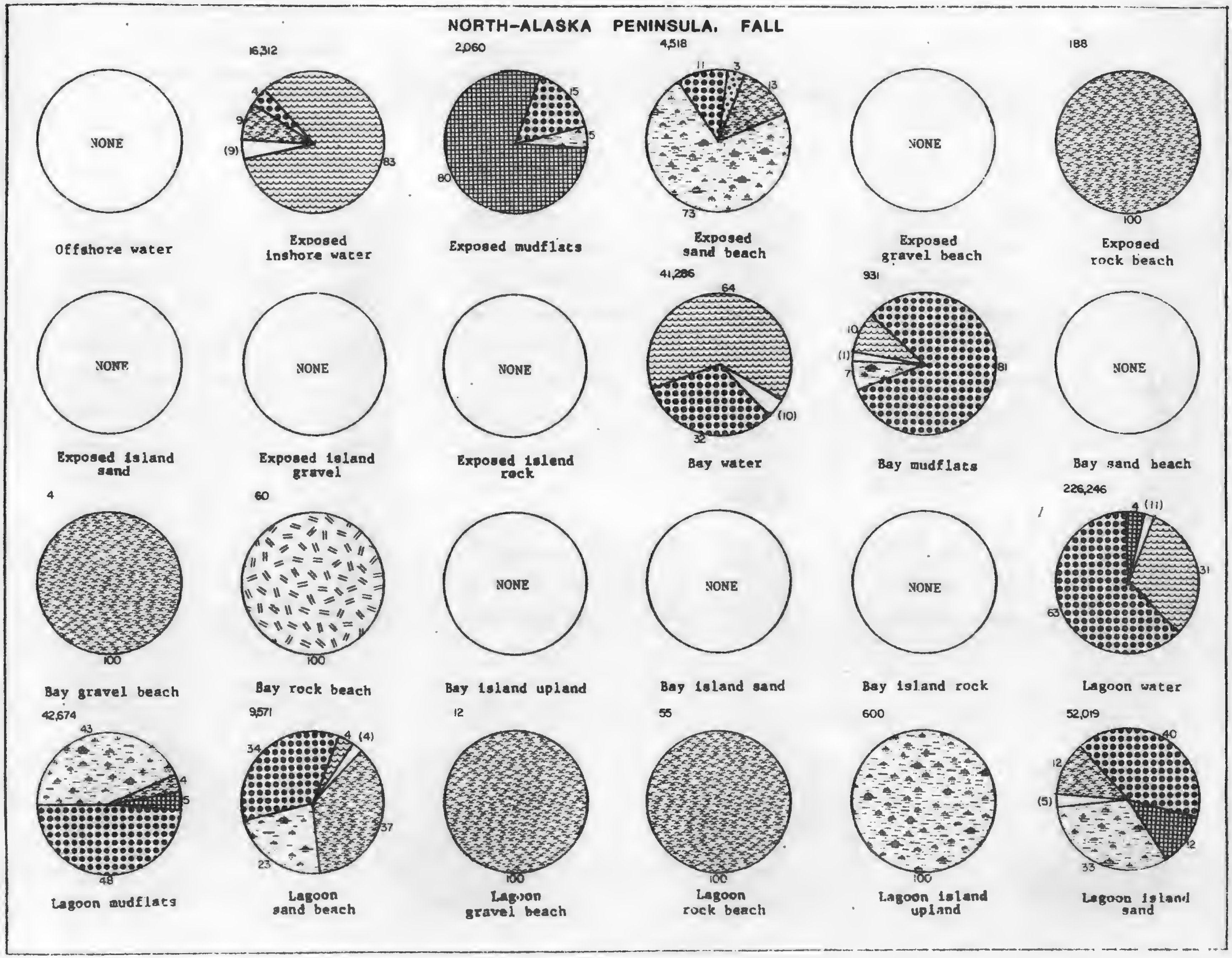


Fig. 130. North-Alaska Peninsula, Fall, 1975 and 1976. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


NORTH-ALASKA PENINSULA, FALL
NONE
Offshore water
16,312
4
9
(9)
83
Exposed inshore water
2,060
15
5
80
Exposed mudflats
4,518
11
3
13
73
Exposed sand beach
NONE
Exposed gravel beach
188
100
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
41,286
64
32
(10)
Bay water
931
10
(1)
7
81
Bay mudflats
NONE
Bay sand beach
4
100
Bay gravel beach
60
100
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
226,246
4
(11)
31
63
Lagoon water
42,674
43
4
5
48
Lagoon mudflats
9,571
34
4
(4)
37
23
Lagoon sand beach
12
100
Lagoon gravel beach
55
100
Lagoon rock beach
600
100
Lagoon island upland
52,019
40
12
(5)
12
33
Lagoon island sand

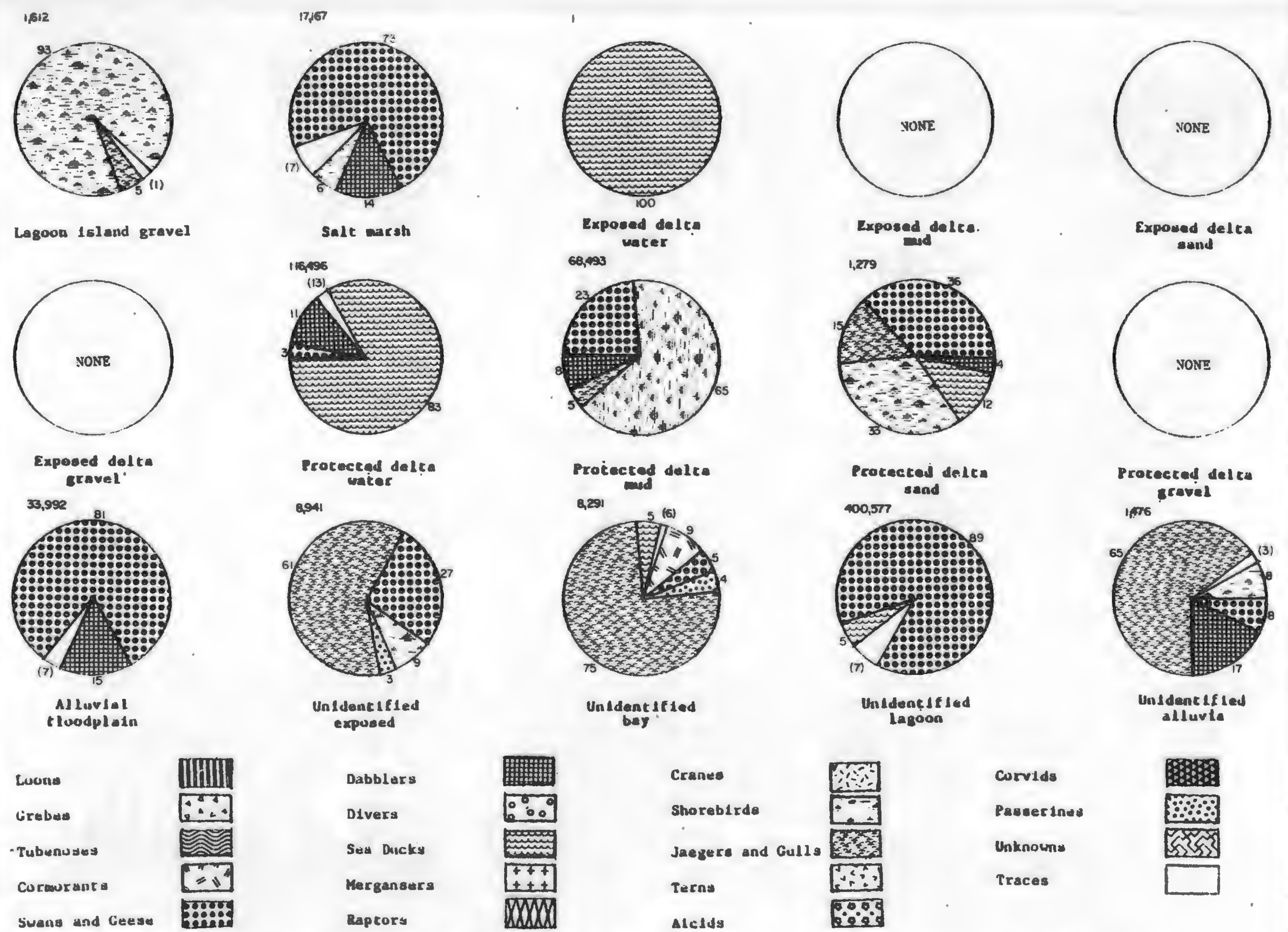


Fig. 131. North-Alaska Peninsula, Fall, 1975 and 1976. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Eleven percent of the birds used protected delta water, and 83 percent of the birds on this habitat were sea ducks and 11 percent were dabbling ducks. Dabblers in large numbers frequently lined the waters' edge at river mouths. Of the almost 70,000 birds found on protected delta mud 65 percent were shorebirds, 23 percent geese, 8 percent dabblers and 5 percent gulls. Lagoon island sand beaches were used by geese (mostly Emperors), shorebirds, gulls and dabblers (percentages were: 40, 33, 12 and 12, respectively). The next most used habitats were lagoon mudflats and bay water. In the former type, geese and shorebirds predominated (48% and 43%, respectively). Sixty-four percent of the birds on bay water were sea ducks and 32 percent were geese.

Over 3 percent of the one million birds counted in North-Alaska Peninsula were on alluvial floodplain vegetation. Most were geese (81%) and dabblers (15%). Over 16,000 birds were on exposed inshore waters. Sea ducks were the most abundant (83% of total). Gulls were next with only 9 percent of the total. Geese and dabblers were the bird groups most frequently found on saltmarshes (73% and 14%, respectively).

Only five bird groups were found in relatively great abundance in fall on North-Alaska Peninsula. Geese, the most abundant, were found on 14 habitats but mostly used lagoon waters. Sea ducks were found 43 percent of the time on protected delta water, 31 percent on lagoon water, 12 percent on bay water and 6 percent on exposed inshore water. Almost one-half of the shorebirds, the third largest group, were found on protected delta mud. An additional 19 percent used lagoon mudflats and 18 percent used lagoon island sand. Over 54,000 dabblers preferred protected delta water (23%) lagoon water (15%), lagoon island sand (12%), protected delta mud (10%) and alluvial floodplain (9%). Eighteen habitats were used by gulls, the fifth most abundant bird group, and no one habitat was utilized significantly more than others.

WINTER

Although three winter surveys were conducted, coverage was limited and six sections were not surveyed. Other sections were surveyed only partially. A portion of one survey was several hundred meters offshore in pelagic waters.

Density - Bird densities dropped from a high of 453 birds/km^2 in fall to 53 birds/km^2 in winter (Table 17). Fourteen bird groups were recorded but only four in measurable numbers: sea ducks, gulls, geese and alcids. They had densities of 33, 13, 3 and 2 birds/km^2, respectively.

Section 10, the coast between Port Heiden and Seal Islands, had the highest bird densities at 197 birds/km^2. No other sections had densities over 100 birds/km^2; however, three were close with 97, 93 and 87 birds/km^2 (Sections 22, 4 and 16, respectively). In Section 10, sea ducks comprised 92 percent of the birds recorded, or 182 birds/km^2. Gulls made up most of the rest (15 birds/km^2). Winter use of sections 16 and 22 was primarily by sea ducks and geese. Both had goose densities of 35 birds/km^2.

Table 17. Bird density by section of coastline in North-Alaska Peninsula, winter 1977. See Figure 105 for section boundaries. (T=trace).

Winter Densities (birds/km^2)

Bird Group	Section of Coastline																							Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Loon				T		T		T		T		T					T				T			T
Grebe				T		T				T		T					T				T	T	T	T
Tubenose																								0
Cormorant								T				T									1	6	1	T
Goose and Swan								T					21			35						35	1	3
Dabbler																							T	T
Diver	2										T	T						1				1	1	T
Sea Duck	1	T		40		16		7	5	182	13	25	9			49	11	52	58		38	52	20	33
Merganser												T										1	T	T
Raptor		T		T		T						T	T			T	T		T		T		T	T
Crane																								0
Shorebird																T		T						T
Gull and Jaeger		T		53	1	35		11	1	15	3	6	2			3	19	14	T		5	2	18	13
Tern																								0
Alcid								T											T		3	T	13	2
Corvid		T		T		T		T		T	T	T				T	T				T		T	T
Other Passerine		7																						T
Other Bird																								0
TOTAL	2	8	*	93	1	52	*	19	6	197	16	32	33	*	*	87	30	67	59	*	48	97	55	53

* Not surveyed.

Section 16 had a sea duck density of 49 birds/km^2 and Section 22 a density of 52 gulls/km^2. The latter section also supported a few diving ducks and mergansers plus a density of 6 cormorants/km^2. Section 4 mostly had gulls (53 birds/km^2) and sea ducks (40 birds/km^2).

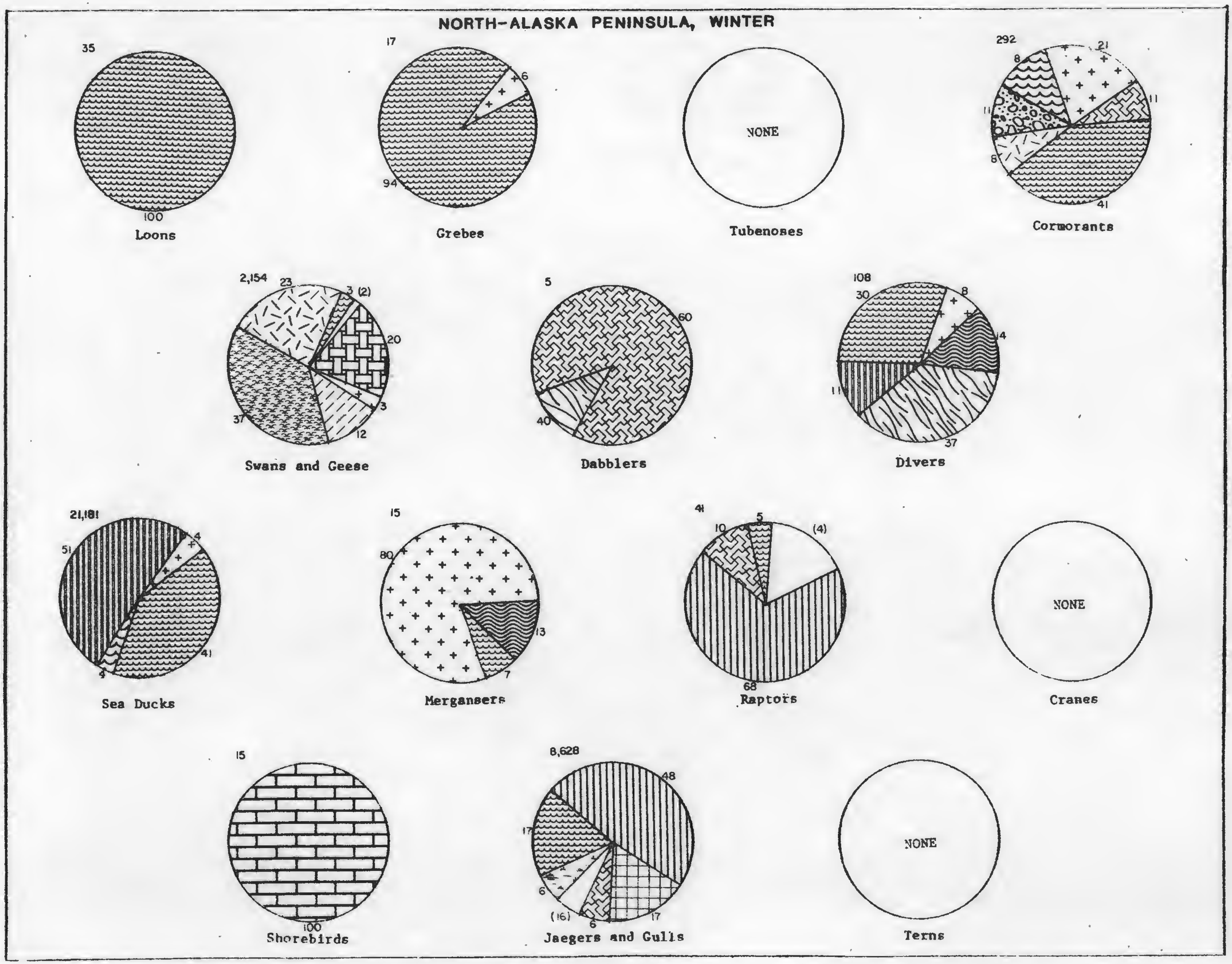
Geese were also common in Section 13, Port Moller, where 21 birds/km^2 were recorded. In the winter surveys only Emperor Geese were recorded. However, on an overflight of Applegate Cove (Section 20) when surveys were not being conducted, a flock of about 2,000 Brant was noted. Because of the mild winter, they were able to overwinter at Izembek. The section with the second highest sea duck density (Section 19) had 58 sea ducks/km^2 and no other measurable bird densities. Eighty-two percent of the identified sea ducks observed on these winter flights were eiders. Scoters were next in abundance with 10 percent followed by Oldsquaw (7%) and Harlequin Duck (1%). Of identified eiders, 79 percent were Steller's, 20 percent King and 1 percent Common. For scoters the percentages of identified birds were: Black 87%, White-winged 13% and Surf trace. Sea ducks were recorded on 17 of the 18 sections surveyed. Only Section 5 did not have sea ducks, but only 2.3 km^2 of this section were surveyed.

Gulls were also found on all but Section 1. Besides the high gull density in Section 4, gulls were most dense in Section 6 at 35 birds/km^2. Gulls were frequently observed roosting on, or flying along, the exposed sand beaches. Observed gull densities were greatest in exposed sections, but 80 percent of the area searched on these winter surveys was exposed habitat.

Alcids were the only other group with a measurable density. Almost all alcids were on the most southern sections. The most were in Section 23 (13 birds/km^2). Bald Eagles and Common Ravens were scattered throughout the coast in winter, but were not abundant in any section.

Habitat Usage - Forty-six percent of the birds observed during winter surveys were found in exposed habitats. An additional 6 percent were on offshore waters and 5 five percent on exposed delta habitats. This ratio of habitat use was biased by the fact that 80 percent of the area surveyed was exposed sections. Lagoon habitats contained 35 percent of the birds and 4 percent were in bays, 3 percent on protected delta habitats and 1 percent on saltmarshes. Information on winter habitat usage is presented in Figs. 132 and 133.

Only five habitats contained 1,000 or more birds. The largest percentage of birds (32%) were on lagoon water and essentially all of these were sea ducks. Exposed inshore water was next with 31 percent of the birds and again the majority (82%) were sea ducks. On exposed sand beaches 13 percent of the birds were found, and 95 percent of these were gulls. Six percent of the birds were on offshore waters and 52 percent of these were alcids and 43 percent sea ducks. Exposed river deltas supported 4 percent of the birds, all of which were gulls. Over 900 birds were seen on bay waters, and sea ducks, geese and cormorants were the most numerous birds (82, 8, and 6%, respectively).


NORTH-ALASKA PENINSULA, WINTER
35
100
Loons
17
6
94
Grebes
NONE
Tubenoses
292
8
21
11
11
8
41
Cormorants
2,154
23
3 (2)
20
3
12
37
Swans and Geese
5
60
40
Dabblers
108
30
8
14
11
37
Divers
21,181
51
4
41
4
Sea Ducks
15
80
13
7
Mergansers
41
10
5
(4)
68
Raptors
NONE
Cranes
15
100
Shorebirds
8,628
48
17
6
(16)
6
17
Jaegers and Gulls
NONE
Terns

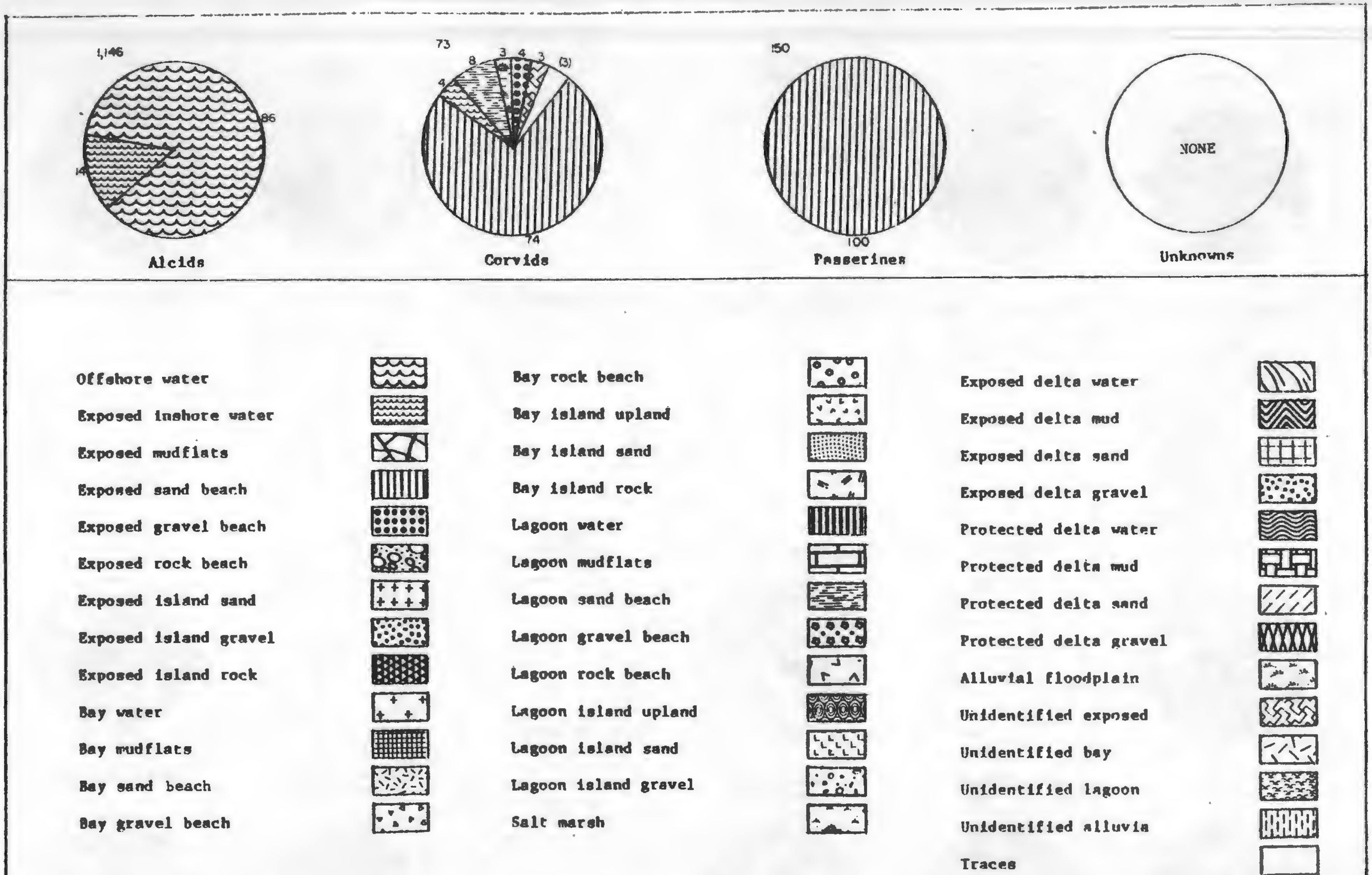
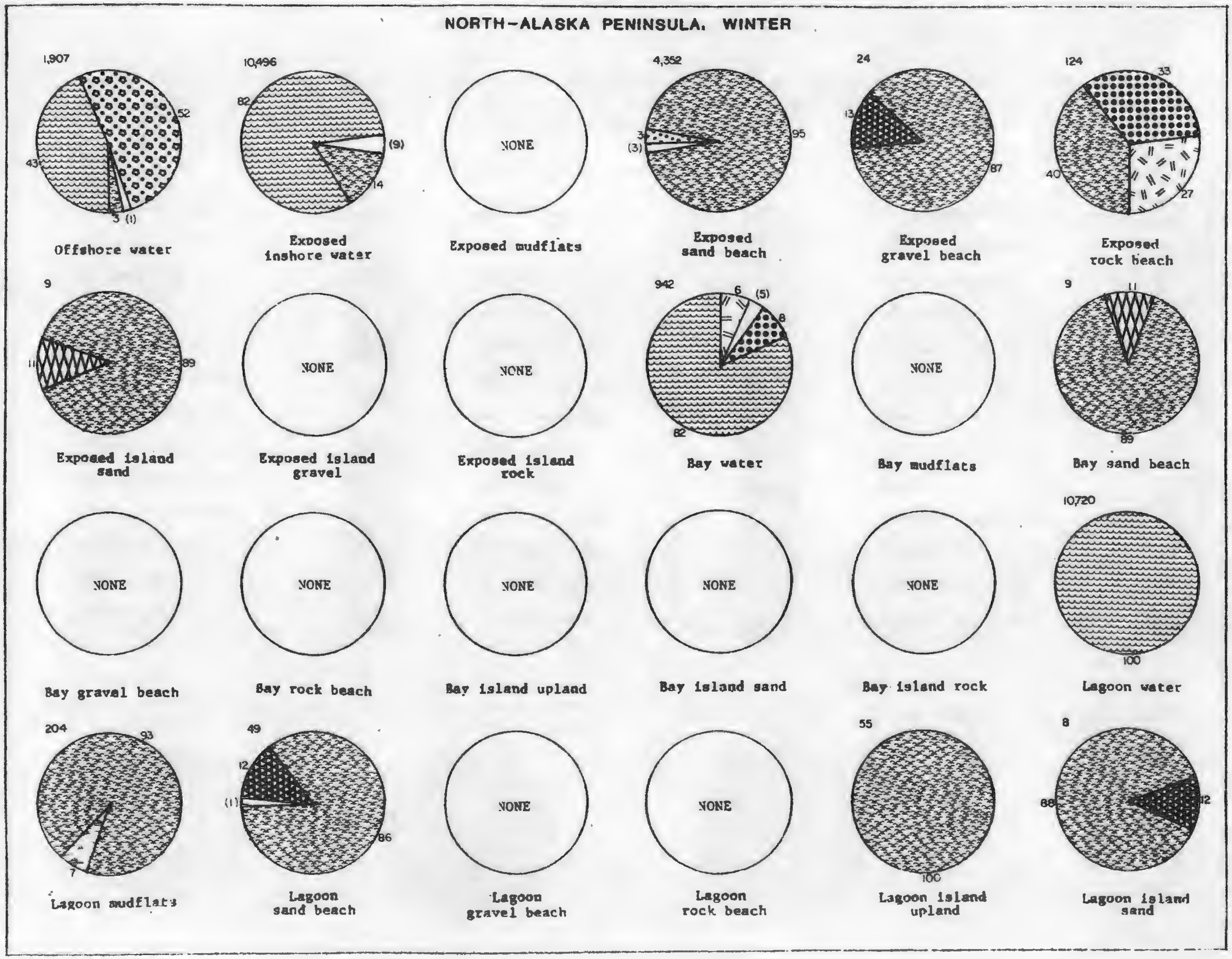


Fig. 132. North-Alaska Peninsula, Winter, 1977. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.



NORTH-ALASKA PENINSULA, WINTER
1,907
52
43
3
(1)
Offshore water
10,496
82
(9)
14
Exposed inshore water
NONE
Exposed mudflats
4,352
3
(3)
95
Exposed sand beach
24
13
87
Exposed gravel beach
124
33
40
27
Exposed rock beach
9
11
89
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
942
6
(5)
8
82
Bay water
NONE
Bay mudflats
9
11
89
Bay sand beach
NONE
Bay gravel beach
NONE
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
10,720
100
Lagoon water
204
93
7
Lagoon mudflats
49
12
(1)
86
Lagoon sand beach
NONE
Lagoon gravel beach
NONE
Lagoon rock beach
55
100
Lagoon island upland
8
88
12
Lagoon island sand

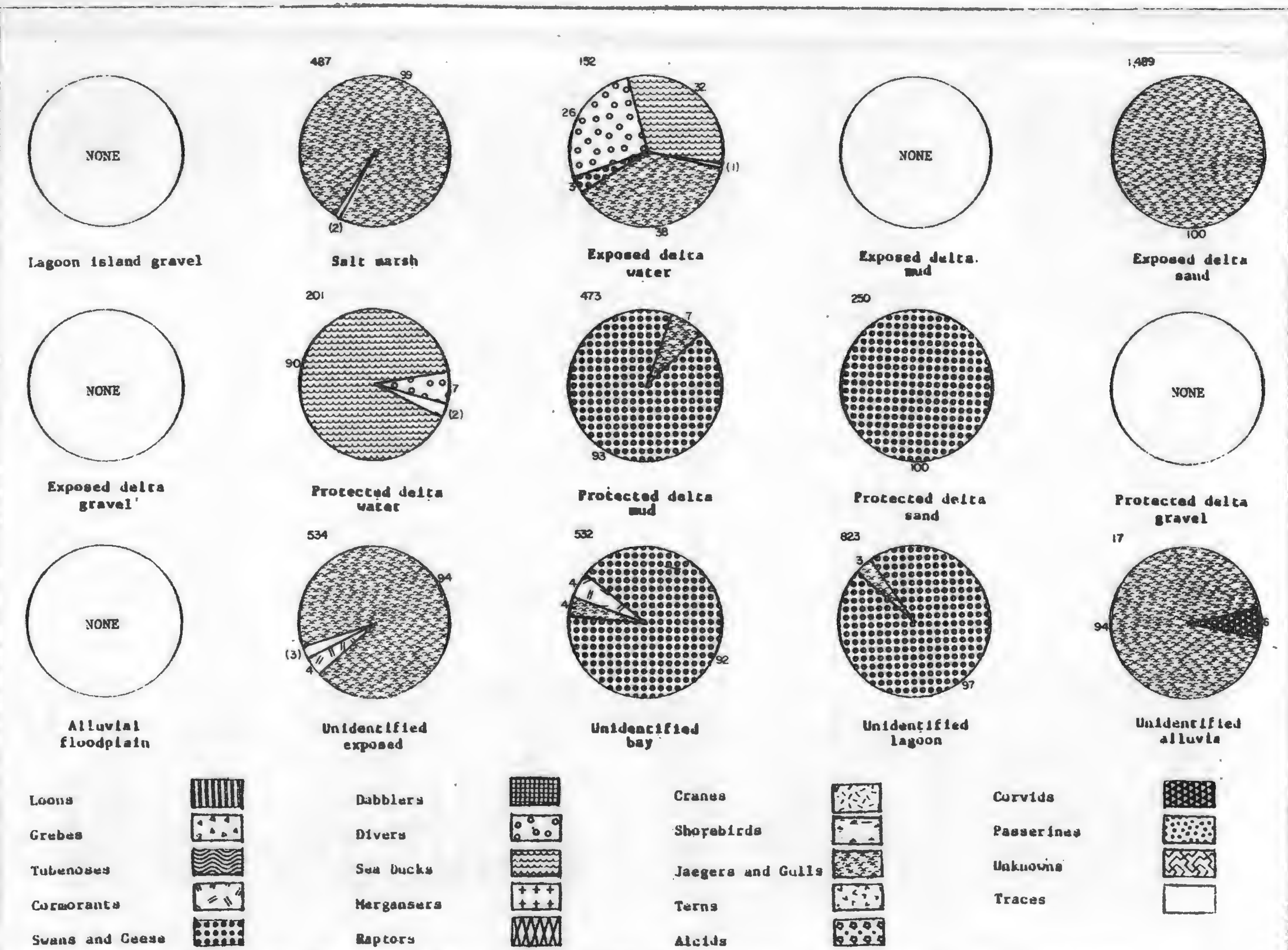


Fig. 133. North-Alaska Peninsula, Winter, 1977. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Four species groups numbered over 1,000 individuals. Sea ducks, the most abundant bird group (63% of the total), were found most on lagoon water (51%), and most of the remainder (41%) were on exposed inshore water. One-fourth of the birds were gulls. They were found on 17 of the 19 identified habitats. Almost 50 percent used exposed sand beaches and 17 percent were on both exposed delta sand and exposed inshore water. The rest were found in small numbers on a variety of habitats. Most (60%) of the Emperor Geese were on unidentified bay and lagoon habitats; others used protected delta mud (20%) and protected delta sand (12%). Eighty-six percent of the 1,100 alcids were in offshore waters and the remainder (14%) on exposed inshore waters.

NORTH - BRISTOL BAY

Three spring surveys were conducted in North-Bristol Bay. The first, in May 1976, covered the entire coastline to Cape Newenham and Hagemeister Island (Fig. 134). The second survey, covering only Kvichak Bay, was done by helicopter, and the shoreline from Kvichak River to Kulukak Bay was flown in the final survey. Only aerial pelagic surveys were conducted in the Walrus Island vicinity in spring. In summer, pelagic surveys by raft were conducted in the Walrus Islands.

For analysis, the mainland coast was subdivided into 11 physiographic sections (Fig. 135). Hagemeister Island constituted one section and the Walrus Islands were another.

SPRING

Density - North-Bristol Bay in spring had a mean bird density of 86 birds/km^2 (Table 18). Bird density data by section are depicted in Figs. 136-153. Four sections had densities exceeding 100 birds/km^2. The coastline from Capes Peirce to Newenham, Section 11, had the highest density at 466 birds/km^2. Alcids were the most dense recorded group with 249 birds/km^2. Over 4,000 Brant were in Nanvak Bay near Cape Peirce, inflating the goose density to 140 birds/km^2 in Section 11. Although gull densities in Section 11 (34 birds/km^2) were high for the region, many gulls were not counted that were on colonies at both Capes Newenham and Peirce. The observation plane had to climb away from the high cliffs where thousands of black-legged kittiwakes flushed from nesting sites and endangering the aircraft (and themselves). Almost 300,000 kittiwakes have been estimated in breeding populations in this section (Sowls et al. 1978).

Section 1 in Kvichak Bay had a density of 259 birds/km^2. Most birds in this section were shorebirds and dabblers, but gulls, diving ducks and geese were also found in substantial numbers. The brackish alluvial floodplain and adjacent intertidal mudflat supported most of the birds.

The avifauna in Section 3, southern Nushagak Bay, was almost entirely diving ducks. Of the 206 birds/km^2 found in the section, 171 birds/km^2 were scaup. There was an almost continuous line of scaup in shallow water of Flounder Flats. Flocks of Black Scoters were mixed in with the scaup but in much lower densities. There were 21 sea ducks/km^2 in Section 3.

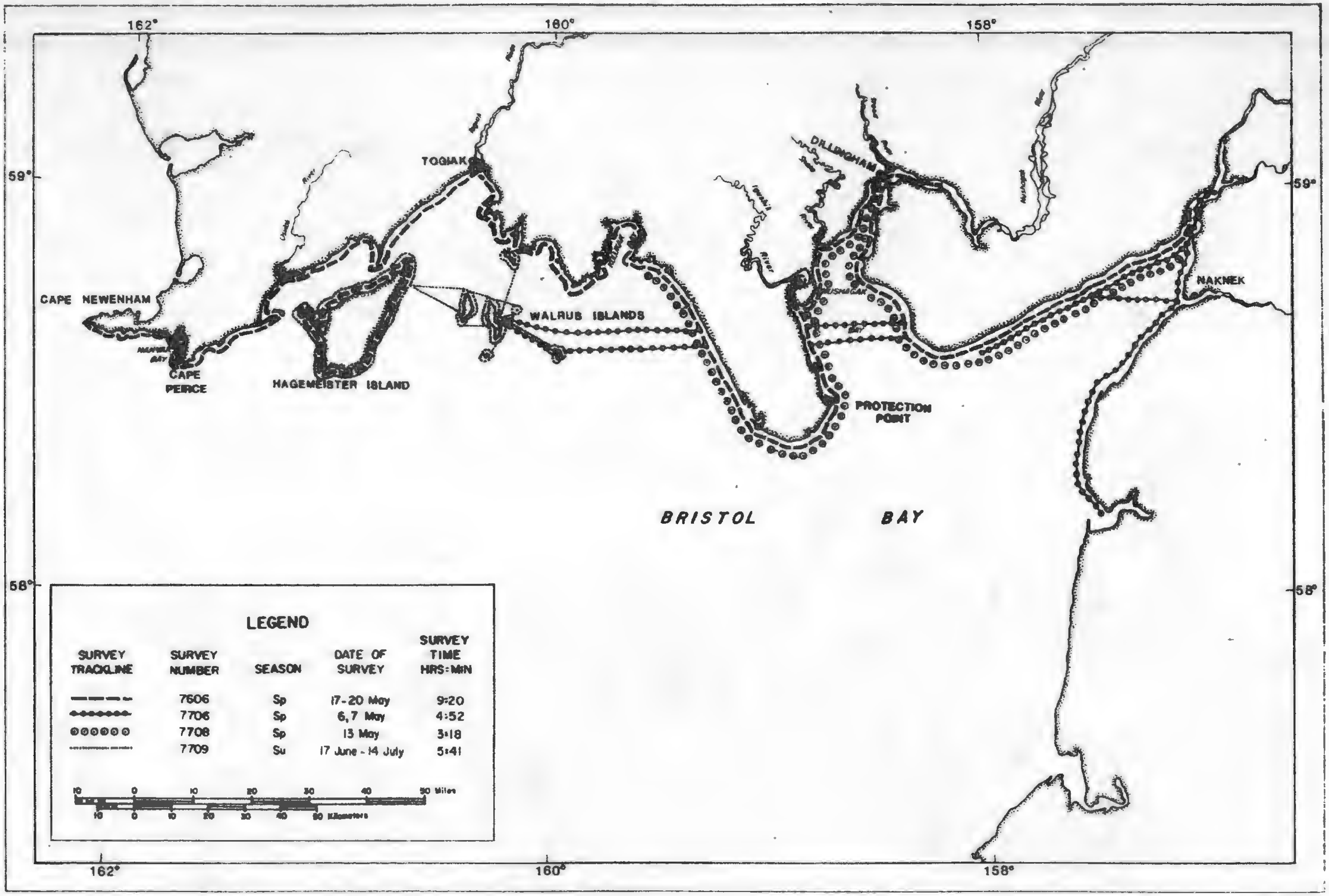


Fig. 134. Tracklines of aerial and boat (7709) surveys in North-Bristol Bay and North-Alaska Peninsula, 1976 and 1977.

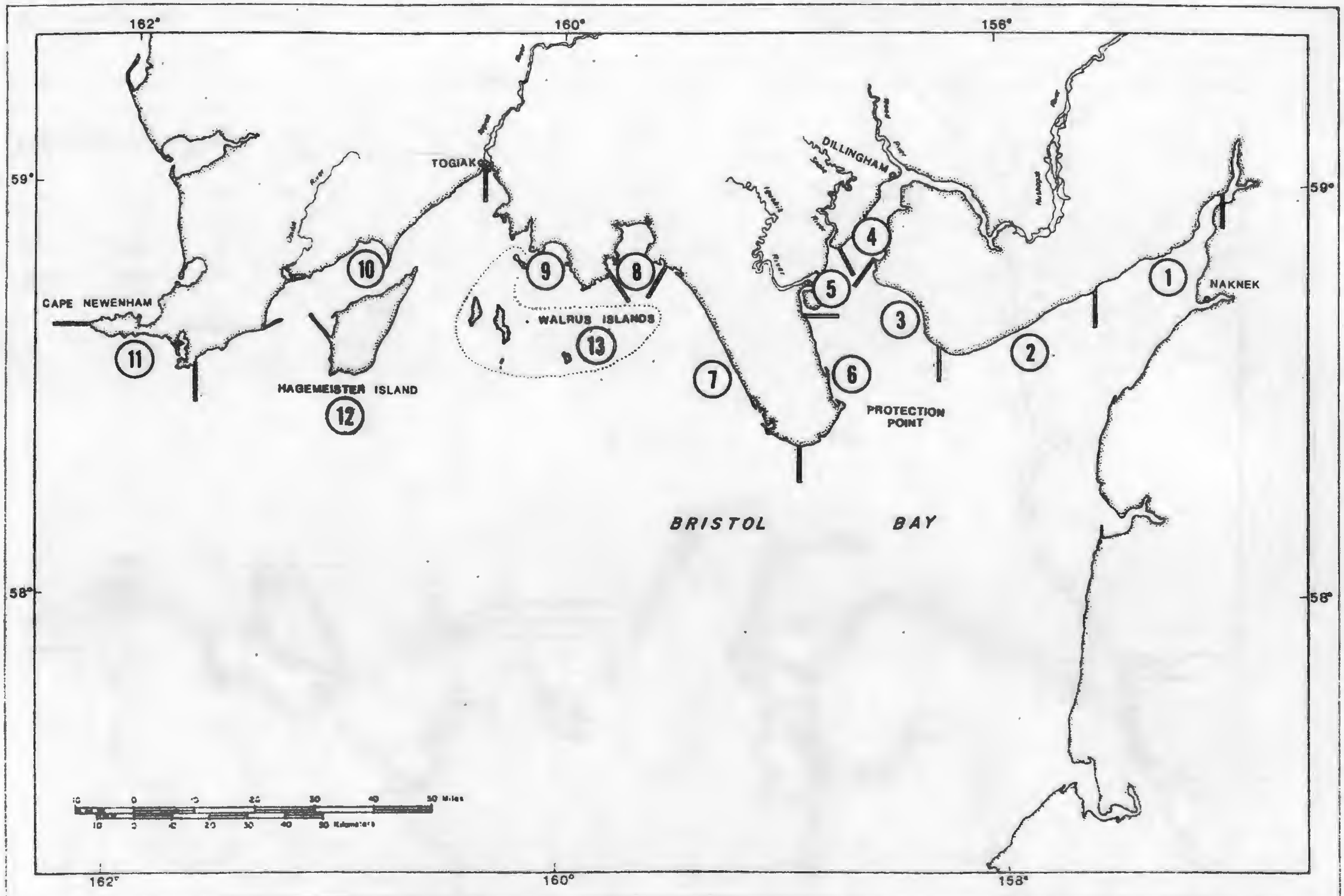


Fig. 135. Physiographic subdivision of North-Bristol Bay for bird density analysis. Each numbered section contains several survey stations.

Table 18. Bird density by section of coastline in North Bristol Bay, spring 1976, 1977, summer 1977. See Figure 135 for section boundaries. (T=trace).

	Spring Densities (birds/km^2)														Summer Density (birds/km^2)
	Section of Coastline														
Bird Group	1	2	3	4	5	6	7	8	9	10	11	12	13	Total	13
Loon	T	1	1	T	T	T	1	2	1	2	T	1	T	1	T
Grebe	T	T	T	T	T		T	T		T	T	T		T	0
Tubenose														0	0
Cormorant	T	T		T		T	2	2	12	10	2	4	T	2	15
Goose and Swan	10	1		2	2	2	T	1	1	11	140	T		7	0
Dabbler	81	1	2	5	1	1	T	3	1	2	1			9	0
Diver	13	13	171	2	13	16	1	14	21	7	14	2		12	0
Sea Duck	7	11	21	T	1	26	5	8	32	18	21	27	7	10	10
Merganser	1	2	1	T	1	1	1	3	4	2	T	1		1	0
Raptor	T	T		T	T		T		T	T				T	0
Crane	T	T		T	T	T		T	T	T	T			T	0
Shorebird	121	24	T	17	3	5	2	32	18	10	2	5		21	T
Gull and Jaeger	21	31	5	6	4	6	18	13	24	24	34	26	5	13	6
Tern	1	1	3	T	1	2	4	2	2	2	1	2		1	T
Alcid	T					T	T	1	7	1	249	8	4	8	103
Corvid	T	T		T	T	T		T		T	T			T	0
Other Passerine	T	T		T	T			T	T	T	T			T	0
Other Bird	3	2	1	T	T	2	T	T		T	1		T	1	0
TOTAL	259	86	206	34	26	61	36	81	121	90	466	76	16	86	134

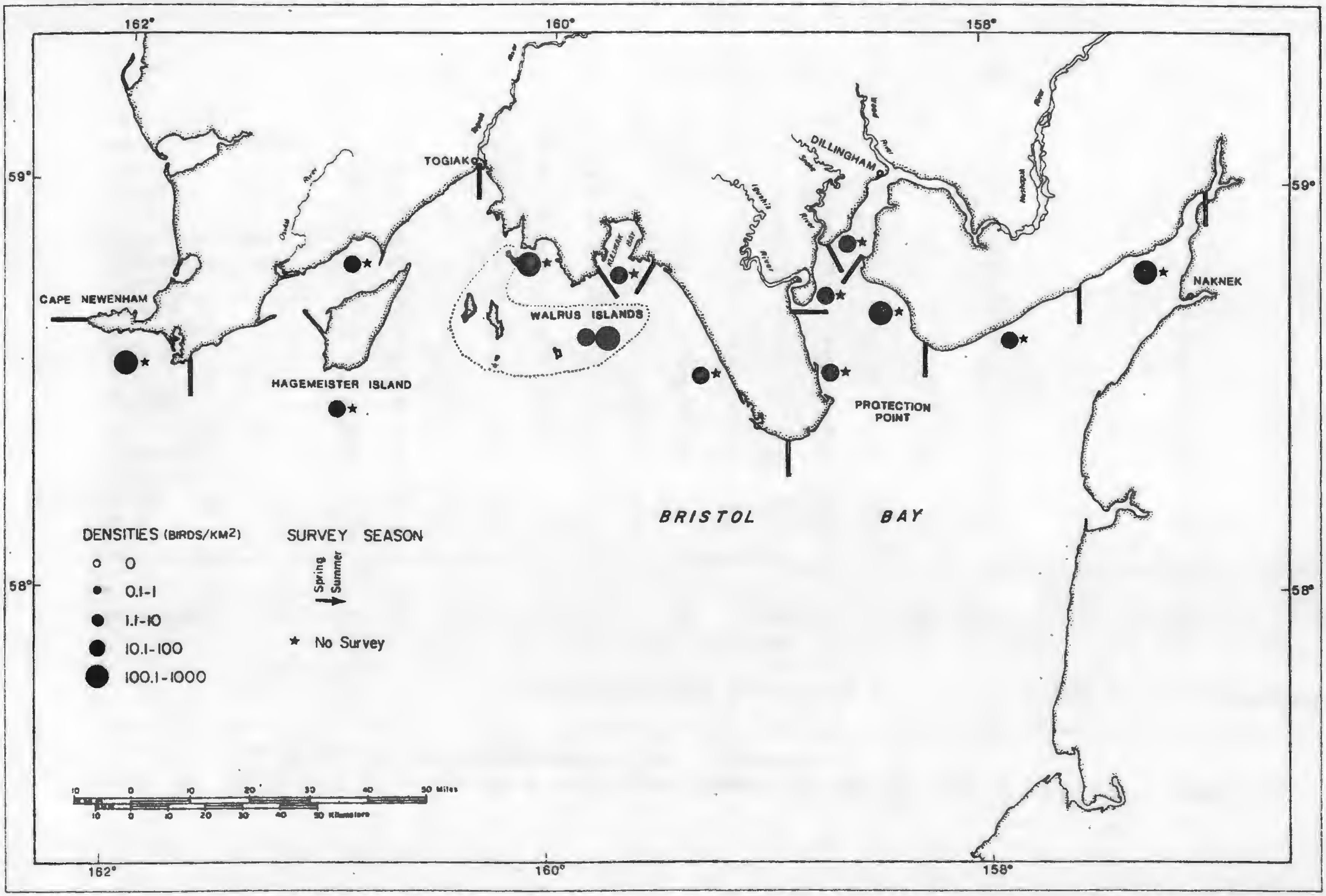


Fig. 136. Total bird density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

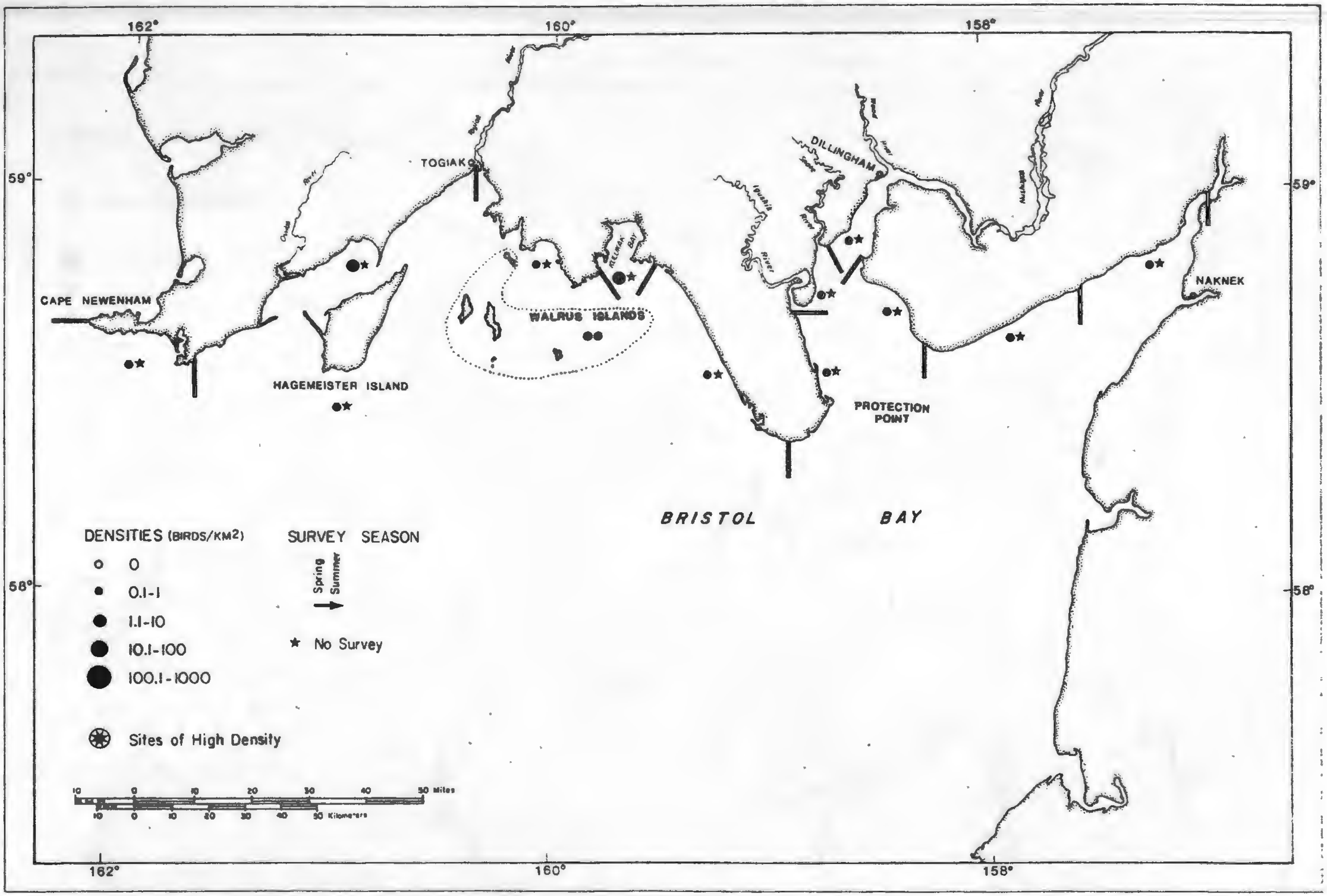


Fig. 137. Loon density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

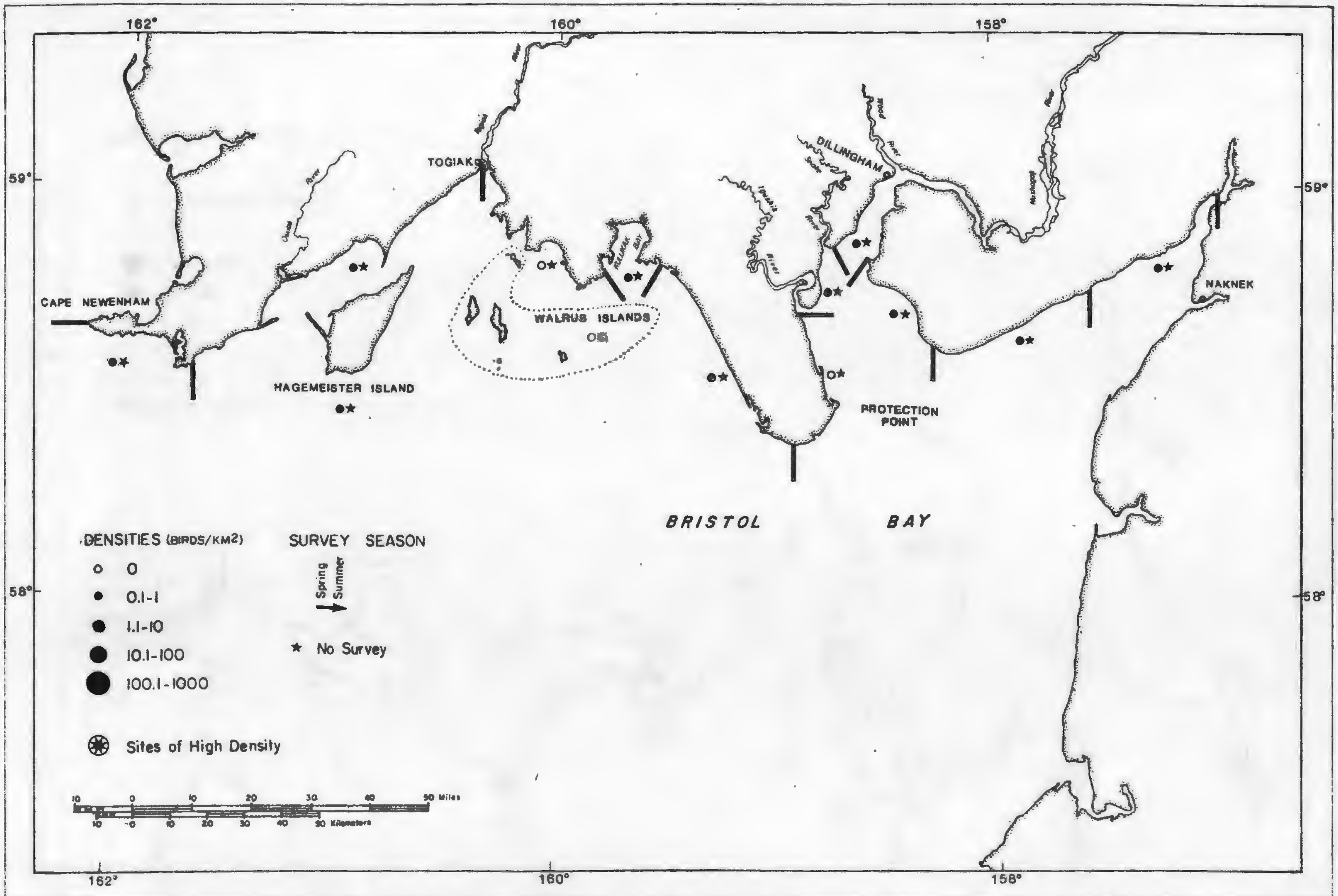


Fig. 138. Grebe density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

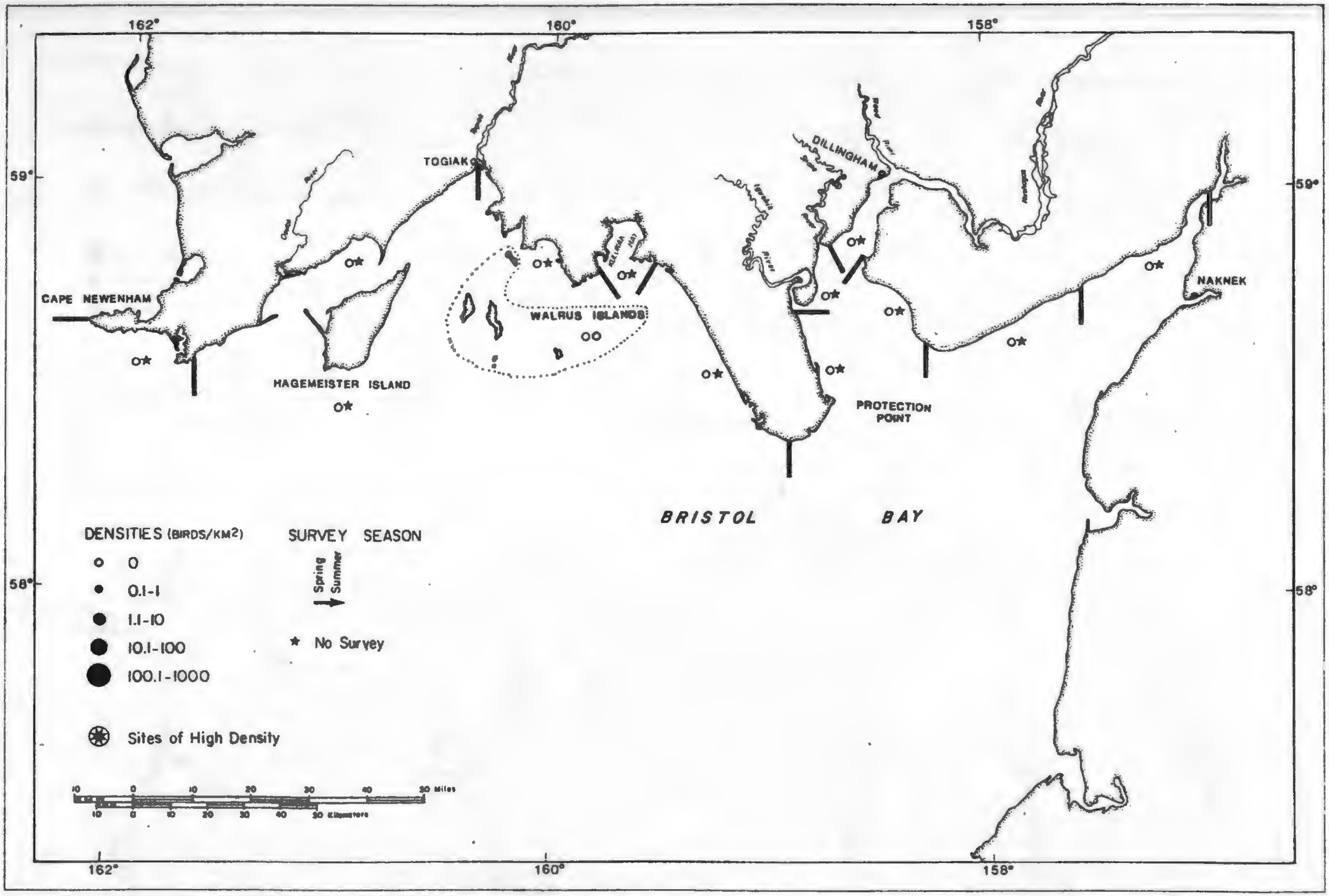


Fig. 139. Tubenose density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. No tubenoses were sighted.

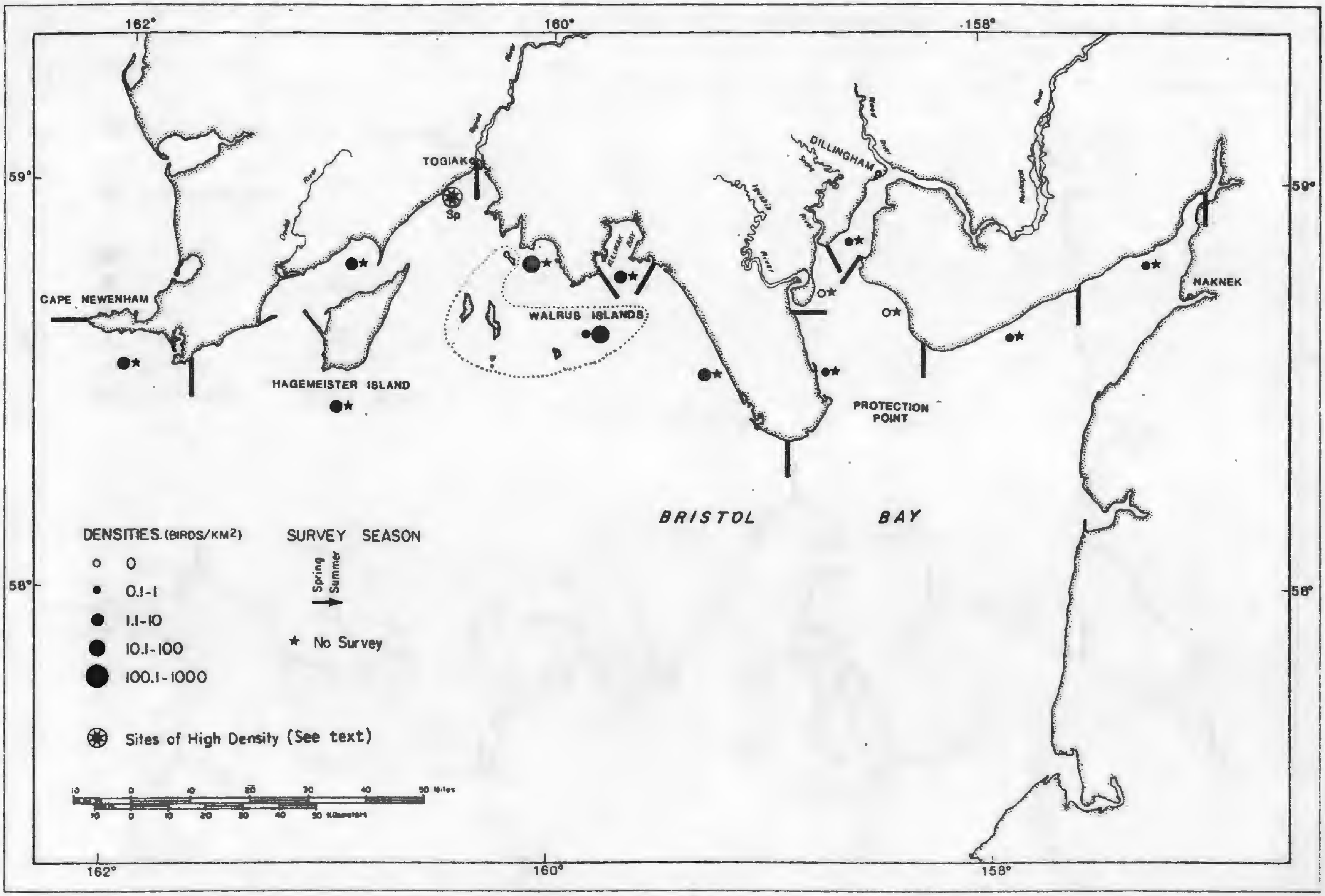


Fig. 140. Cormorant density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

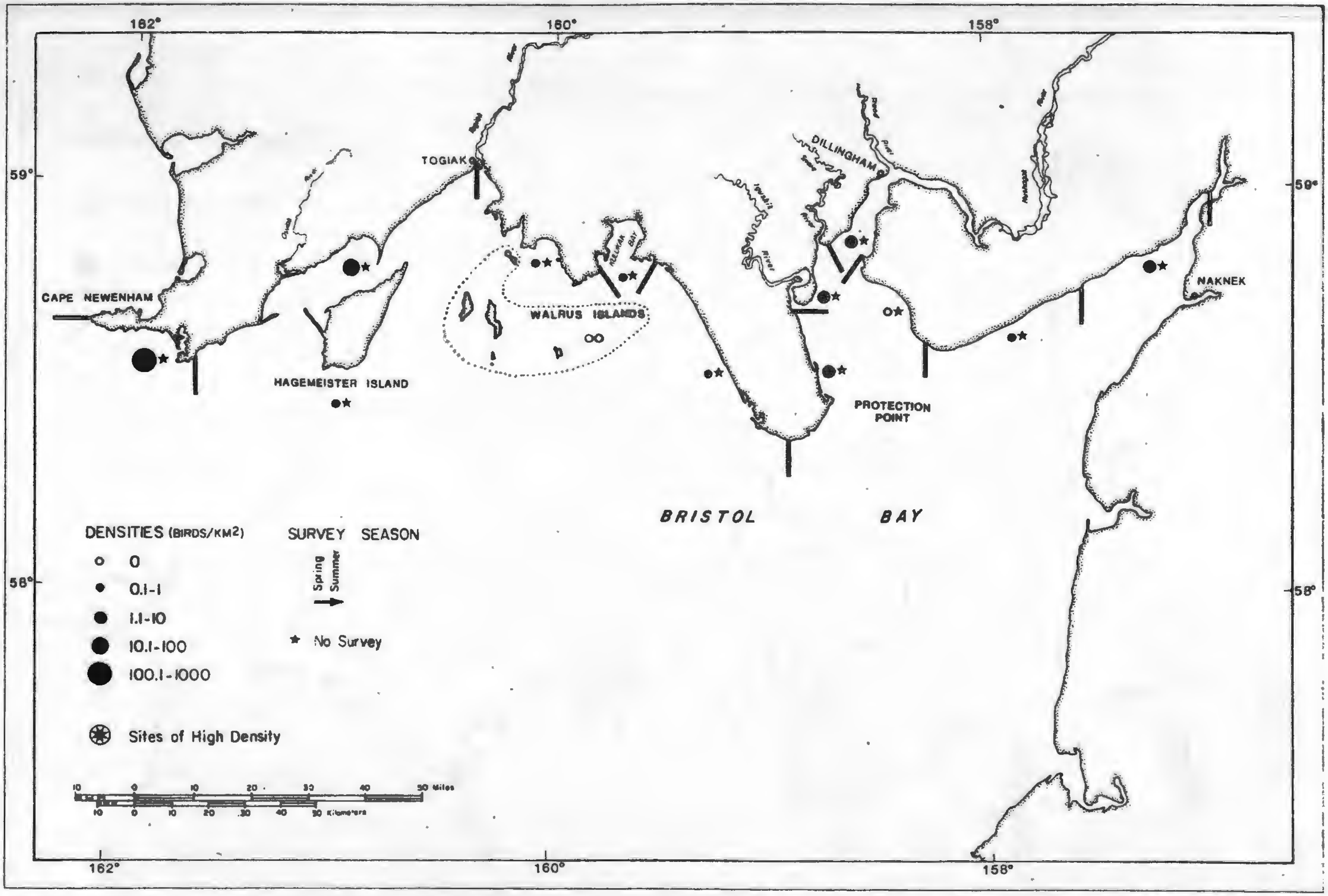


Fig. 141. Goose and swan density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

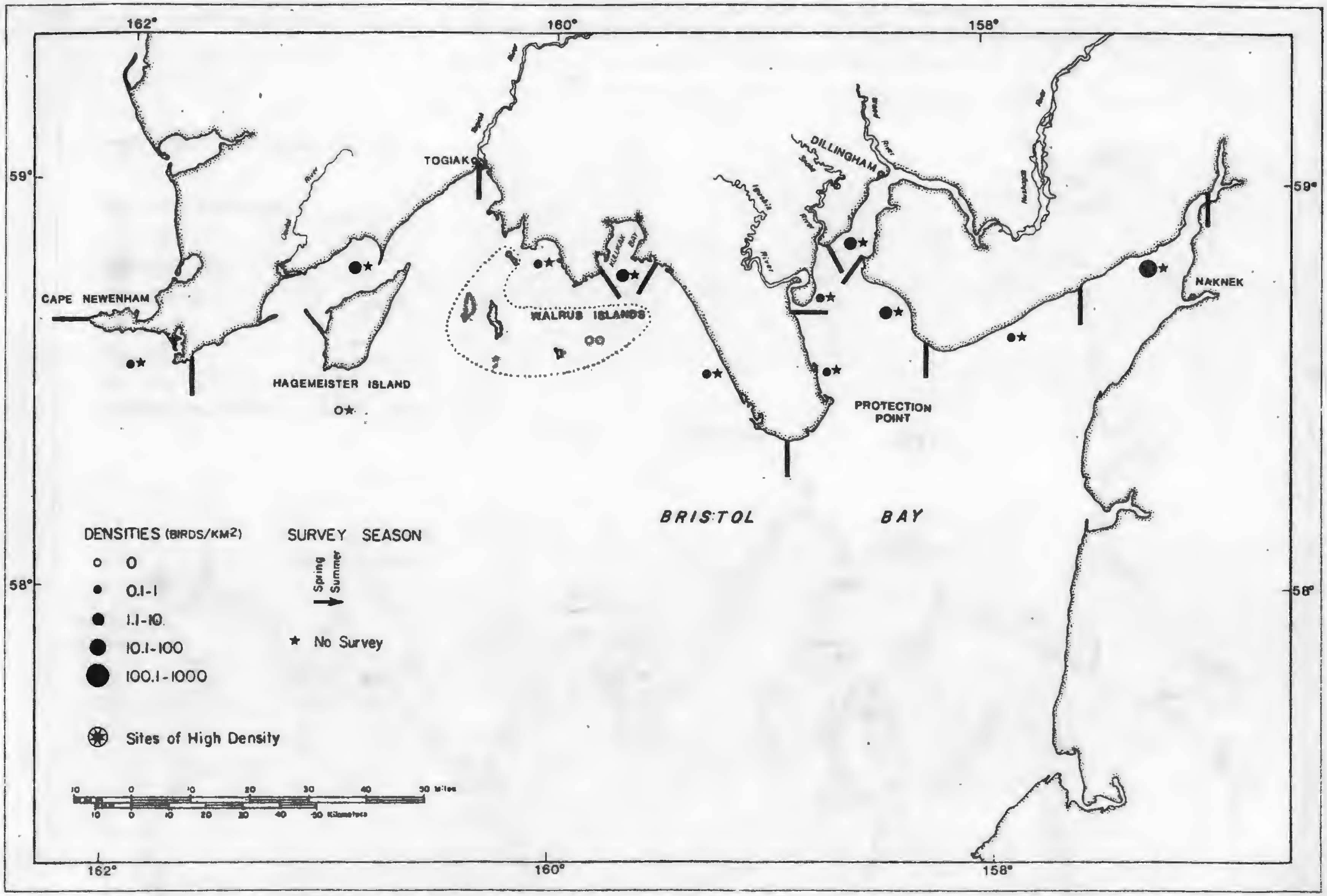


Fig. 142. Dabbling duck density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

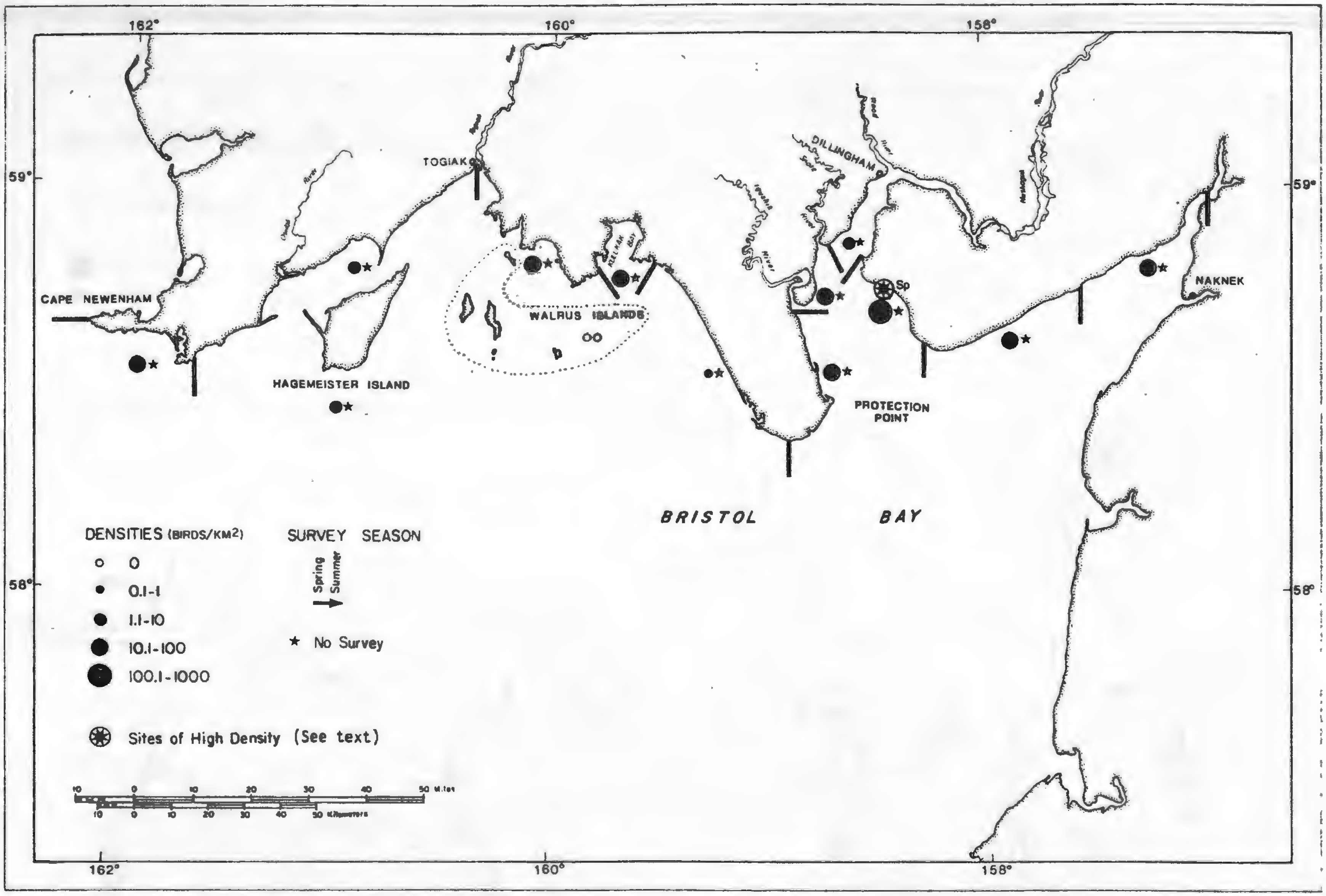


Fig. 143. Diving duck density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

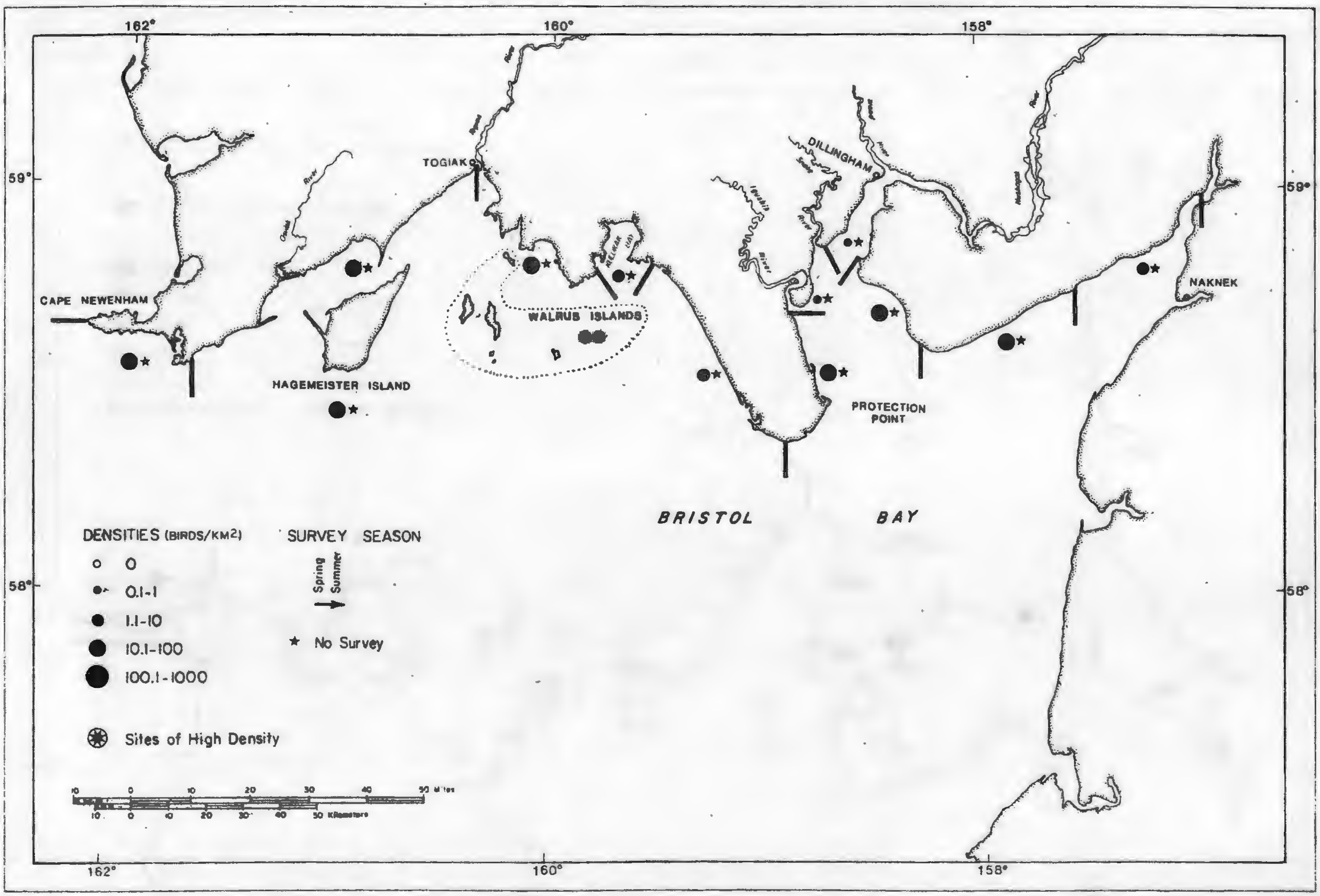


Fig. 144. Sea duck density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

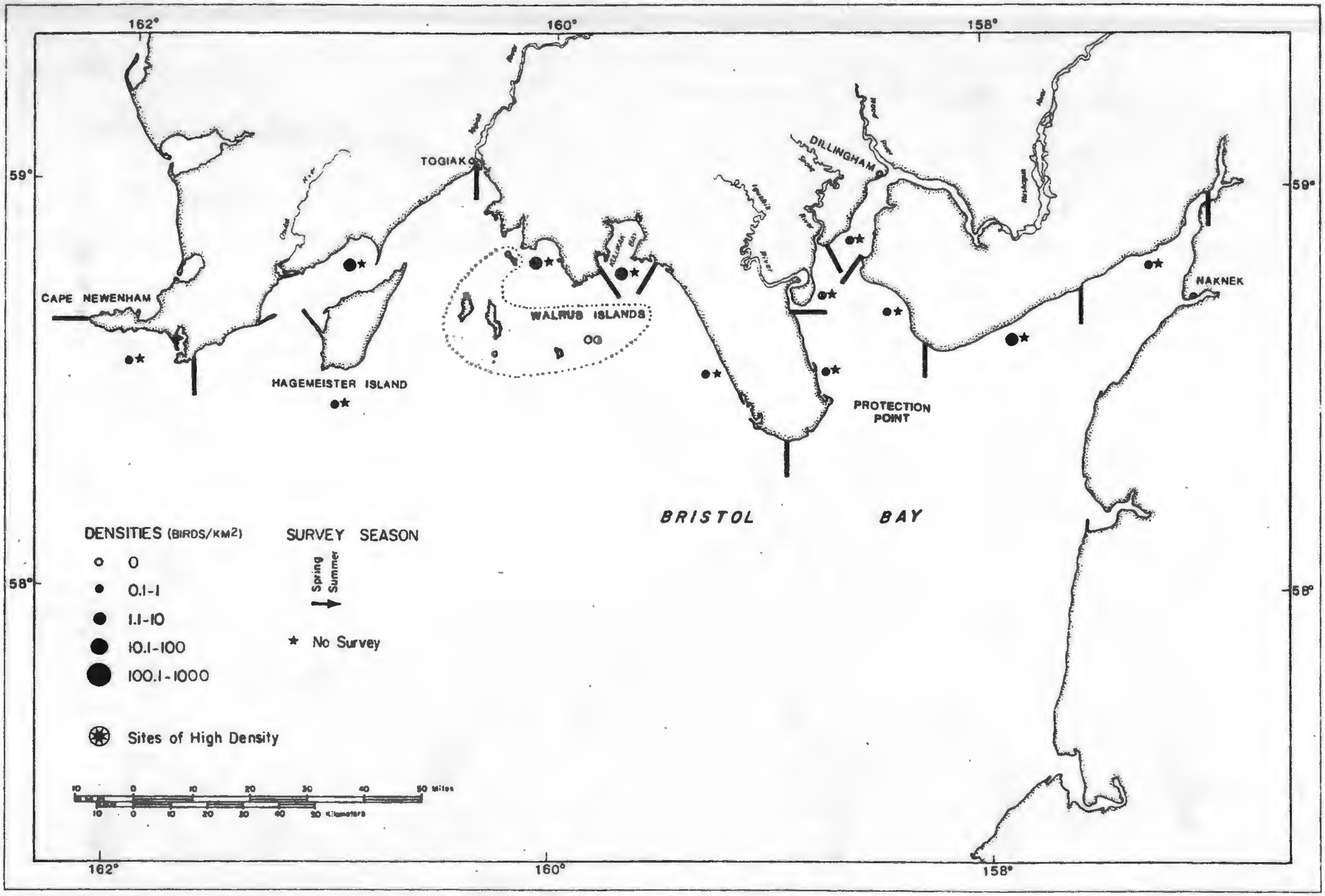


Fig. 145. Merganser density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

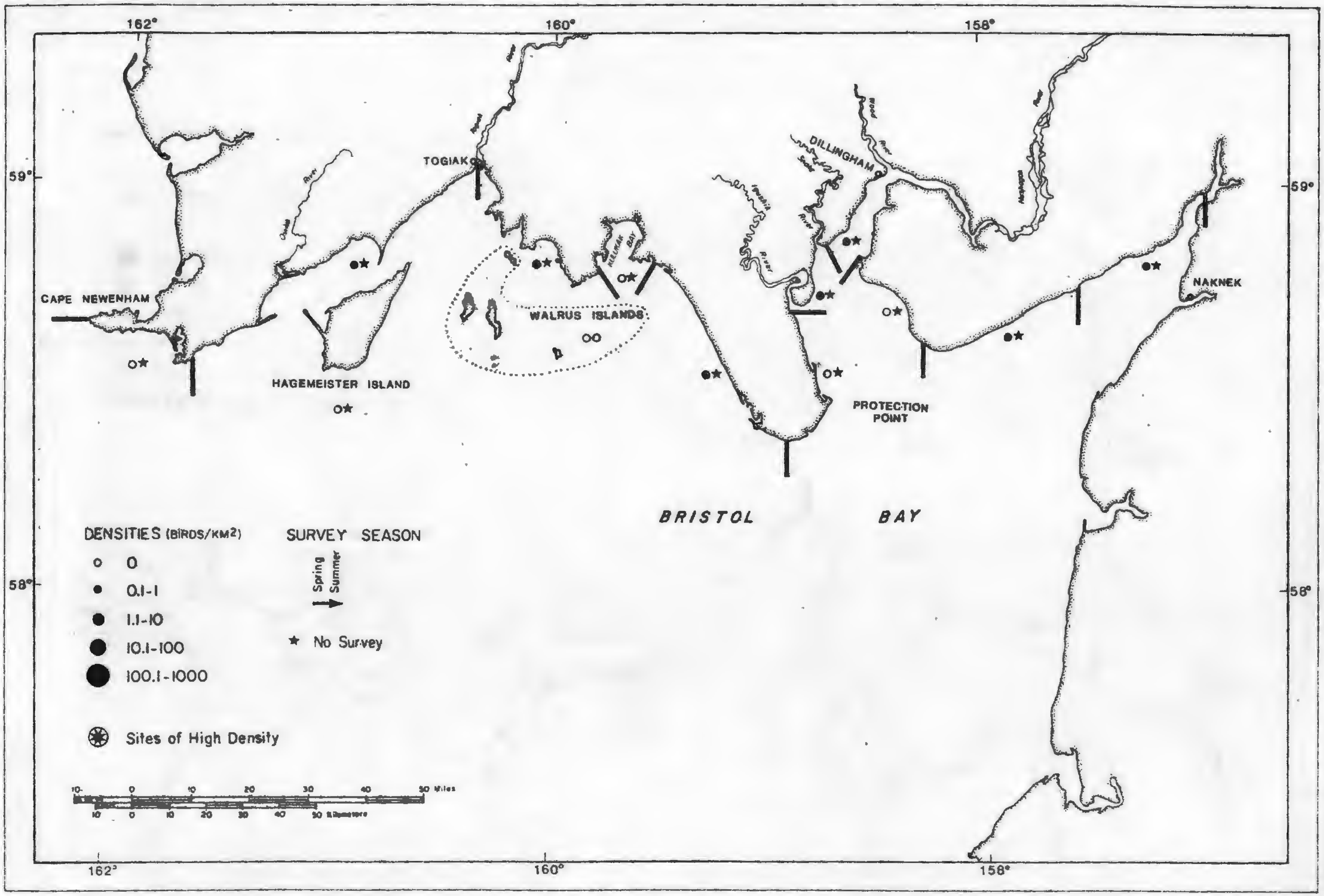


Fig. 146. Raptor density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

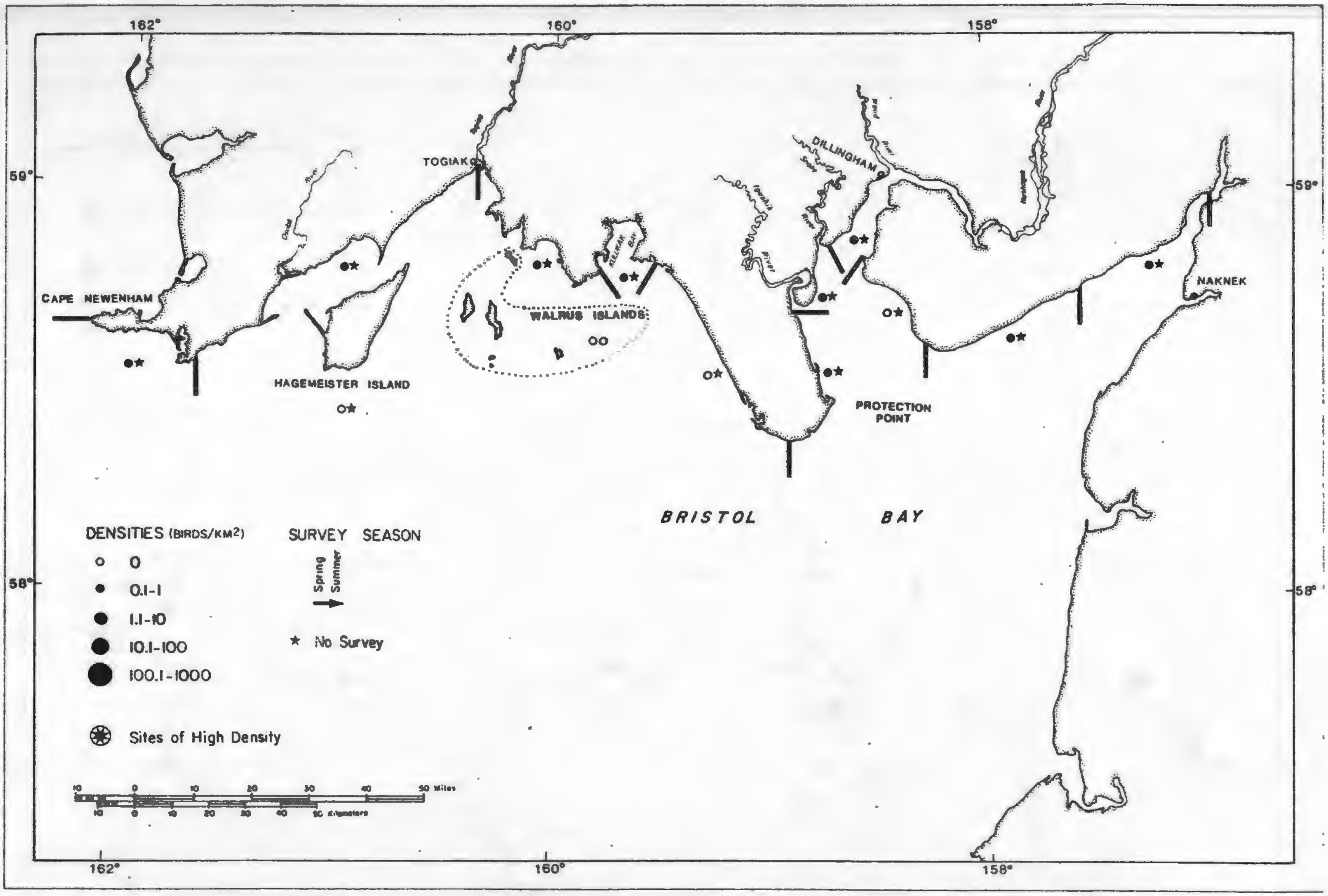


Fig. 147. Crane density by section in North-Bristol Bay during spring and summer seasons as determined by aerial survey. Densities read from left to right: spring, summer.

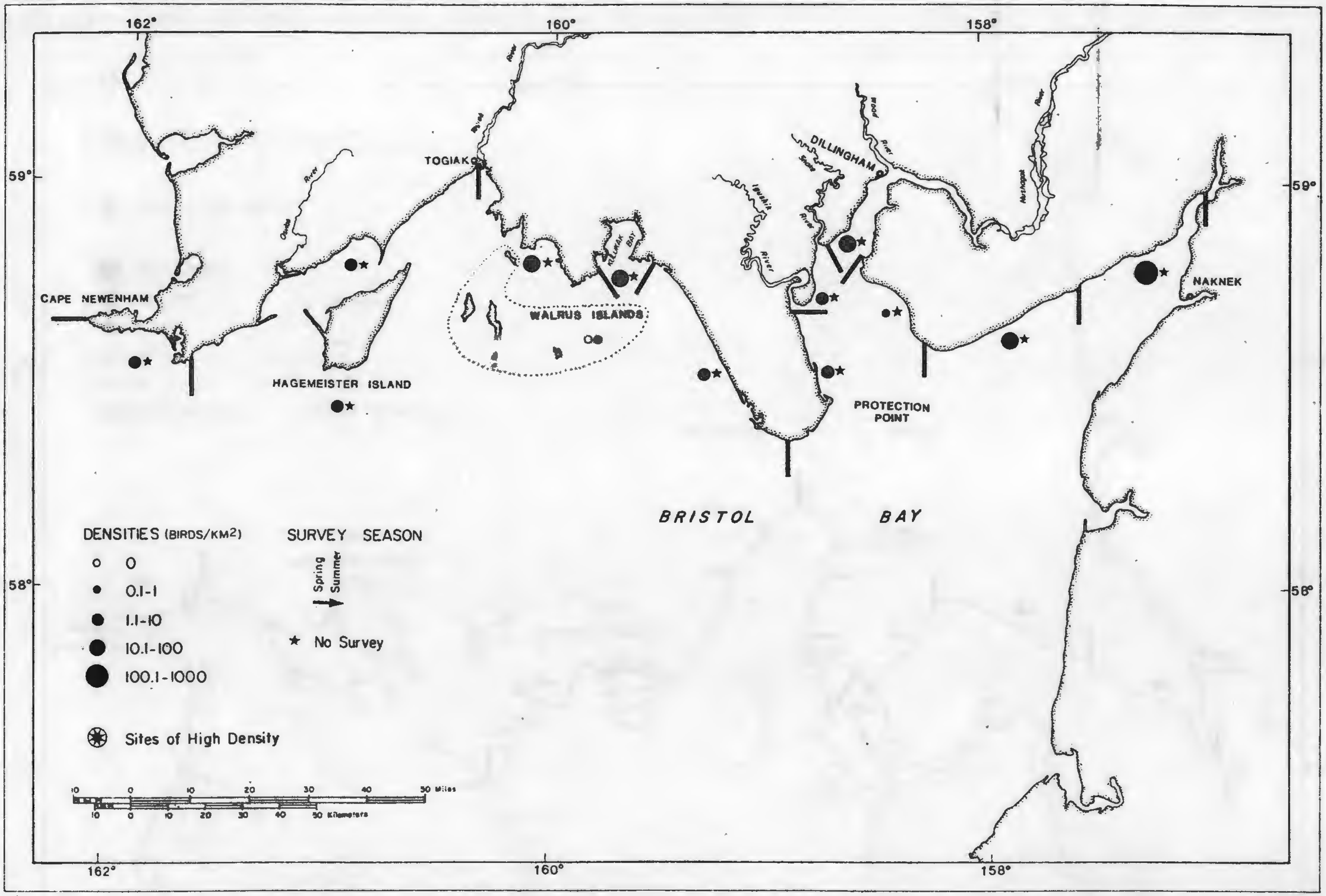


Fig. 148. Shorebird density by section in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

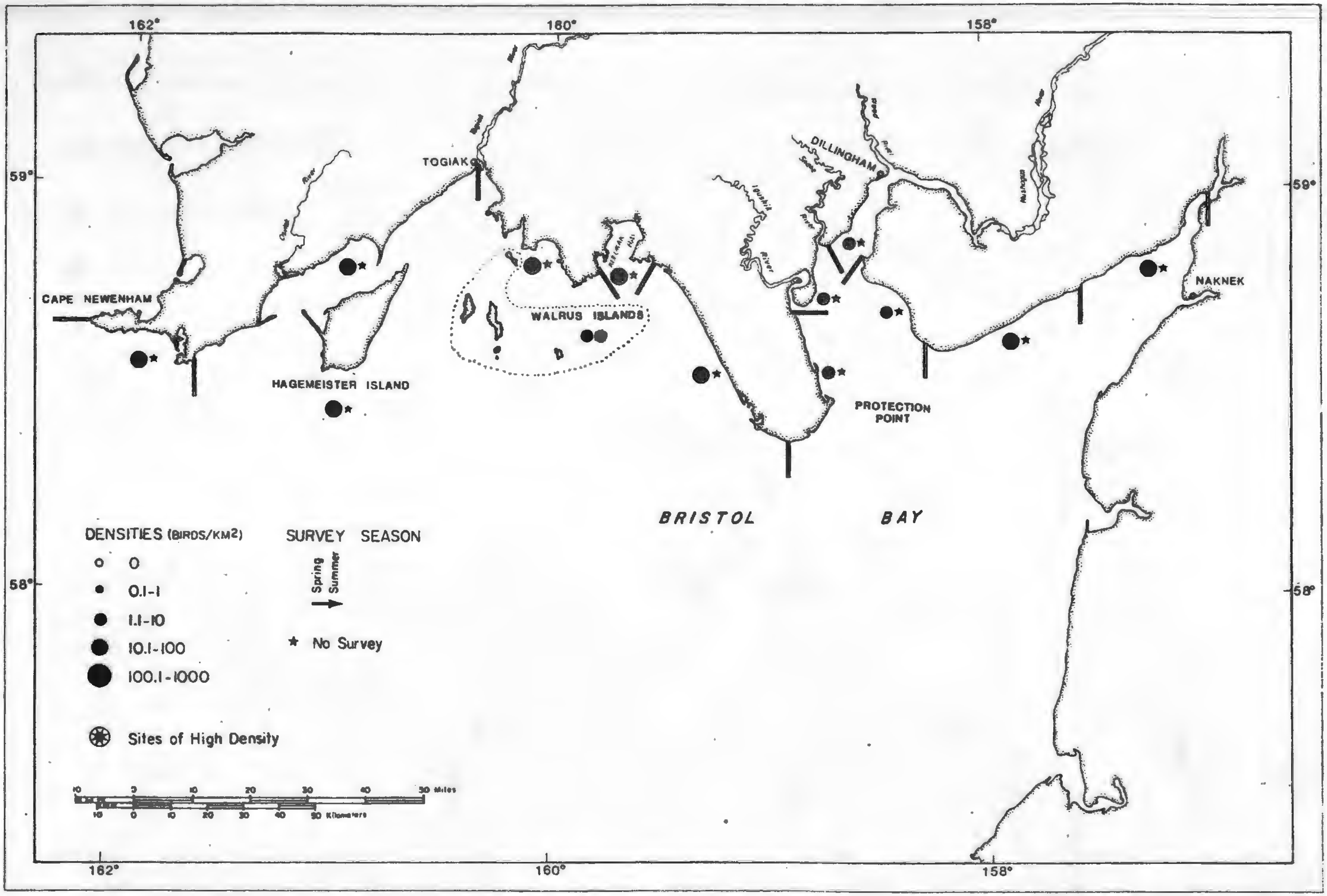


Fig. 149. Gull and jaeger density by section in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

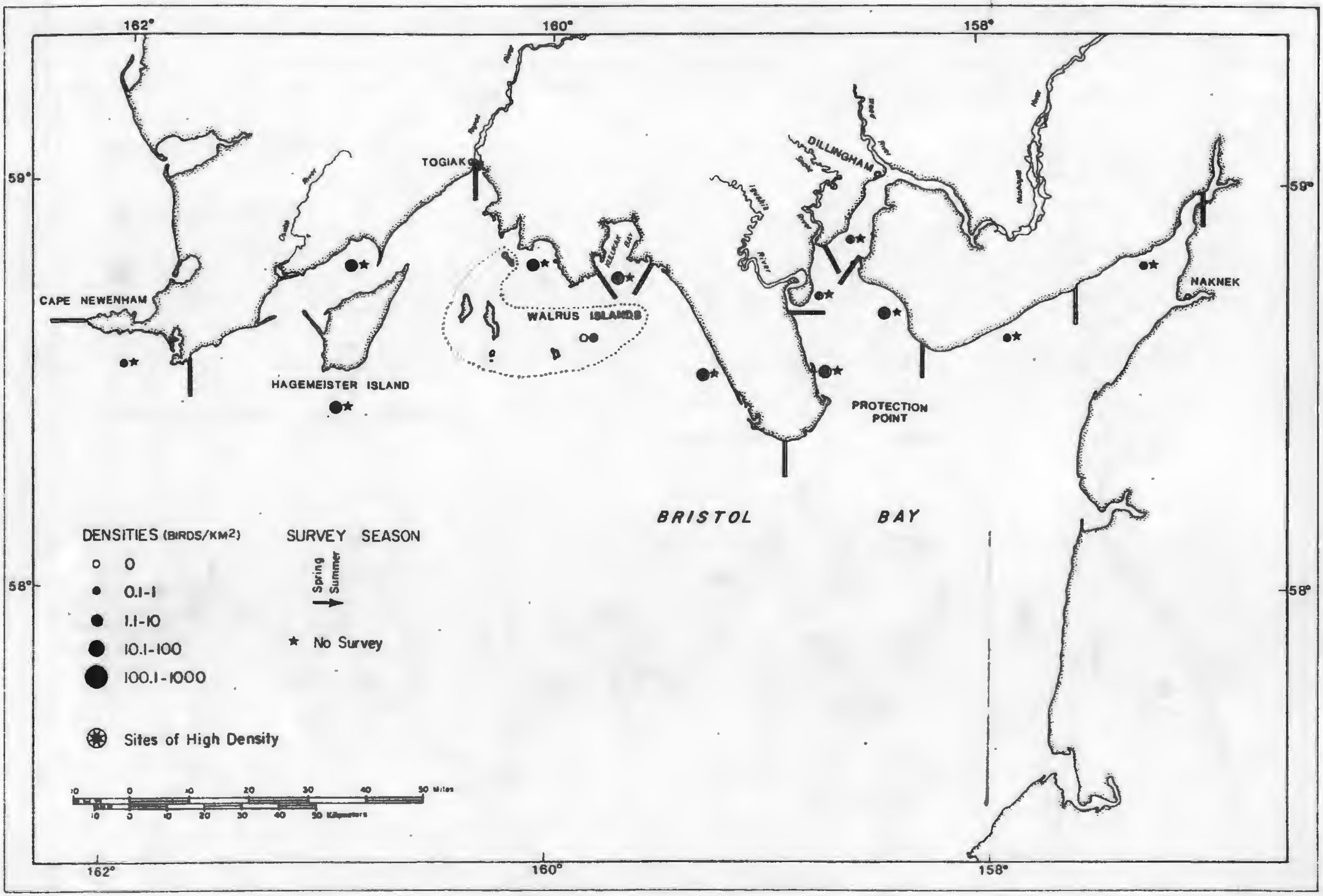


Fig. 150. Tern density by section in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

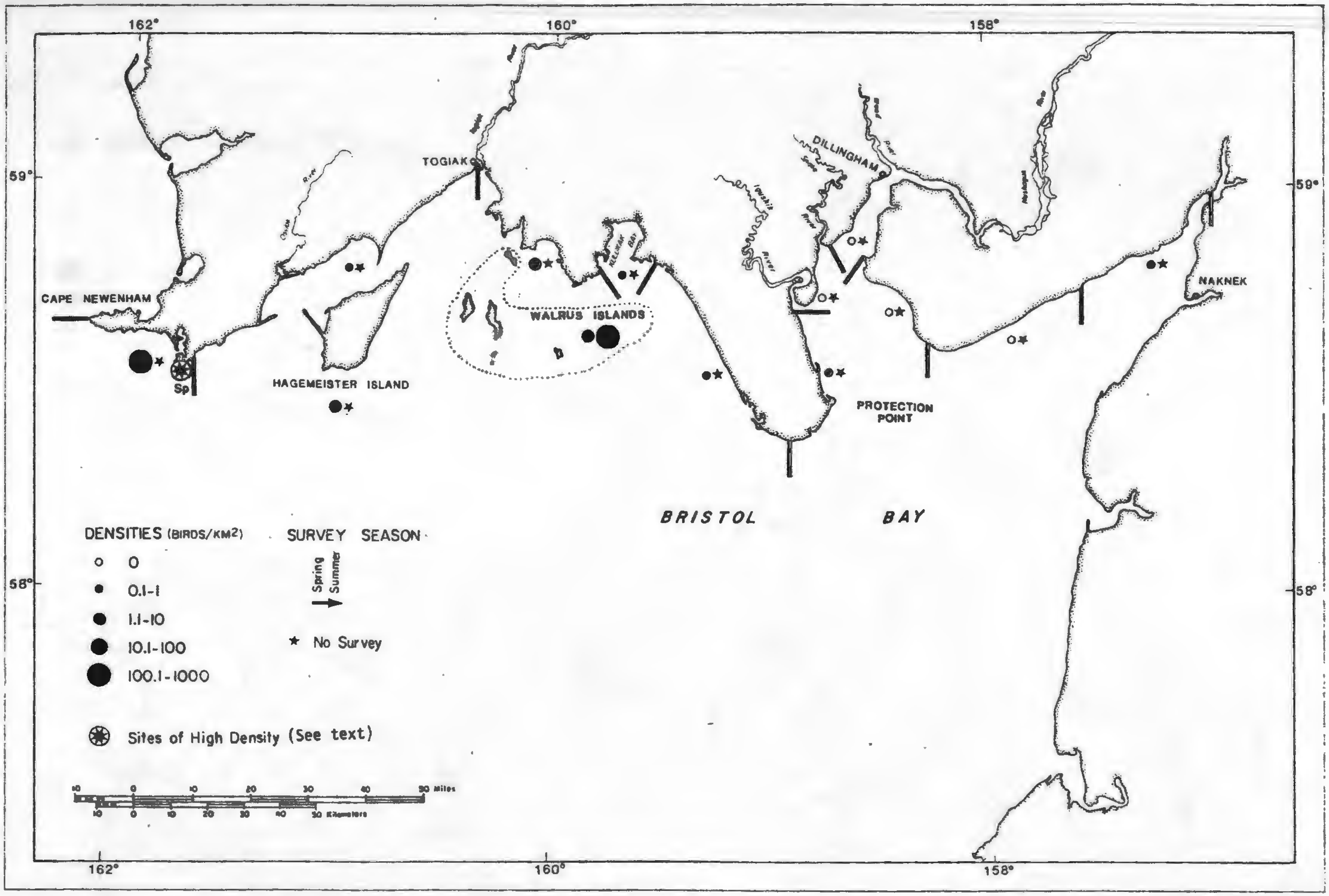


Fig. 151. Alcid density by section in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

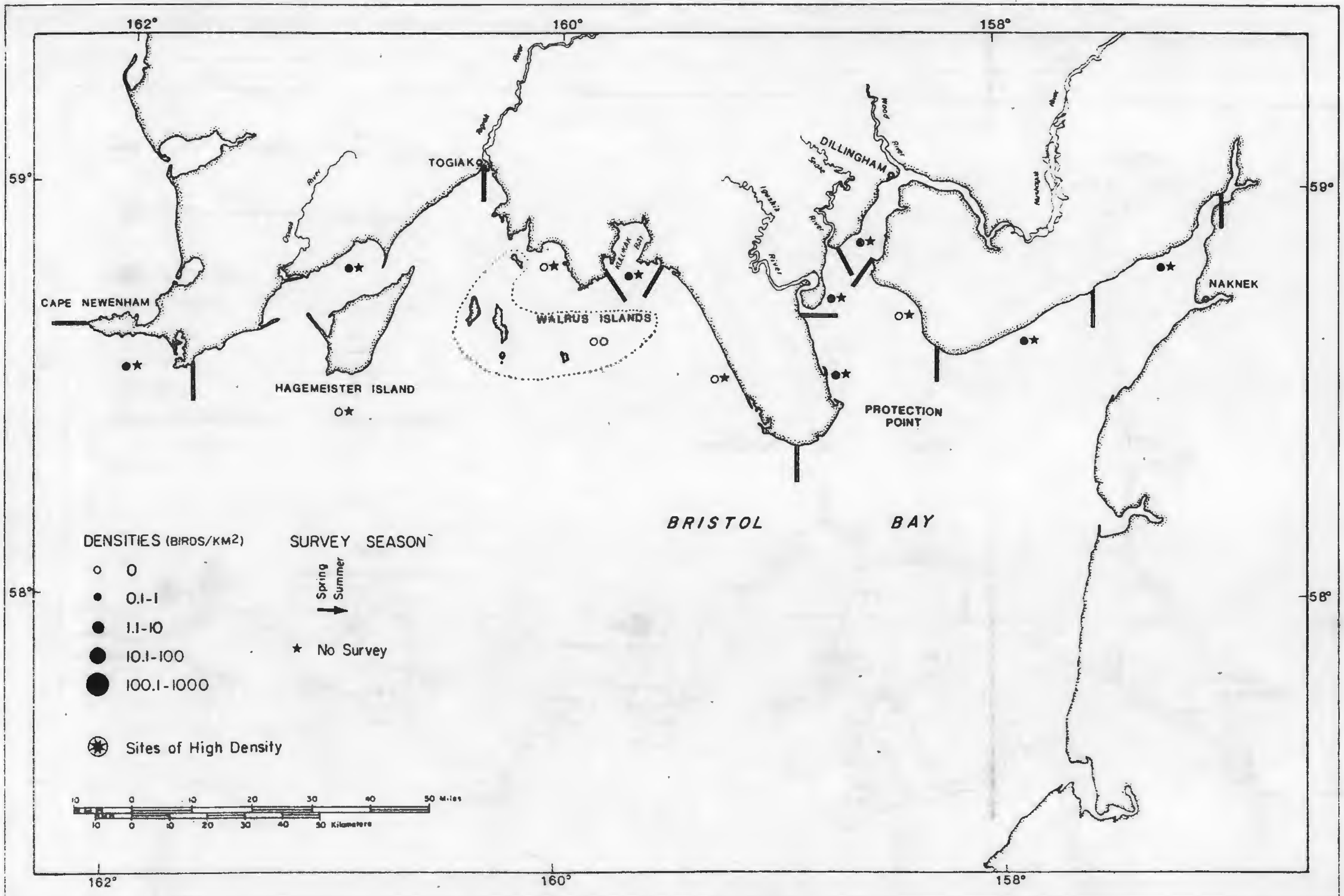


Fig. 152. Corvid density by section in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

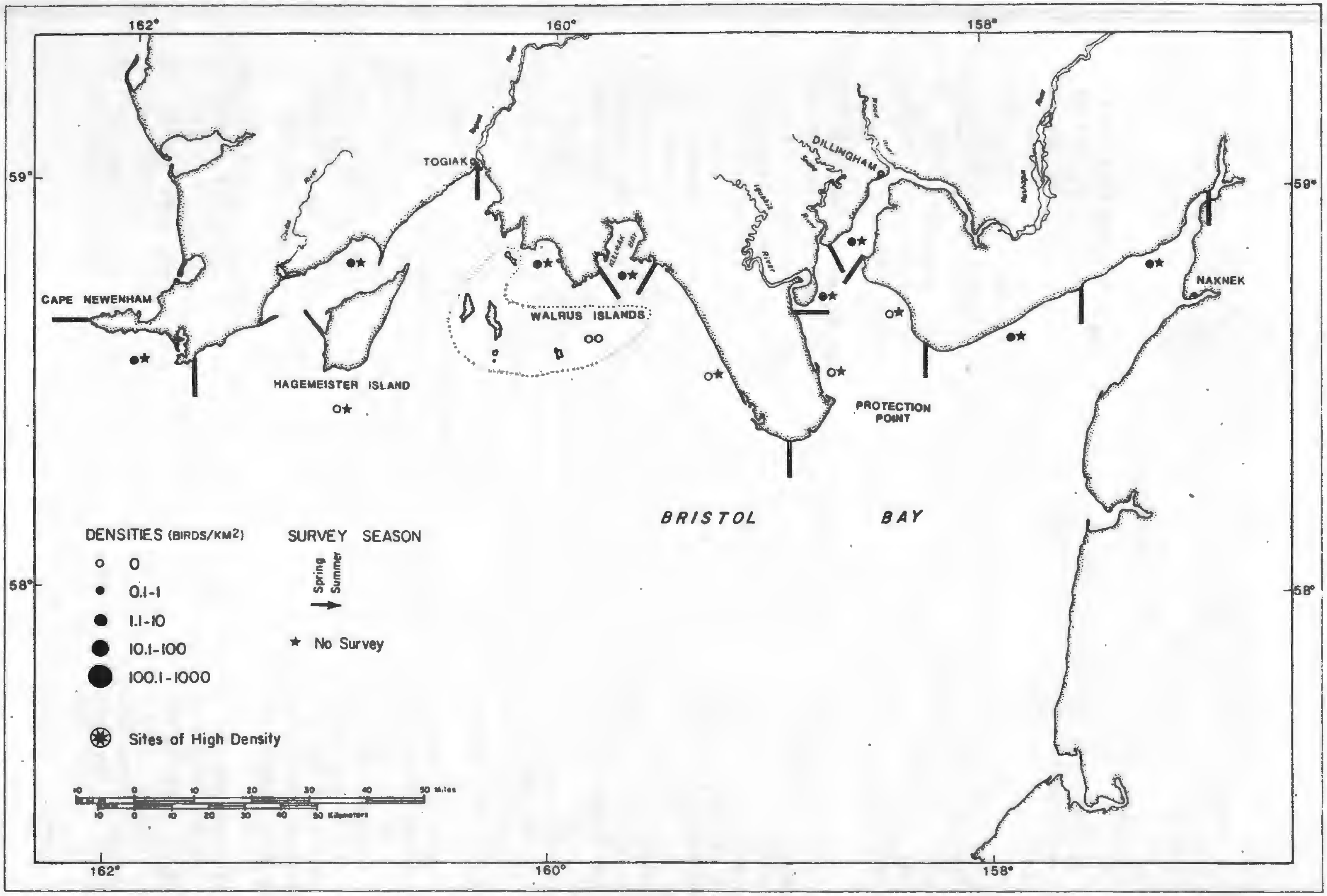


Fig. 153. Passerine (other than corvid) density in North-Bristol Bay during spring and summer seasons as determined by aerial surveys. Densities read from left to right: spring, summer.

The coast from Kulukak Bay to Togiak, Section 9, was the fourth section with a mean density over 100 birds/km^2 (121). No one bird group dominated in this section. The largest were sea ducks with 32 birds/km^2 followed by gulls 24 birds/km^2, divers 21 birds/km^2, shorebirds 18 birds/km^2, cormorants 12 birds/km^2, alcids 7 birds/km^2, mergansers 4 birds/km^2, plus several groups with 2 or fewer birds/km^2.

The section with the lowest density, Section 13, had 16 birds/km^2, but this represented only pelagic transects to, from and between the Walrus Islands. A shoreline survey of the islands was not conducted in spring.

For North-Bristol Bay in spring, there was a well-balanced distribution of overall densities in all bird groups. Shorebirds had the highest density at 21 birds/km^2. This was followed by 13 gulls/km^2, 12 divers/km^2, 10 sea ducks/km^2, 9 dabblers/km^2, 8 alcids/km^2 and 7 geese/km^2. Cormorants occurred at a density of 2 birds/km^2, three groups had densities of 1 bird/km^2 and five had traces. No tubenoses were observed.

Loons were observed in all sections but were most dense in Sections 7-10 where 1-2 birds/km^2 were found. Red-throated Loons were by far the most abundant. They were observed in shallow water all along the coast. Cormorants reached greatest densities of 10 and 12 birds/km^2 in the two Togiak Bay sections. Besides the large number of geese in Nanvak Bay, concentrations were also found in Osviak Bay and at the mouth of the Kvichak River. At Protection Point all five goose species commonly observed in Alaska (Canada, Brant, Emperor, White-fronted and Snow) were recorded as well as swans, cranes and many duck species. Dabblers were most dense in Section 1 and divers in Section 3. Densities of dabblers were low in all other sections, but densities of divers were moderately high in many of the sections. Scaup made up 99 percent of all diving ducks observed. The difference in dabbler and diver density likely reflected a differential in migration timing rather then absolute bird usage patterns in the area.

Twenty or more sea ducks/km^2 were recorded in several sections. The highest densities (32 birds/km^2) were in Section 9 and next highest in Sections 6 and 12. Composition of identified sea ducks was: 10 percent Oldsquaws, 12 percent Harlequin Ducks, 19 percent eiders, and 59 percent scoters. King Eiders were the prevalent identified eider (45% of the total), while 36 percent of the eiders were Common and 19 percent Steller's. Most of the identified scoters were Black (97%). Three percent were White-winged scoters and only a trace of Surf Scoters as recorded.

Red-breasted Mergansers were relatively common in North-Bristol Bay and Sections 8-10 supported the highest densities (2-4 birds/km^2). Sandhill Cranes, although never abundant, were frequently observed (9 of 13 sections). Besides Section 1, where 121 shorebirds/km^2 were found, the densest concentrations of shorebirds were in Section 8, Kulukak Bay, where 32 birds/km^2 were found and in outer Kvichak Bay (Section 2) with 24 birds/km^2. Nearly 5,000 shorebirds were recorded in Section 4 but densities were only 17 birds/km^2.

Densities of over 10 gulls/km^2 were observed in all sections except the Nushagak Bay area. In Sections 3-6 only 4 to 6 gulls/km^2 were found. Many gulls were paired and apparently on breeding territories along the Nushagak River and over 4,000 gulls were counted in those four sections. However, the area searched was large, and gull densities were correspondingly low. Tern migration had reached its peak in May, and the North-Bristol Bay surveys caught at least part of the migration. Terns were observed in all sections except No. 13 and densities up to 4 terns/km^2 were recorded.

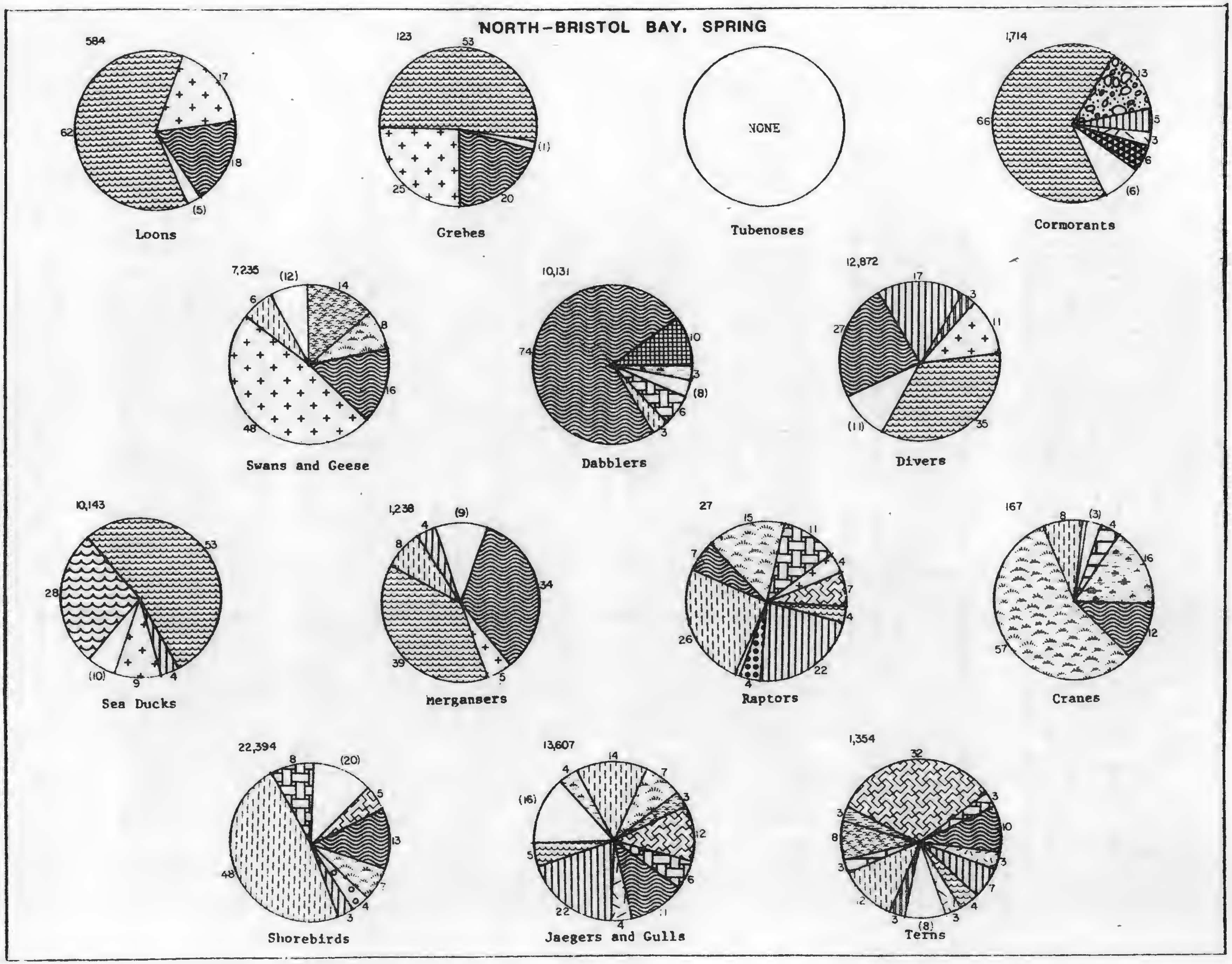
Alcids were found in measurable numbers only beyond Kulukak Bay. The majority (249 birds/km^2) were in Section 11 but other concentrations were in Sections 9 and 12. Murres comprised 91 percent of the total identified alcids, Pigeon Guillemots 5 percent and puffins (mostly Tufted) 4 percent. Corvids were most numerous in Section 10 and other passerines in Section 5 but both groups were found only in trace quantities.

Habitat Usage - Habitat preferences of each species group and what species groups were found on each habitat type for the spring survey of North-Bristol Bay are shown in Figs. 154 and 155, respectively. Forty-two percent of the birds were recorded on protected delta habitats, 37 percent on exposed inshore habitats, 12 percent on bay habitats, 4 percent on offshore waters, 3 percent in lagoon habitats, 2 percent on saltmarshes and 1 percent on exposed deltas. Six habitats were used by 3,500 or more birds (4% or more of the total). The remaining 20 identified habitats on which birds were found contained only small numbers of birds.

During the spring surveys most birds were found on exposed inshore waters (22% of the total). Three bird groups predominated in this habitat: alcids (34% of the birds), sea ducks (27%) and divers (23%). Nineteen percent of the birds used protected delta water, and many of these were dabblers (43%), divers (20%), shorebirds (16%) and gulls (9%). Exposed sand beach and bay water were each used by 7 percent of the birds. On sand beaches most birds were gulls and divers (46% and 33%, respectively) and on bay water waterfowl predominated, 52 percent geese, 22 percent divers and 14 percent sea ducks. Four percent of the birds were found on both alluvial floodplain and protected delta mud. On the former habitat, shorebirds, gulls and geese were most abundant (41%, 26%, and 16% respectively). The latter habitat was used most by shorebirds (48%), gulls (23%) and dabblers (16%).

On a species group basis, shorebirds, the most abundant group, were found on 23 of 26 identified habitats, but almost one-half were on unidentified protected alluvial habitats. Thirteen percent were on or flying over protected alluvial floodplains. The remainder was divided among the other habitats. Gulls, too, were on a variety of habitats (22 of 26) but most frequently used exposed sand beaches (22%), protected delta water (11%), alluvial floodplain (7%) and protected delta mud (6%).

Almost 13,000 birds observed during the spring survey were diving ducks (scaup). They were found most on exposed inshore water (35%), protected delta water (27%), exposed sand beaches (17%) and bay water (11%).


NORTH-BRISTOL BAY, SPRING
584
Loons
123
Grebes
NONE
Tubenoses
1,714
Cormorants
7,235
Swans and Geese
10,131
Dabblers
12,872
Divers
10,143
Sea Ducks
1,238
Mergansers
27
Raptors
167
Cranes
22,394
Shorebirds
13,607
Jaegers and Gulls
1,354
Terns

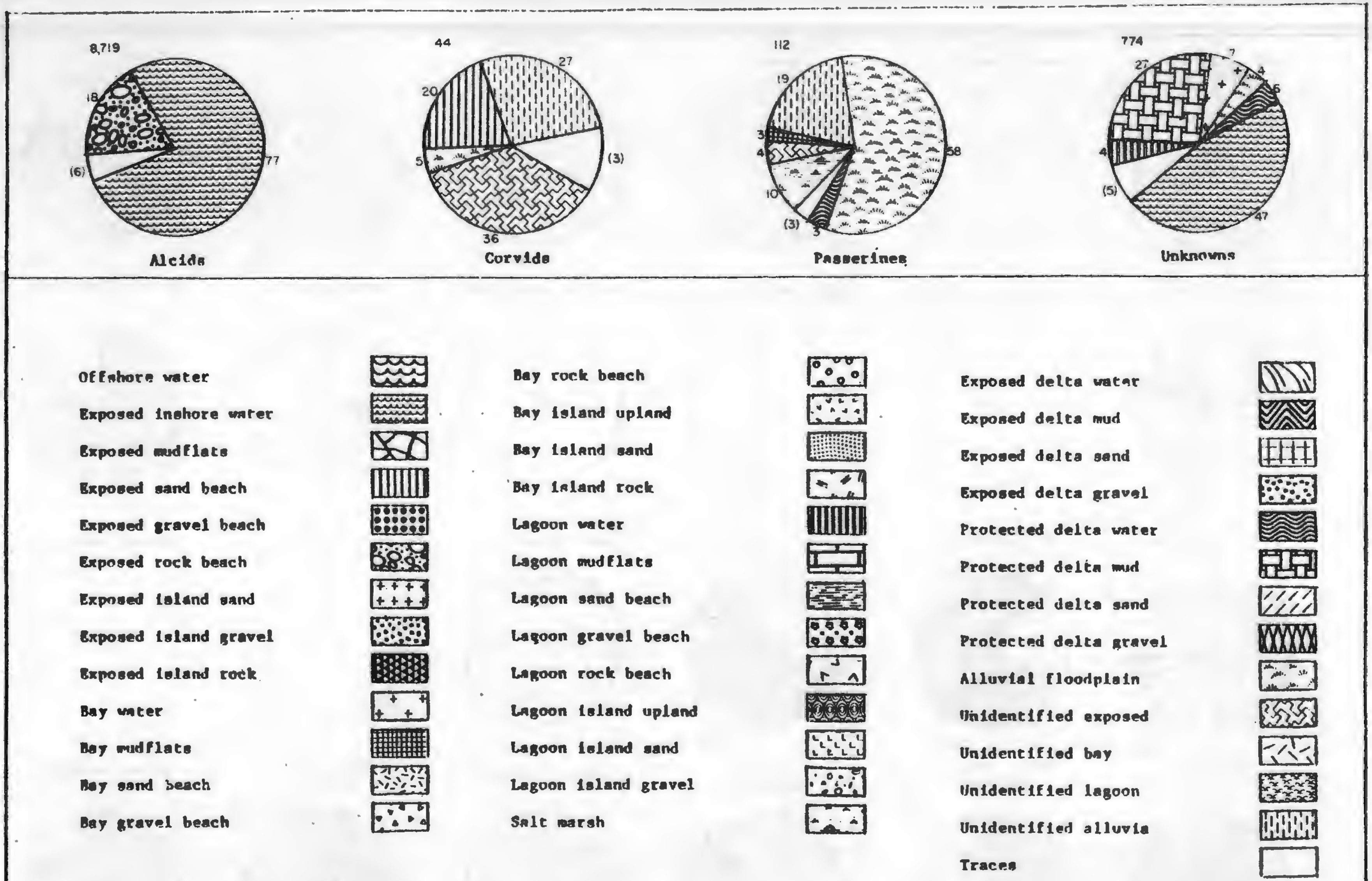
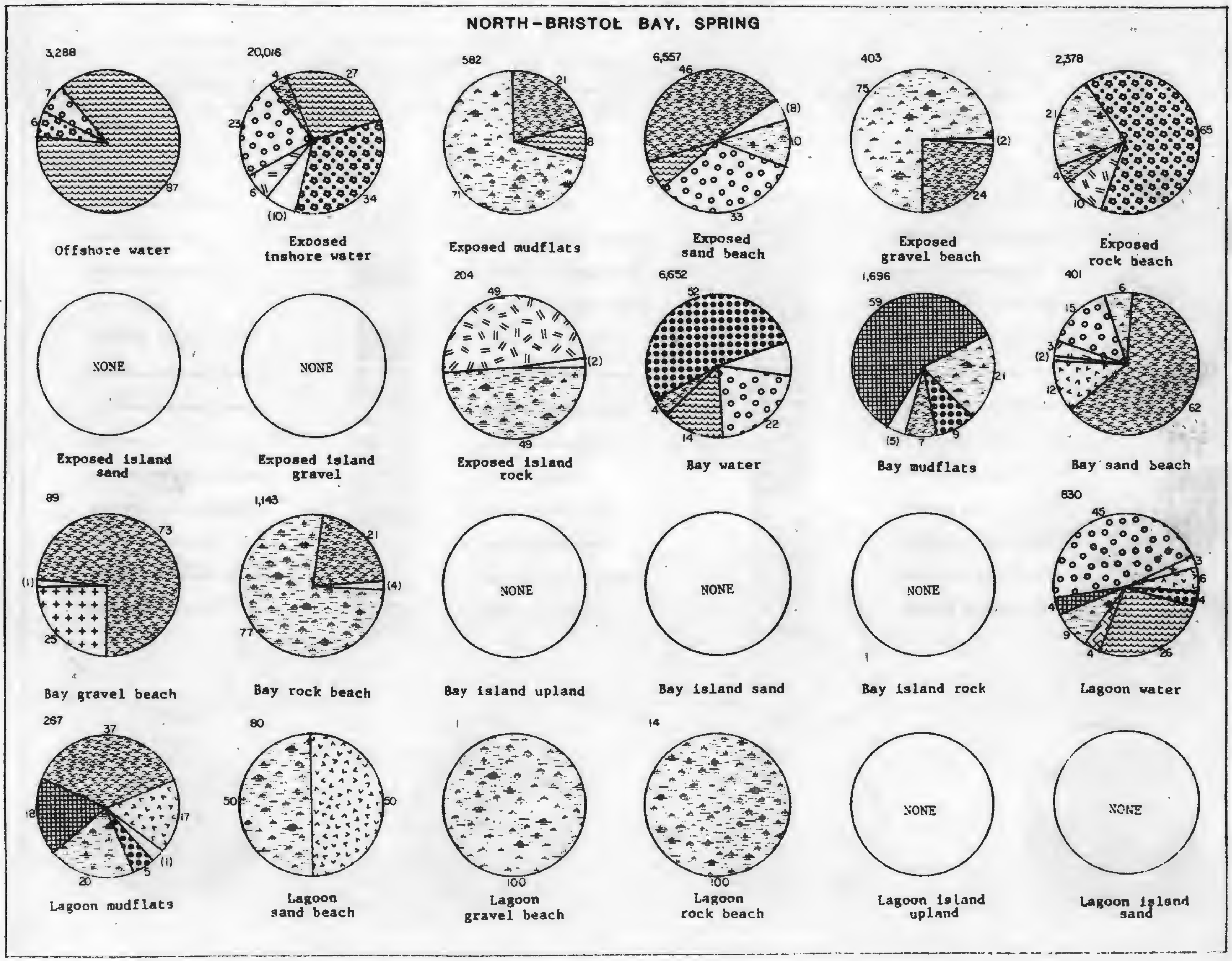


Fig. 154. North-Bristol Bay, Spring 1976, 1977. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


NORTH-BRISTOL BAY, SPRING
3,288
7
6
87
Offshore water
20,016
4
27
23
6
(10)
34
Exposed inshore water
582
21
8
71
Exposed mudflats
6,557
46
(8)
10
6
33
Exposed sand beach
403
75
(2)
24
Exposed gravel beach
2,378
21
65
4
10
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
204
49
(2)
49
Exposed island rock
6,652
52
4
14
22
Bay water
1,696
59
21
(5)
7
9
Bay mudflats
401
6
15
3
(2)
12
62
Bay sand beach
89
73
(1)
25
Bay gravel beach
1,143
21
(4)
77
Bay rock beach
NONE
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
830
45
3
6
4
4
9
4
26
Lagoon water
267
37
18
17
20
5
(1)
Lagoon mudflats
80
50
50
Lagoon sand beach
1
100
Lagoon gravel beach
14
100
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

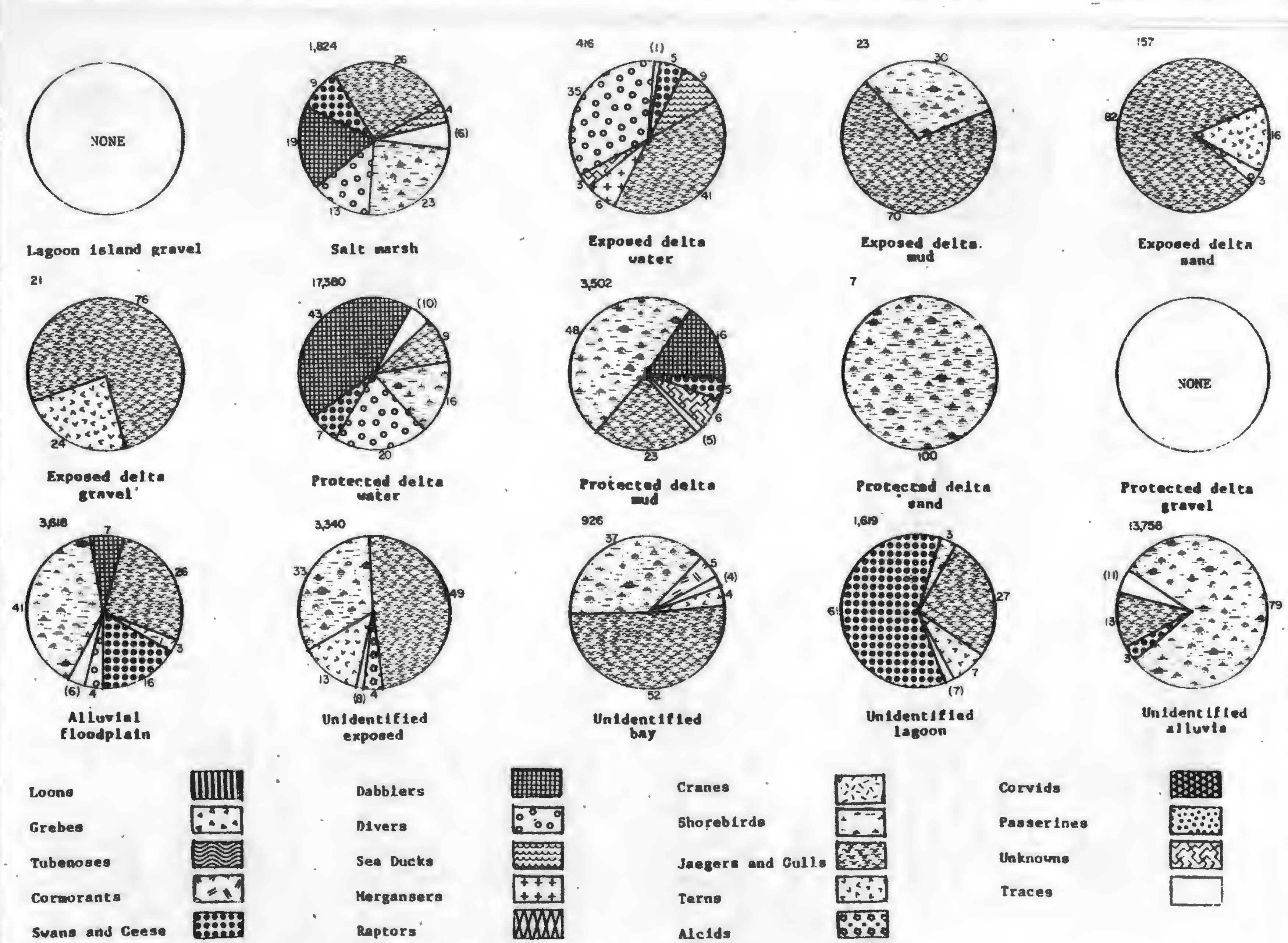


Fig. 155. North-Bristol Bay, Spring 1976, 1977. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

About 10,000 dabblers and sea ducks were recorded. Dabblers preferred protected delta water (74% of the total) and often roosted and fed at river's edge. Other dabblers were found on bay mudflats (10%) and protected delta mud (6%). Almost all sea ducks were on exposed inshore water (53%), offshore water (28%) or bay water (9%). About one-half the geese used bay water, 16 percent were on protected delta water and 8 percent alluvial floodplains.

Of the almost 9,000 alcids, 77 percent were found on exposed inshore water and 18 percent on exposed rock beach. Three other species groups had sample sizes of over 1,000 birds (cormorants, mergansers and terns.) Cormorants were most often on exposed inshore water, mergansers were on that habitat plus protected delta water and terns used bay habitats most frequently. Loons were more numerous in North-Bristol Bay than in any other region and were found on exposed inshore water 62 percent of the time. Eighteen percent were on protected delta water and 17 percent on bay water.

SUMMER

Density - Only 18 transects were conducted by raft between the Walrus Islands in the summer in North-Bristol Bay. The mean density for all birds was 134 birds/km^2 (Table 18). Most were alcids (103 birds/km^2), followed by cormorants (15 birds/km^2), sea ducks (10 birds/km^2) and gulls (6 birds/km^2). Most of the sea ducks were non-breeding White-winged Scoters.

Habitat Usage - Because these surveys were pelagic transects, most birds were on offshore waters and further evaluation of habitat use was unnecessary.

ALEUTIAN SHELF

Only one winter survey was conducted in this region (Fig. 156). At the time of the survey, weather was generally poor with snow squalls, high winds and rough seas. Parts of some stations were missed and others completely bypassed. The south side of Unalaska Island and the east side of Umnak Island were not surveyed. More birds were present than are represented here.

The subdivision into sections (Fig. 157) was arbitary. Many of the bays and islands are physiographically similar and were therefore combined into the large sections. Exposure was the only obvious difference. Samalga Island was selected as one section in itself because of its relative importance. Bogoslof Island and the accompanying transects to and from the island were also given sectional status.

WINTER

Density - Bird densities by section for the winter survey of the Aleutian Shelf are shown in Figs. 158-175. The mean density for all birds was 94 birds/km^2 (Table 19). The section with the highest density of all

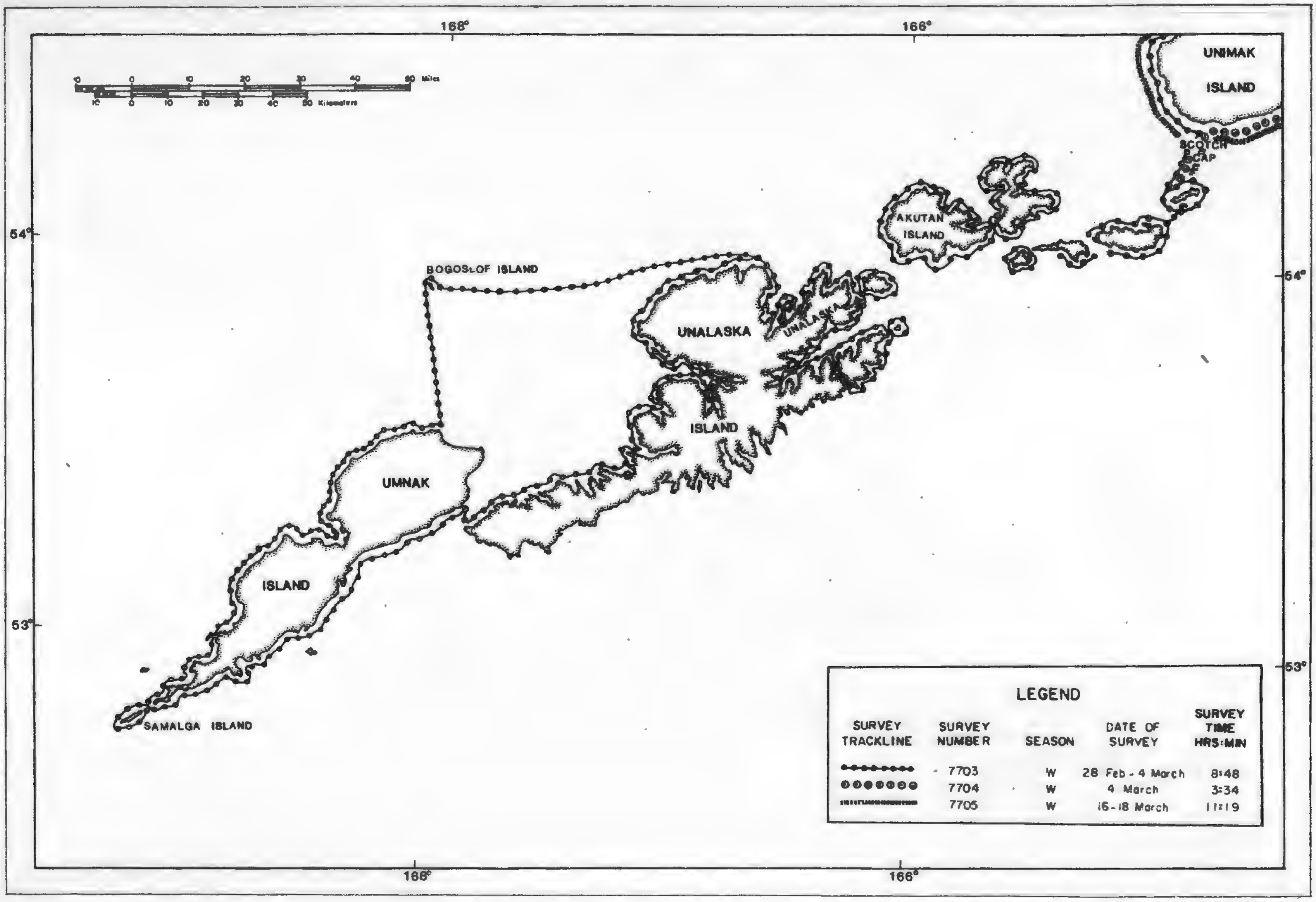


Fig. 156. Tracklines of aerial bird surveys along the Aleutian Shelf, 1977.

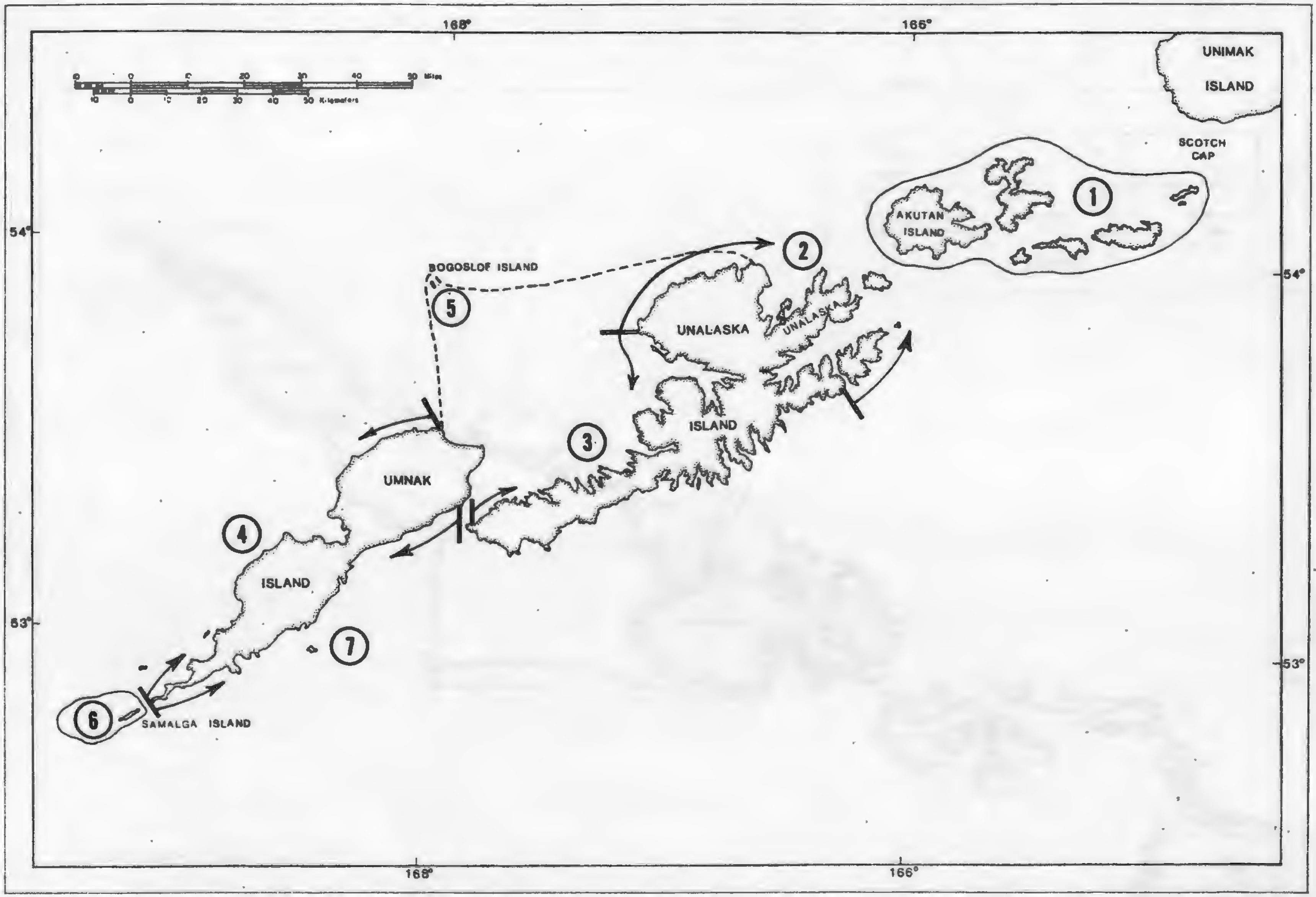


Fig. 157. Physiographic subdivision of the Aleutian Shelf for bird density analysis. Each numbered section contains several survey stations.

Table 19. Bird density by section of coastline in Aleutian Shelf, winter 1978. See Figure 157 for section boundaries. (T=trace).

	Winter Densities (birds/km^2)							
	Section of Coastline							
Bird Group	1	2	3	4	5	6	7	Total
Loon	T	T	T	T				T
Grebe	T	T	T			T		T
Tubenose					1			T
Cormorant	6	4	4	2	T		2	4
Goose and Swan	6	9	23	8		1435	10	17
Dabbler	T	T		2		30	1	1
Diver	T	1	1	T		20	1	1
Sea Duck	50	41	51	30	T	416	57	43
Merganser	T	T	T			T	T	T
Raptor	T	T	T	T			T	T
Crane								0
Shorebird	1	1	1	1		1240	48	13
Gull and Jaeger	7	14	10	11	12	99	9	11
Tern								0
Alcid	4	8	10	T	T			5
Corvid	T	1	T	T			T	T
Other Passerine		T	T				1	T
Other Bird		T	2				T	T
TOTAL	75	80	103	54	13	3240	129	94

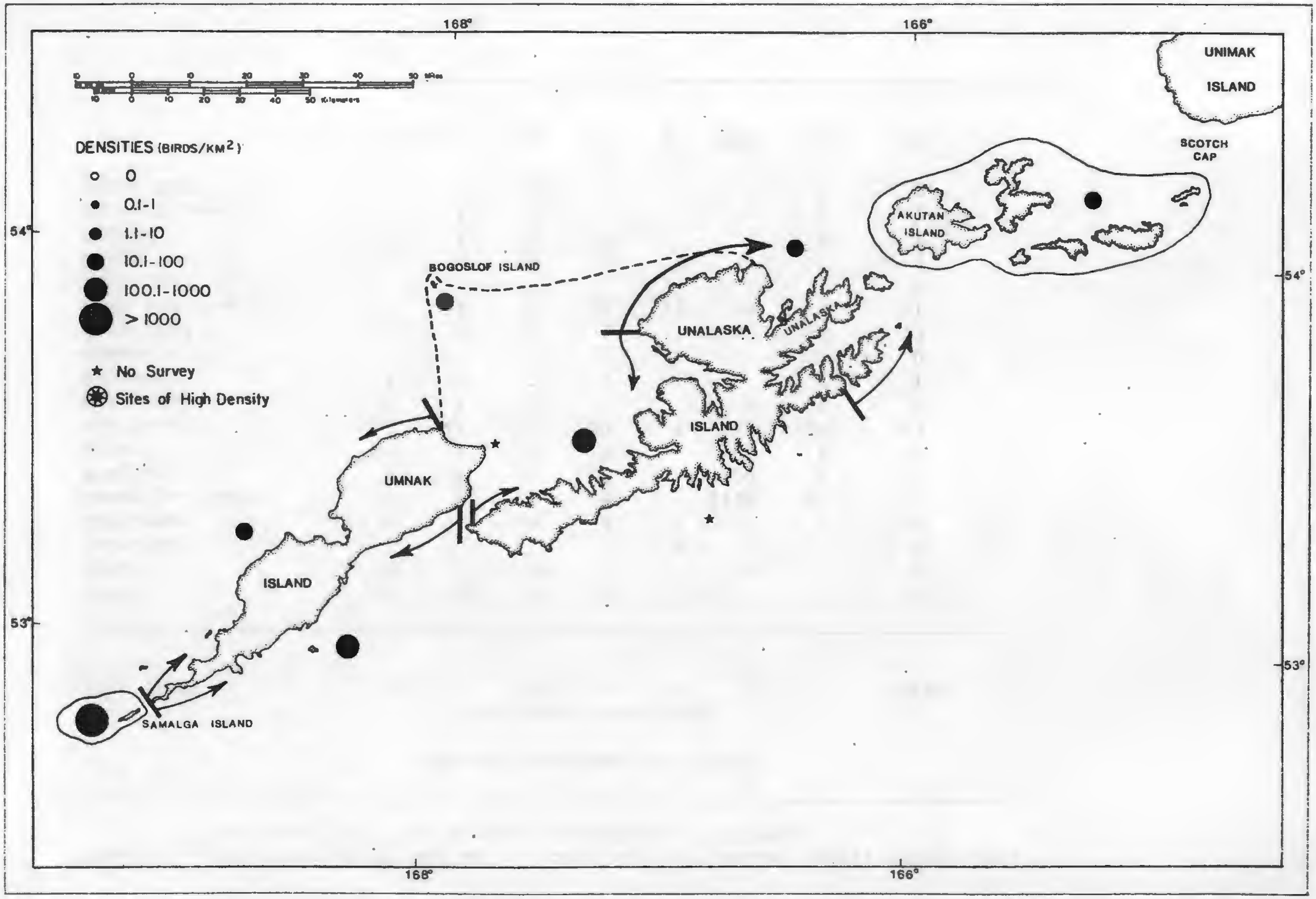


Fig. 158. Total bird density by section along the Aleutian Shelf during winter as determined by aerial survey.

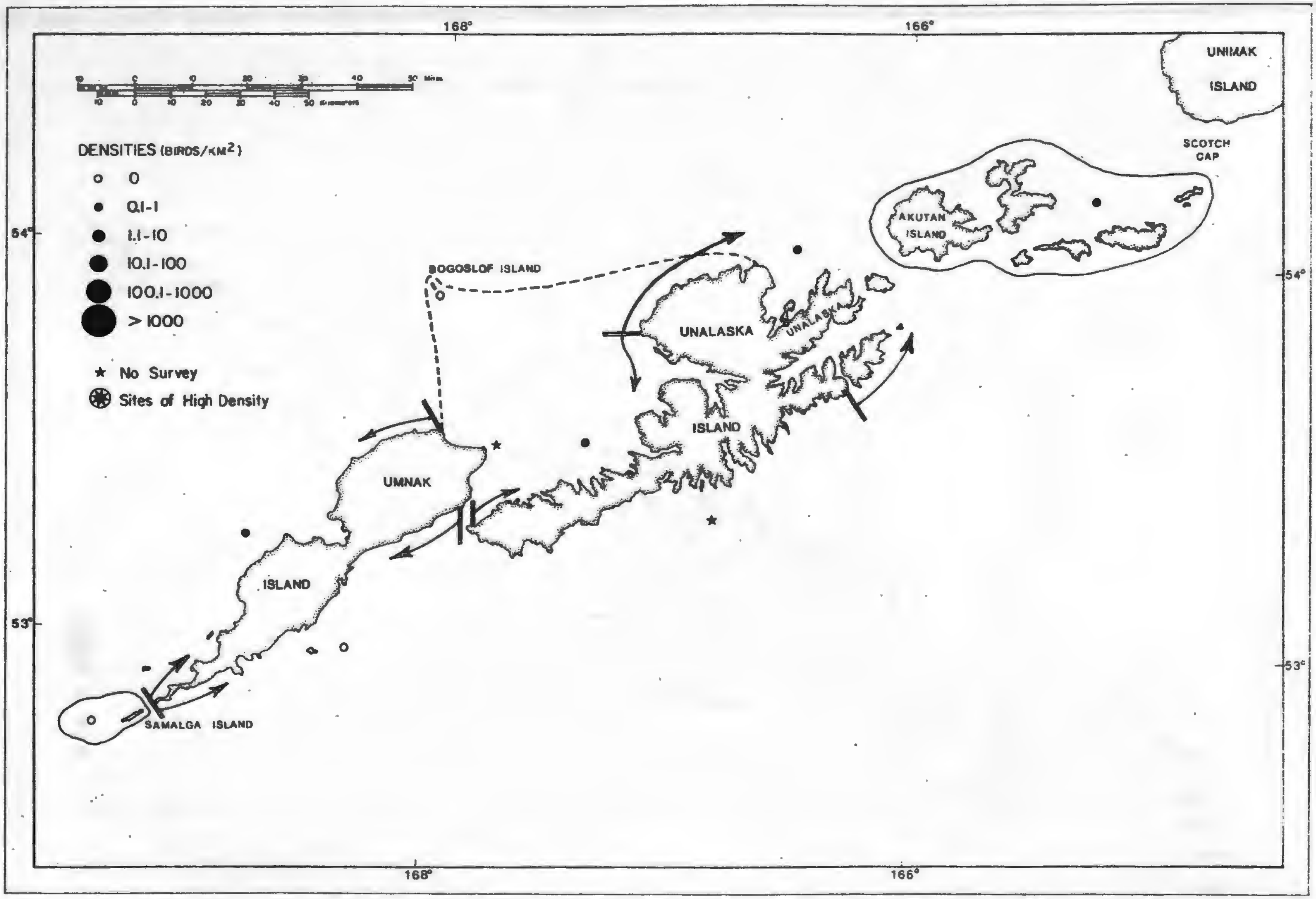


Fig. 159. Loon density by section along the Aleutian Shelf during winter as determined by aerial survey.

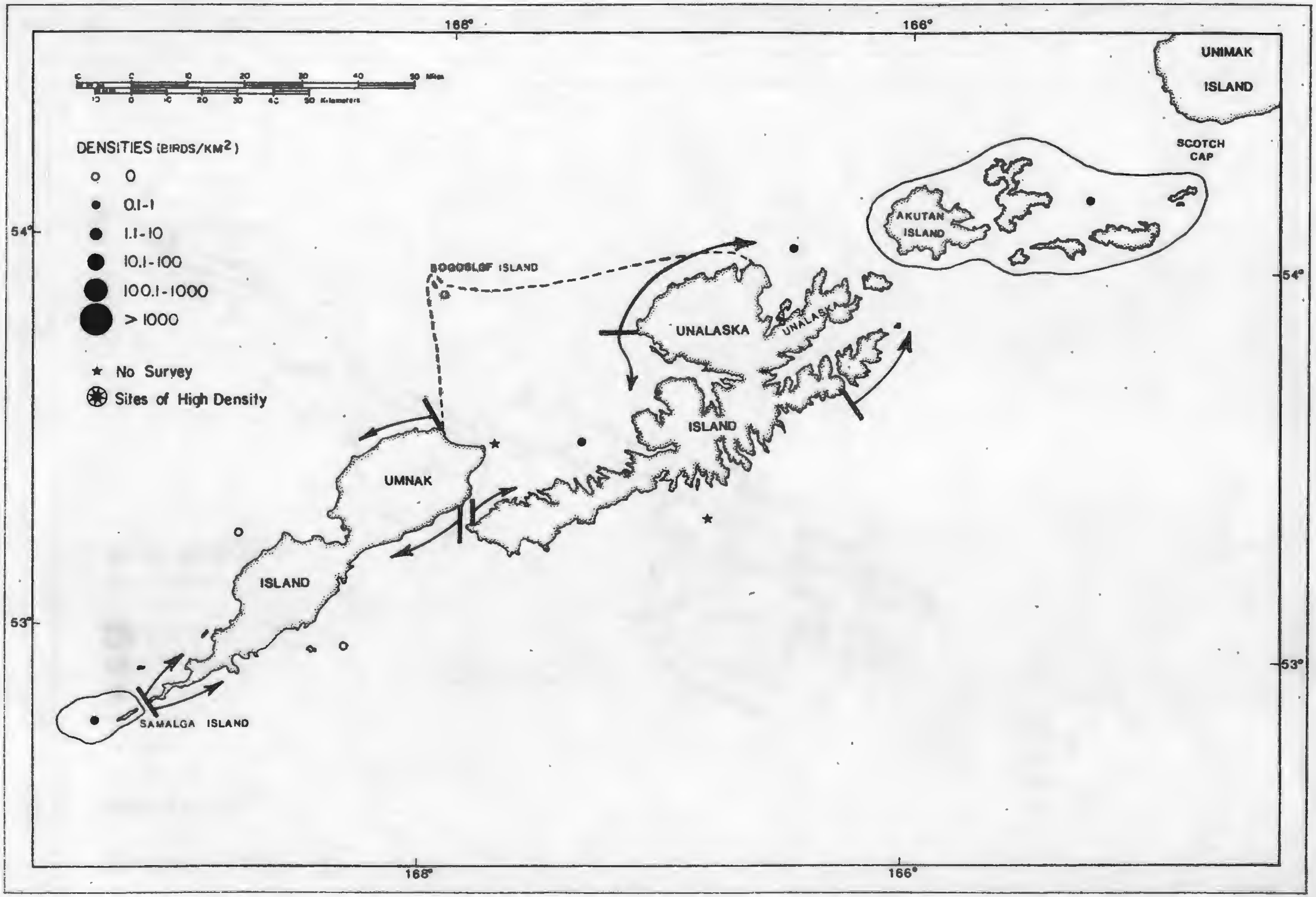


Fig. 160. Grebe density by section along the Aleutian Shelf during winter as determined by aerial survey.

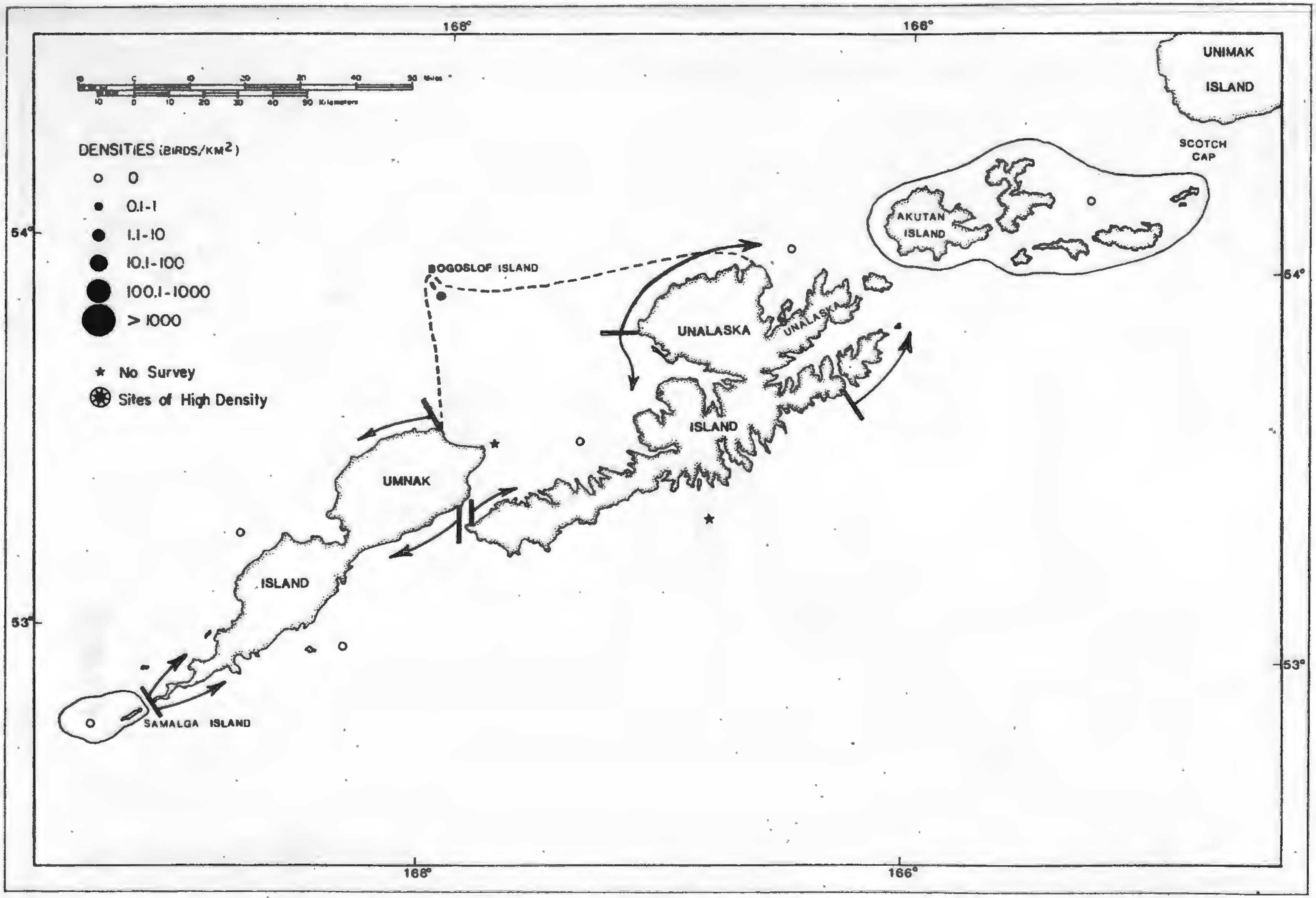


Fig. 161. Tubenose density by section along the Aleutian Shelf during winter as determined by aerial survey.

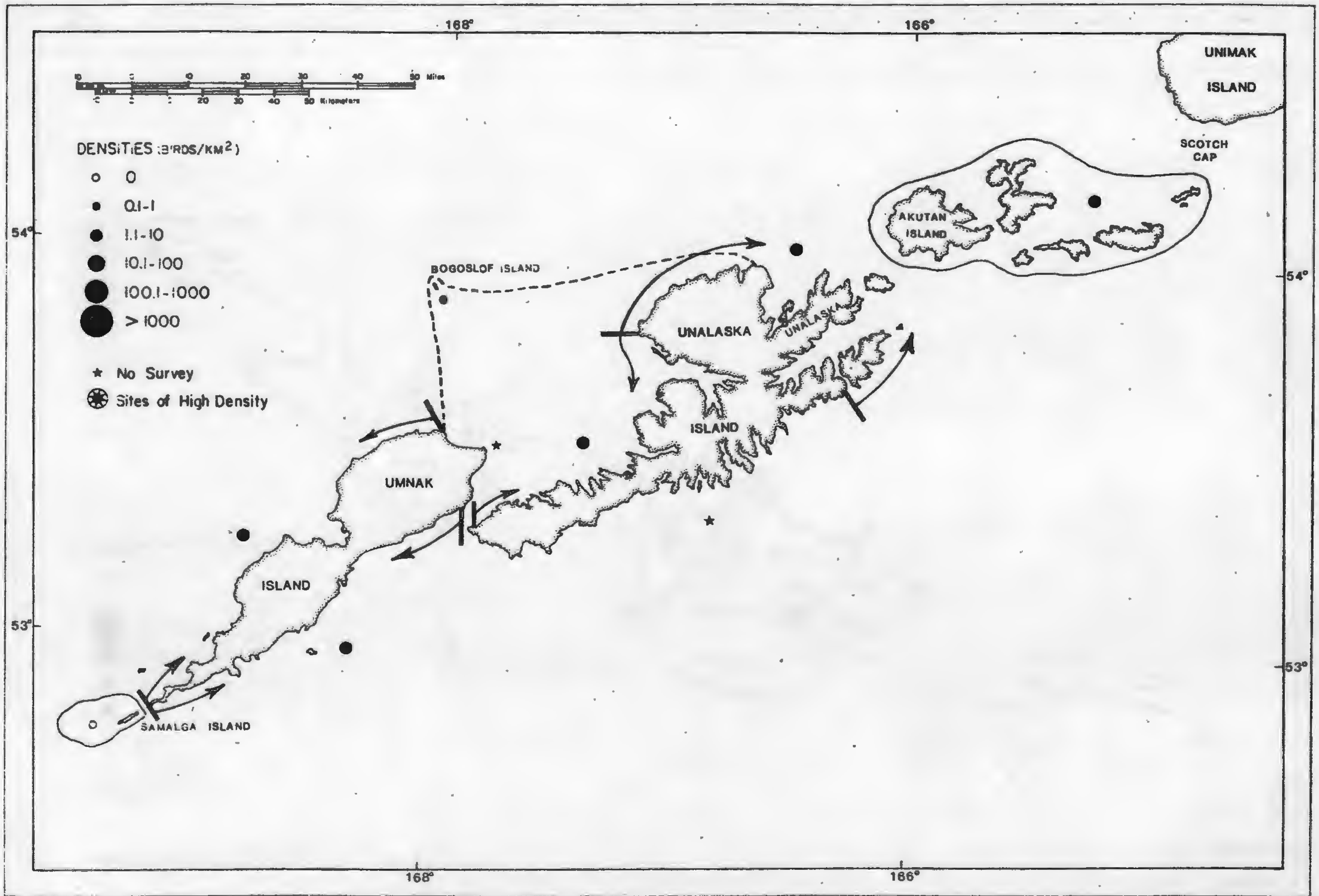


Fig. 162. Cormorant density by section along the Aleutian Shelf during winter as determined by aerial survey.

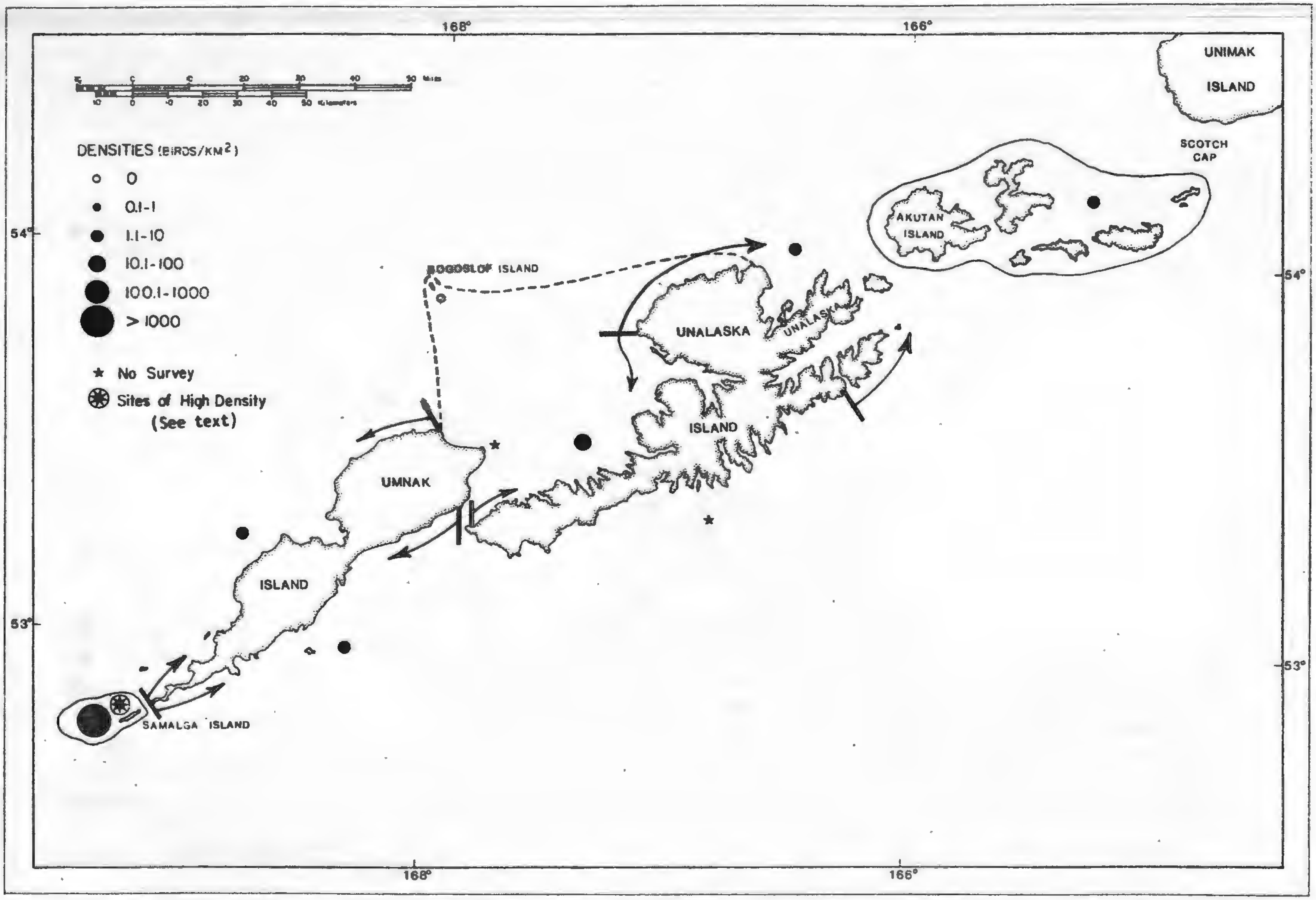


Fig. 163. Goose and swan density by section along the Aleutian Shelf during winter as determined by aerial survey.

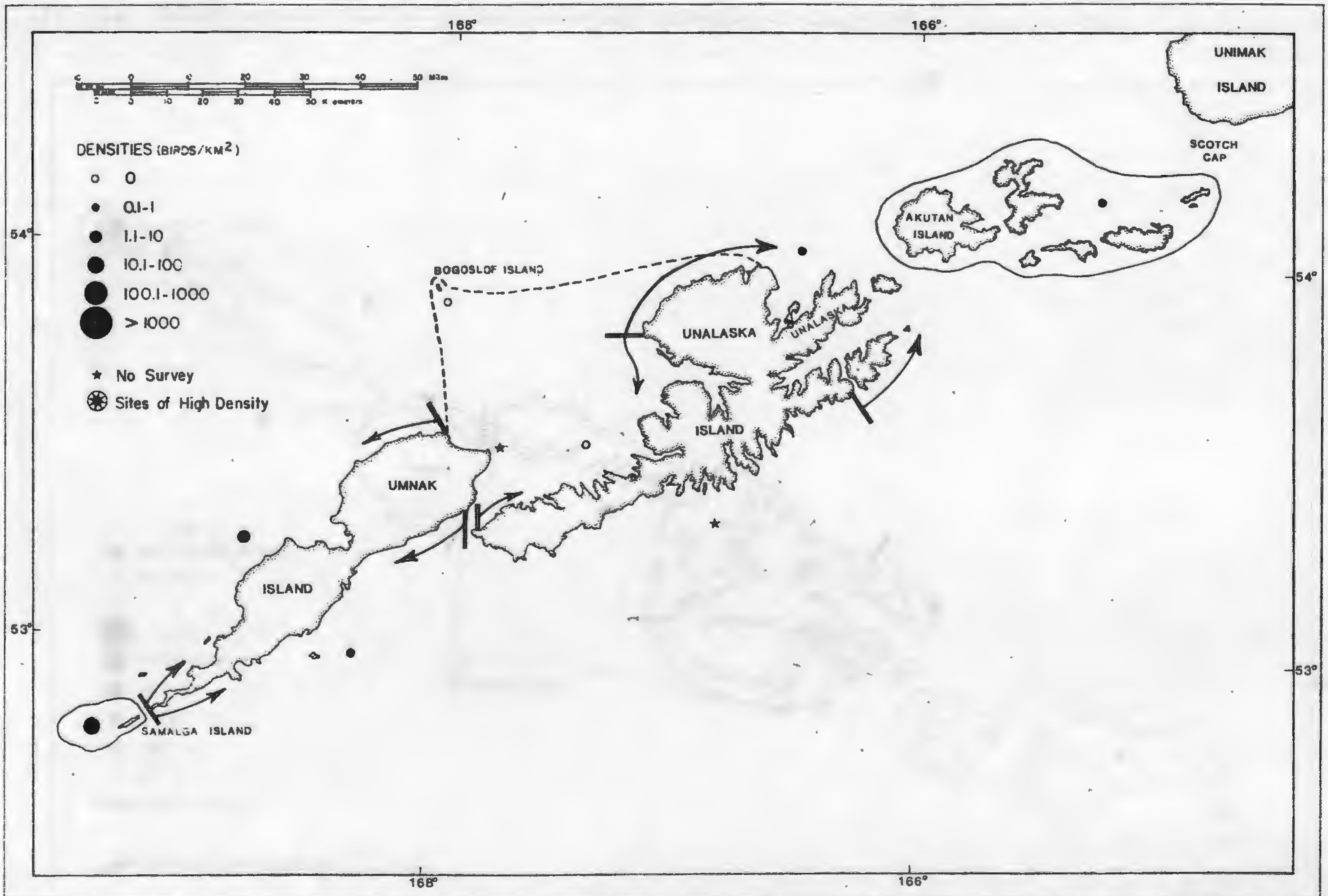


Fig. 164. Dabbling Duck density by section along the Aleutian Shelf during winter as determined by aerial survey.

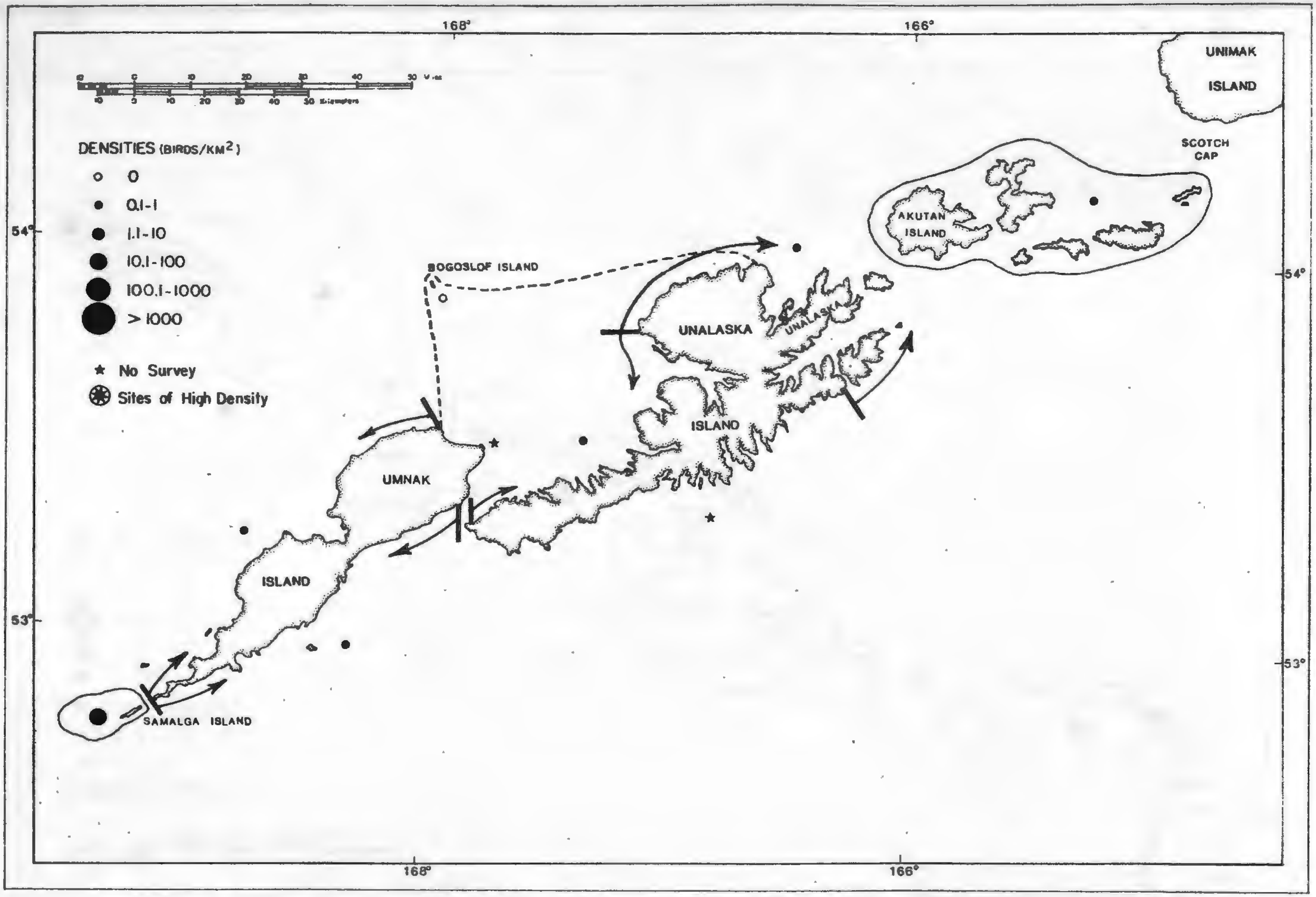


Fig. 165. Diving duck density by section along the Aleutian Shelf during winter as determined by aerial survey.

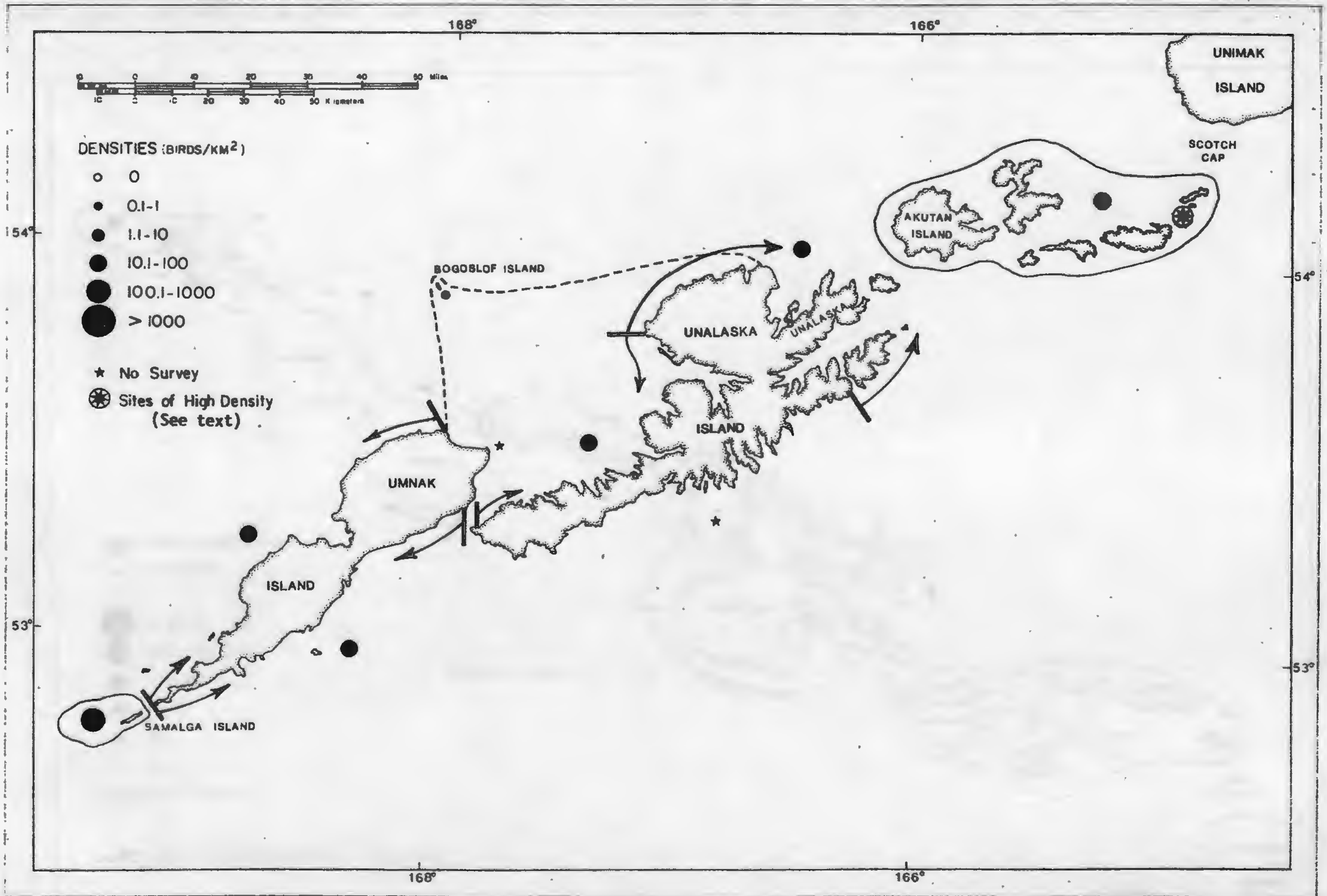


Fig. 166. Sea duck density by section along the Aleutian Shelf during winter as determined by aerial survey.

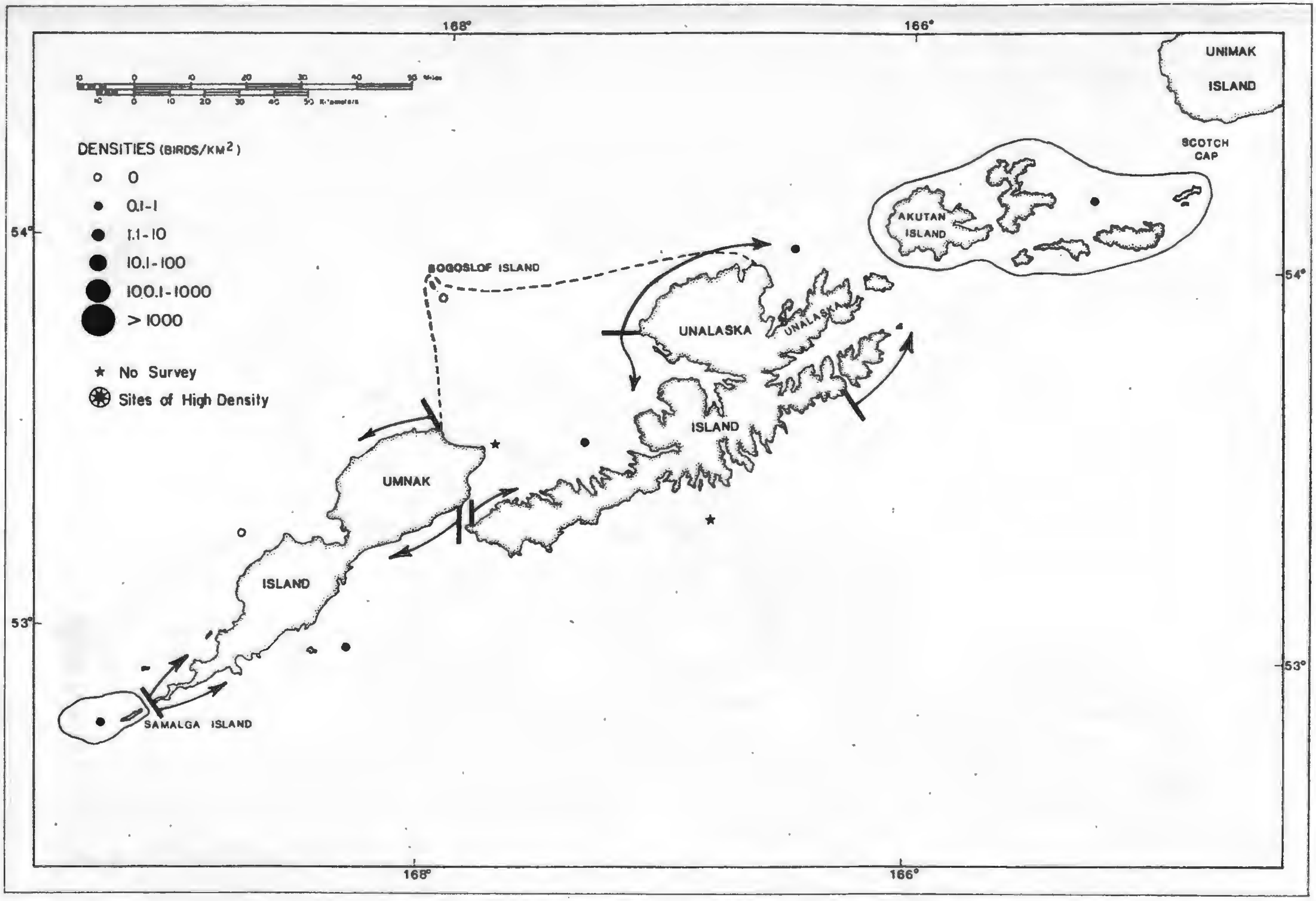


Fig. 167. Merganser density by section along the Aleutian Shelf during winter as determined by aerial survey.

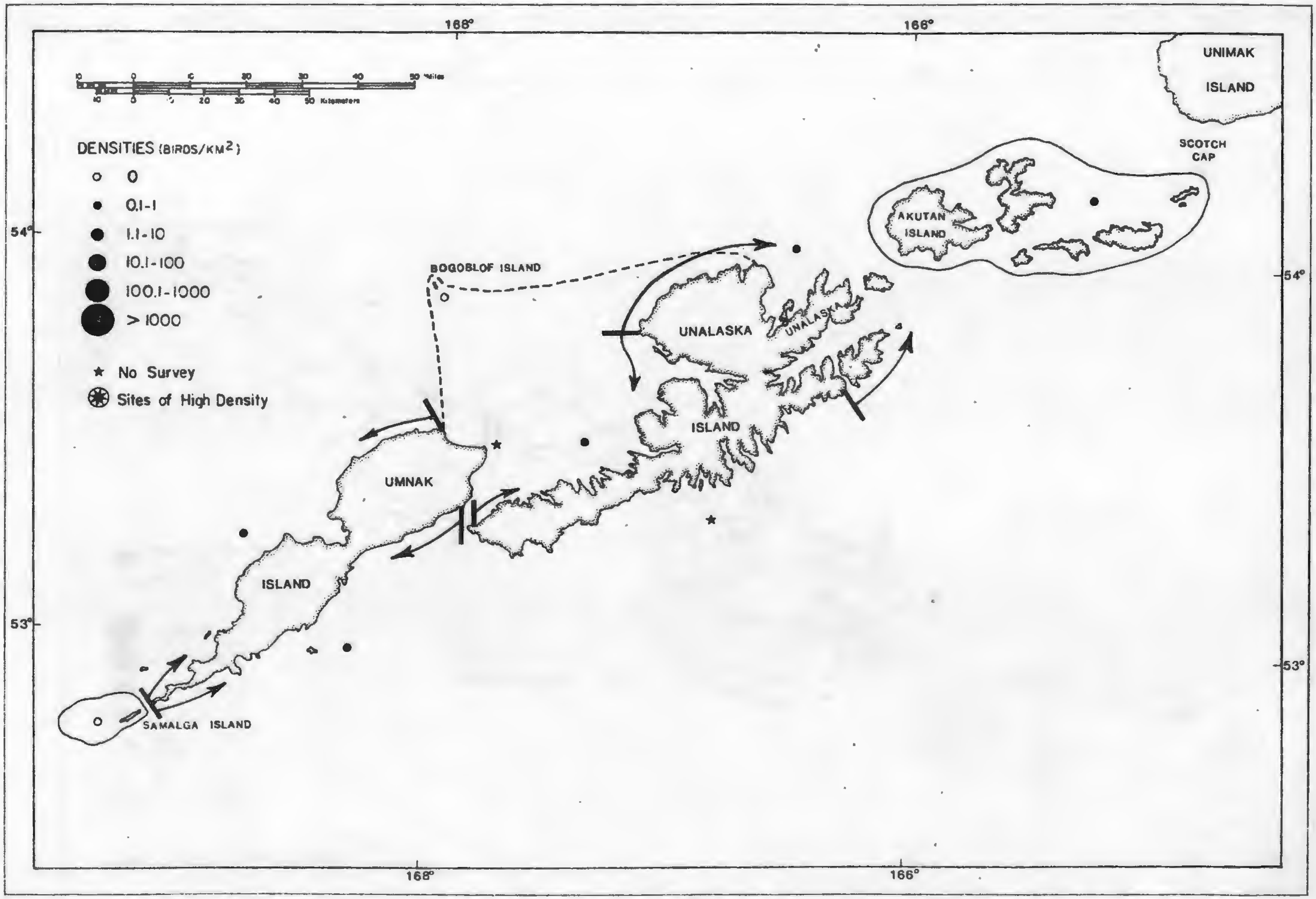


Fig. 168. Raptor density by section along the Aleutian Shelf during winter as determined by aerial survey.

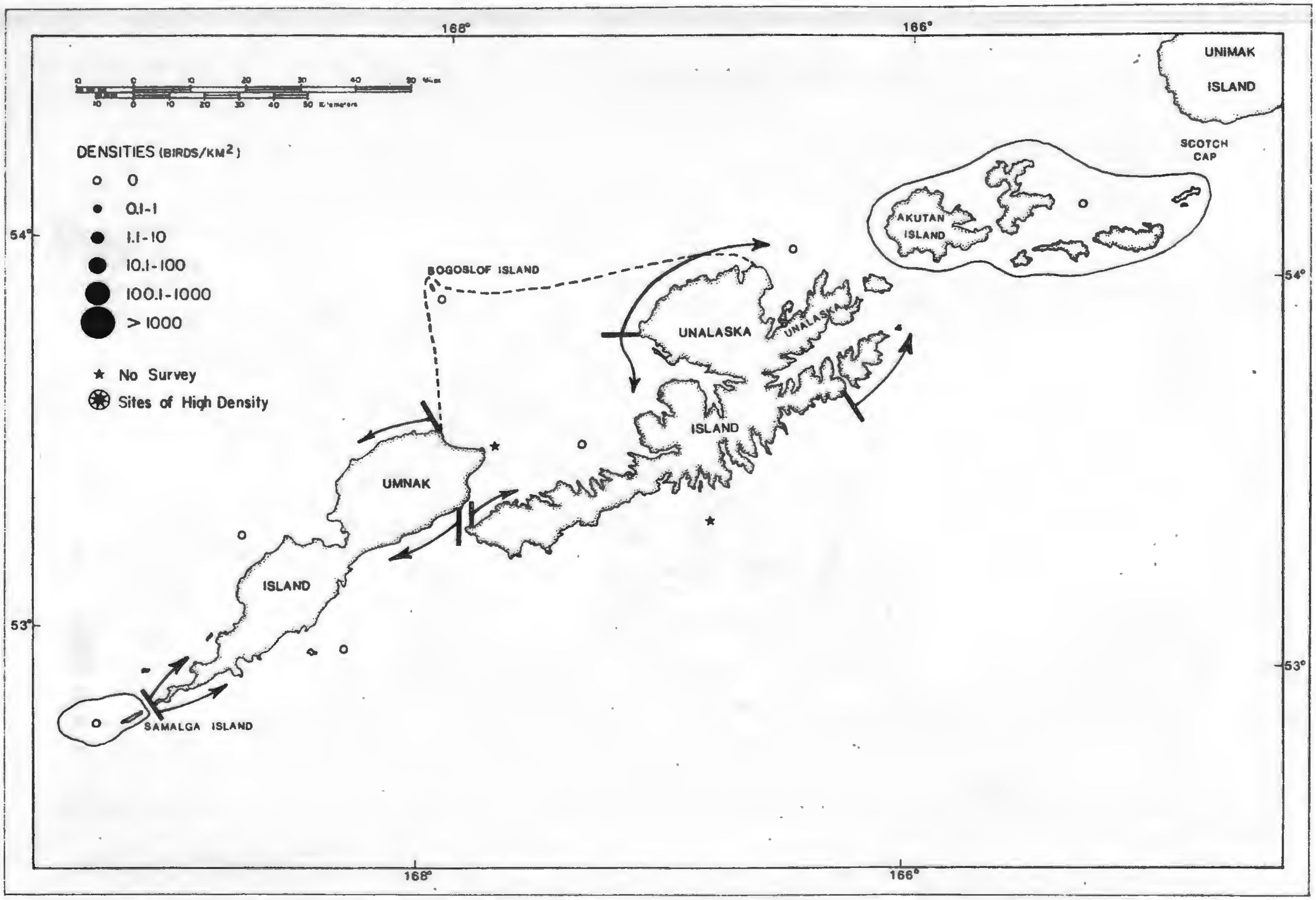


Fig. 169. Crane density by section along the Aleutian Shelf during winter as determined by aerial survey. No cranes were sighted.

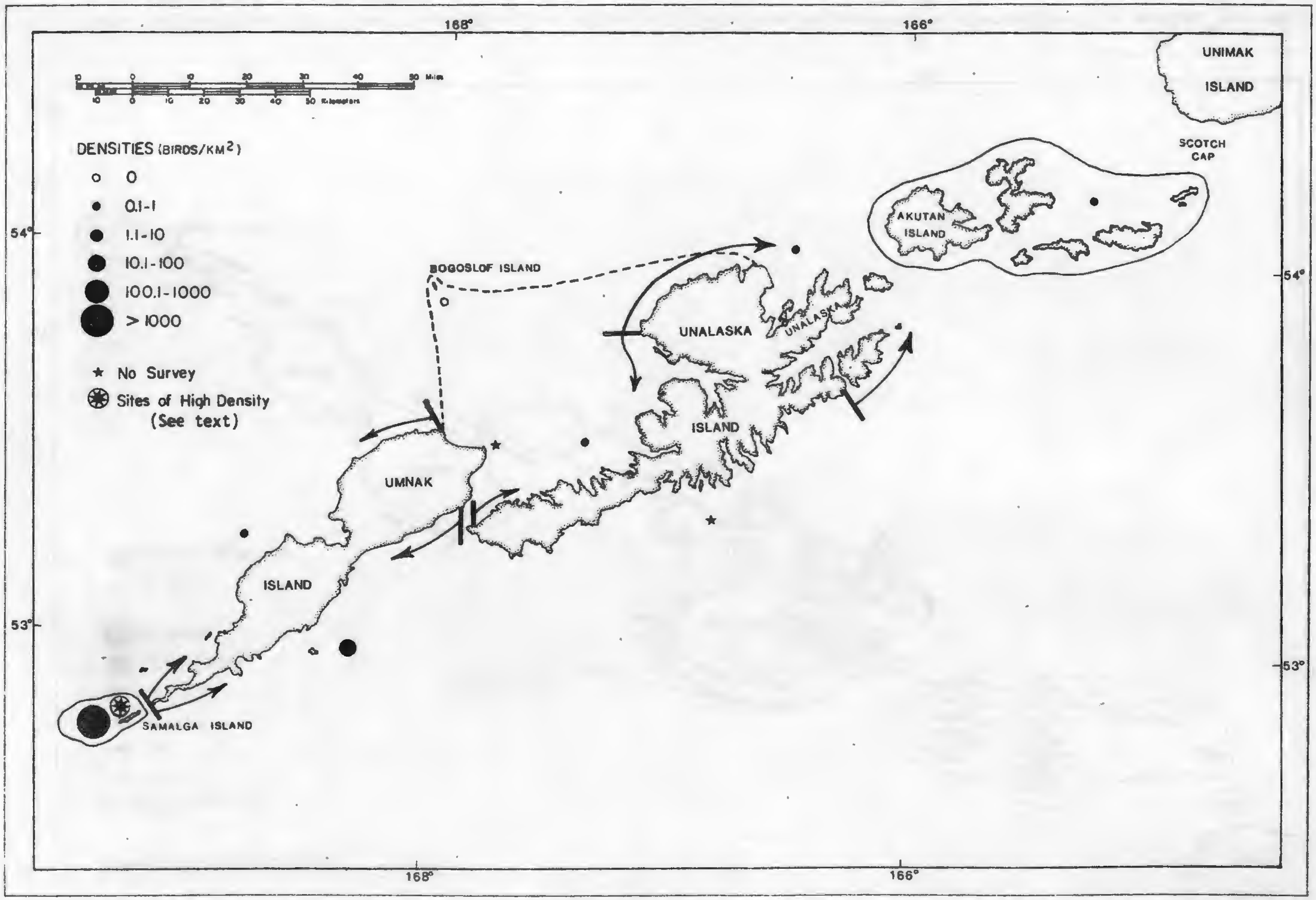


Fig. 170. Shorebird density by section along the Aleutian Shelf during winter as determined by aerial survey.

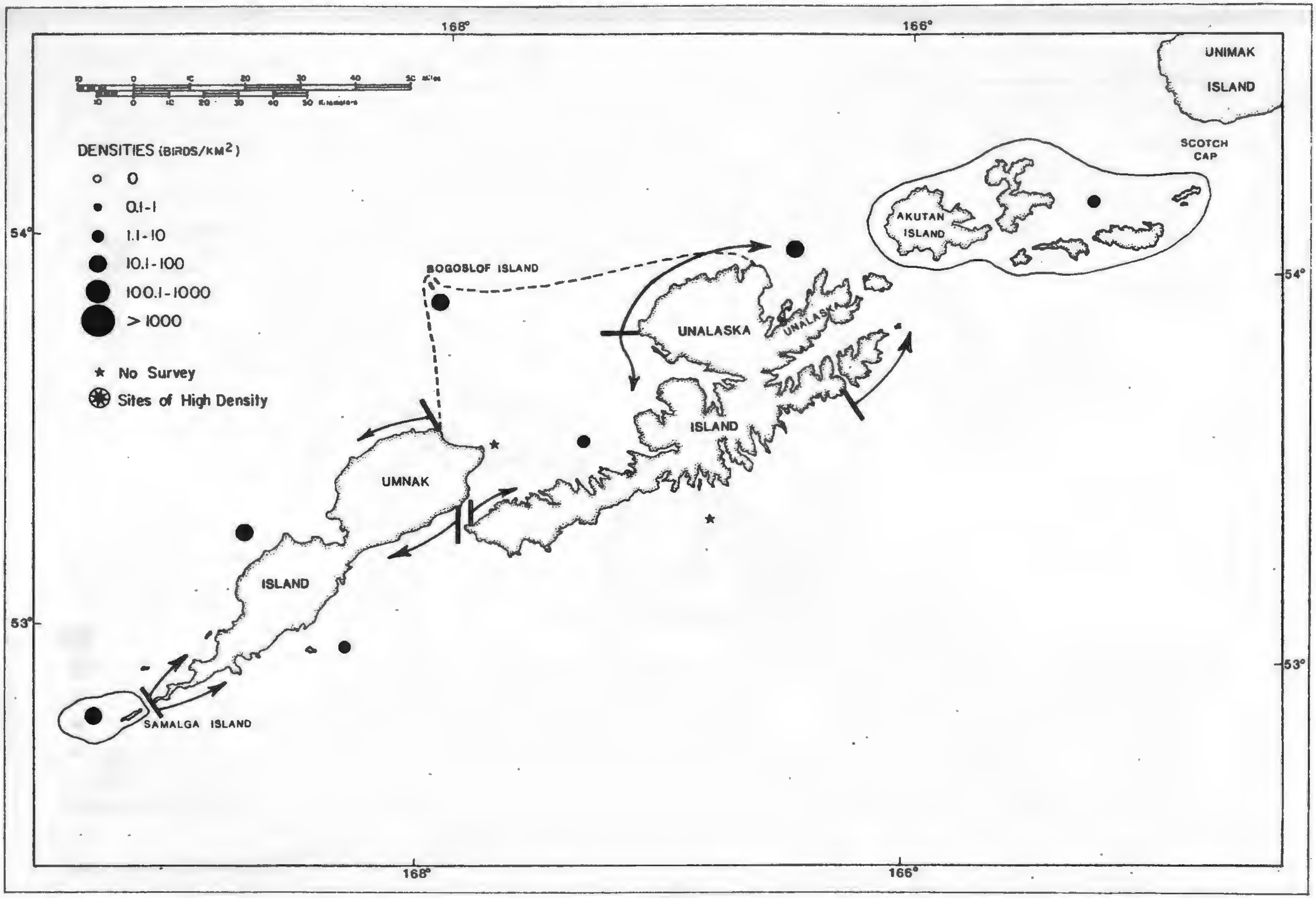


Fig. 171. Gull and jaeger density by section along the Aleutian Shelf during winter as determined by aerial survey.

Fig. 172. Tern density by section along the Aleutian Shelf during winter as determined by aerial survey. No terns were sighted.

Fig. 173. Alcid density by section along the Aleutian Shelf during winter as determined by aerial survey.

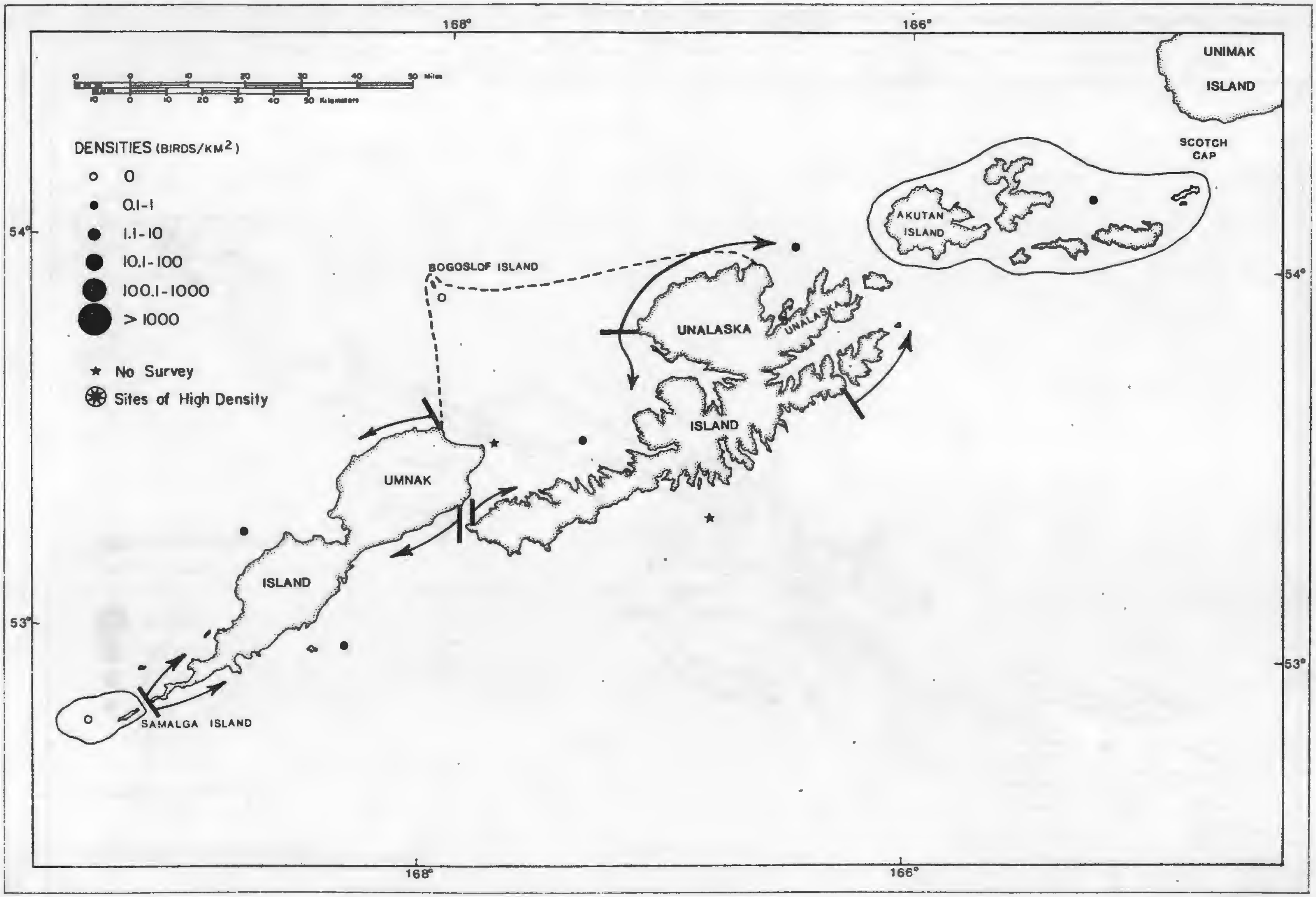


Fig. 174. Corvid density by section along the Aleutian Shelf during winter as determined by aerial survey.

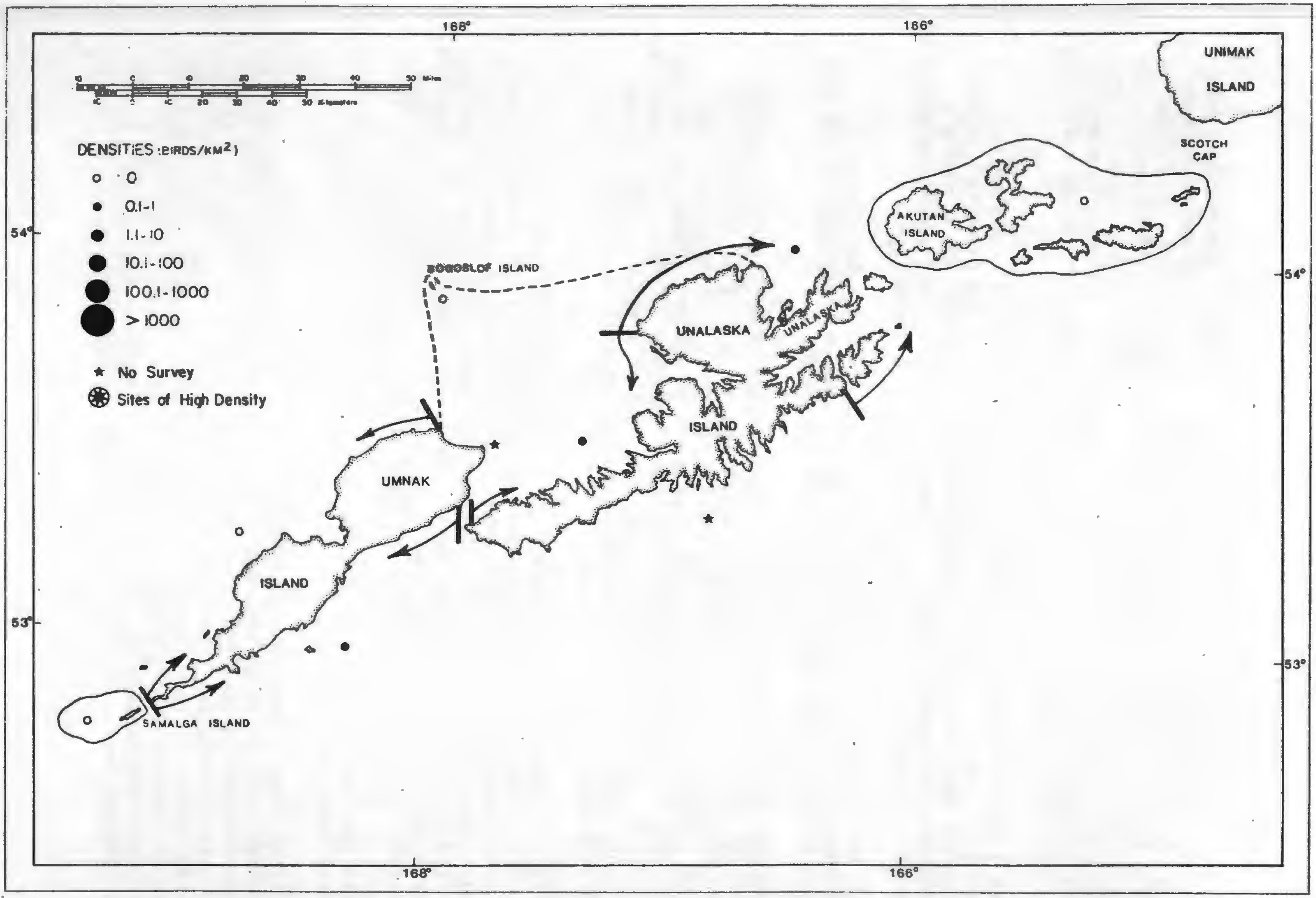


Fig. 175. Passerine (other than corvid) density by section along the Aleutian Shelf during winter as determined by aerial survey.

regions in the study was Samalga Island with 3240 birds/km^2. Over 8,000 birds were estimated in an area of 2.5 km^2. This was one-fifth of the birds in the entire survey. Samalga Island had the highest densities for all bird groups recorded in measurable amounts. Geese (all Emperors) were first with 1435 birds/km^2. Shorebirds numbered 1240 birds/km^2, sea ducks 416 birds/km^2, gulls 99 birds/km^2, dabblers (mostly mallards) 30 birds/km^2 and divers 20 birds/km^2. At the time of the survey an Arctic fox was observed on the island. Fox predation on birds may be a limiting factor to bird use of the island if foxes are abundant.

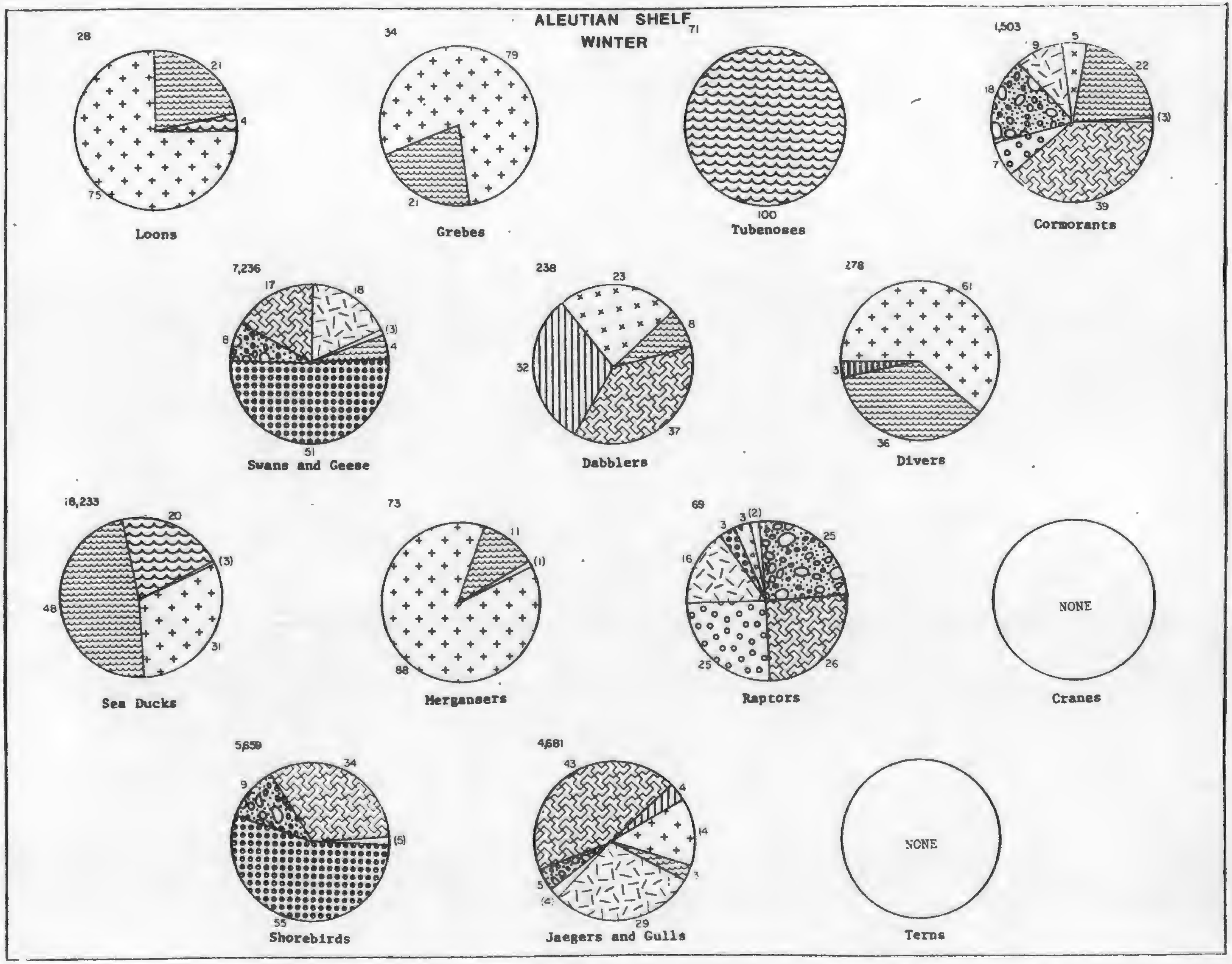
Two other sections had bird densities higher than 100 birds/km^2. Section 7, on the south side of Umnak Island, had 129 birds/km^2; most abundant were shorebirds (48 birds/km^2) and sea ducks (57 birds/km^2). Northwestern Unalaska Island (Section 3) had 51 sea ducks/km^2, 23 geese/km^2, 10 gulls and 10 alcids/km^2 out of a total of 103 birds/km^2.

The low density of 13 birds/km^2 was found on the Bogoslof Island - offshore section. Most birds were gulls; however, Northern Fulmars were also found in measurable quantities (1 bird/km^2).

Overall, sea ducks were the most abundant bird group with 43 birds/km^2. Samalga Island had the densest population, and the other sections all had similar densities from 30-57 birds/km^2 and a mean of 43 birds/km^2. Composition of sea ducks in the region was 49 percent eiders, 33 percent scoters, 10 percent Harlequin Ducks and 9 percent Oldsquaw. Of identified eiders 65 percent were King, 27 percent Steller's and 8 percent Common. Seventy-three percent of identified scoters were Black, 25 percent White-winged and 2 percent Surf.

Seventeen geese/km^2 were recorded in the Aleutian Shelf survey, all Emperor Geese. Of over 7,000 observed, one-half were on Samalga Island. Highest densities of shorebirds were found in Sections 6 and 7 with a mean density of 13 birds/km^2. Except for Samalga Island, gull densities varied from 7 to 14 birds/km^2 in all sections. The mean was 11 birds/km^2. Fewer alcids and cormorants were seen. Only 5 alcids/km^2 were recorded overall, and the greatest density (10 birds/km^2) was in Section 3. The majority of alcids were murres. The mean density for cormorants was 4 birds/km^2 and similar densities were found in all sections but No. 6 where none were sighted.

<u>Habitat Usage</u> - Habitat preferences of each species group and the particular species group found on each habitat type during the winter survey of the Aleutian Shelf region are shown in Figs. 176 and 177. Birds were found on only 11 habitats. There was not as much habitat diversity here as in other regions of the study area. Exposed habitats are more predominant in the Aleutian Shelf, and most birds (62%) were found in that type. Bays provided habitat for 28 percent of the birds, 9 percent were found in offshore waters and less than 1 percent in lagoons.


ALEUTIAN SHELF
WINTER
28
21
4
75
Loons
34
79
21
Grebes
71
100
Tubenoses
1,503
9
5
22
18
(3)
7
39
Cormorants
7,236
17
18
(3)
8
4
51
Swans and Geese
238
23
8
32
37
Dabblers
278
61
3
36
Divers
18,233
20
(3)
48
31
Sea Ducks
73
11
(1)
88
Mergansers
69
3
3
(2)
25
16
25
26
Raptors
NONE
Cranes
5,659
34
9
(5)
55
Shorebirds
4,681
43
4
14
3
5
(4)
29
Jaegers and Gulls
NONE
Terns

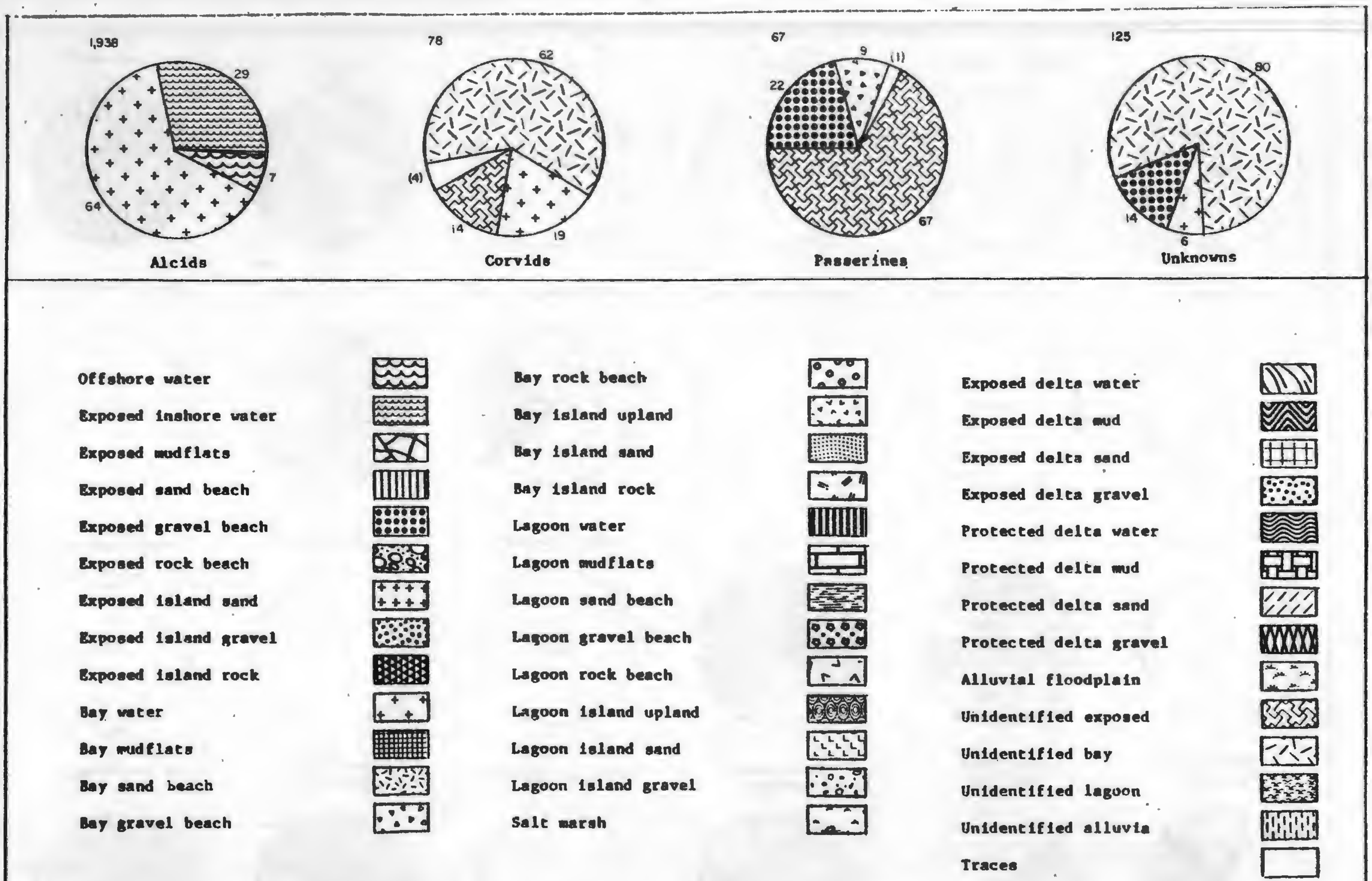
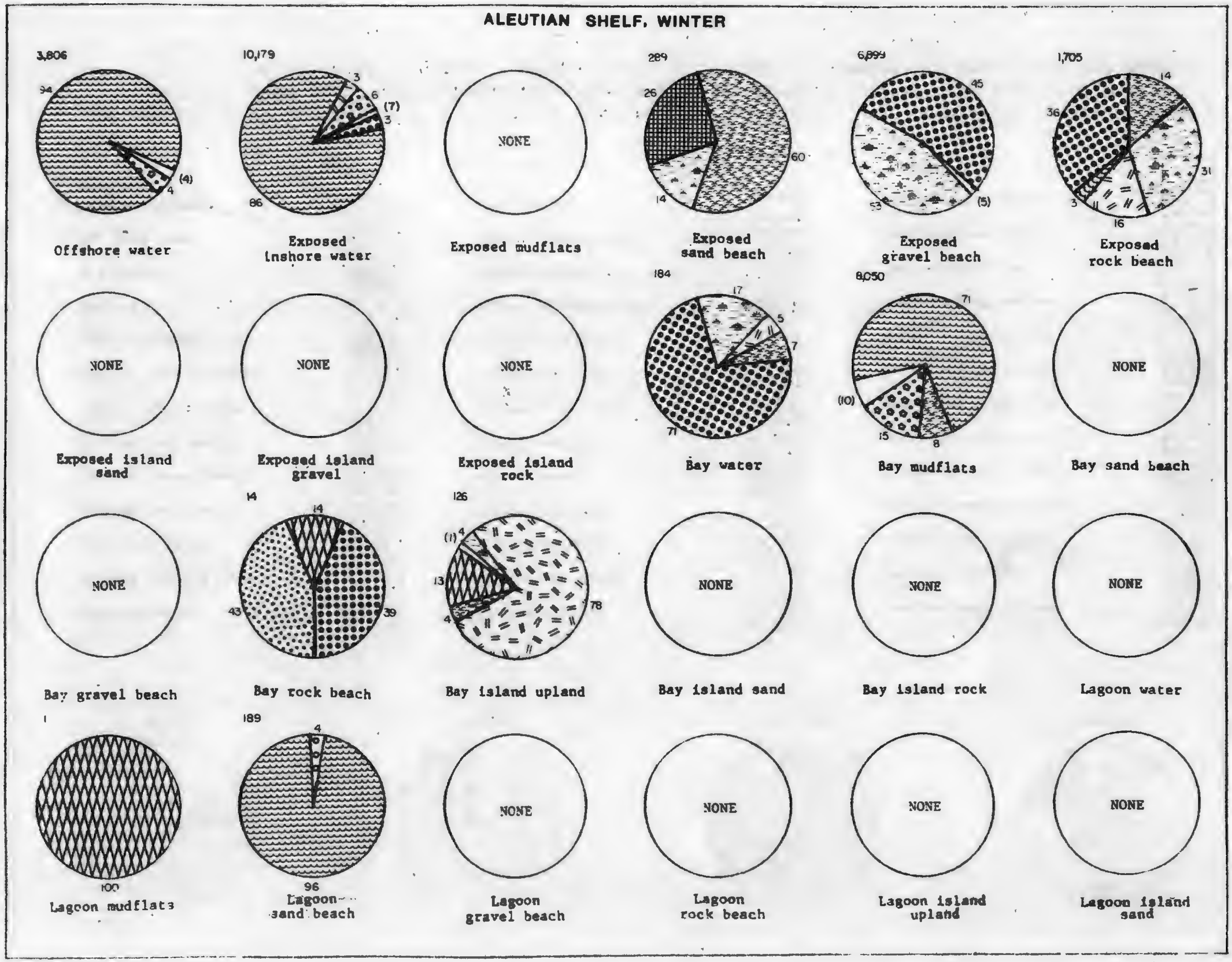


Fig. 176. Aleutian Shelf, Winter 1977. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


ALEUTIAN SHELF, WINTER
3,806
94
(4)
4
86
Offshore water
10,179
3
6
(7)
3
Exposed inshore water
NONE
Exposed mudflats
289
26
60
14
Exposed sand beach
6,899
45
53
(5)
Exposed gravel beach
1,705
14
36
31
3
16
Exposed rock beach
NONE
Exposed island sand
NONE
Exposed island gravel
NONE
Exposed island rock
184
17
5
7
71
Bay water
8,050
71
(10)
15
8
Bay mudflats
NONE
Bay sand beach
NONE
Bay gravel beach
14
14
43
39
Bay rock beach
126
(1)
4
13
4
78
Bay island upland
NONE
Bay island sand
NONE
Bay island rock
NONE
Lagoon water
1
100
Lagoon mudflats
189
4
96
Lagoon sand beach
NONE
Lagoon gravel beach
NONE
Lagoon rock beach
NONE
Lagoon island upland
NONE
Lagoon island sand

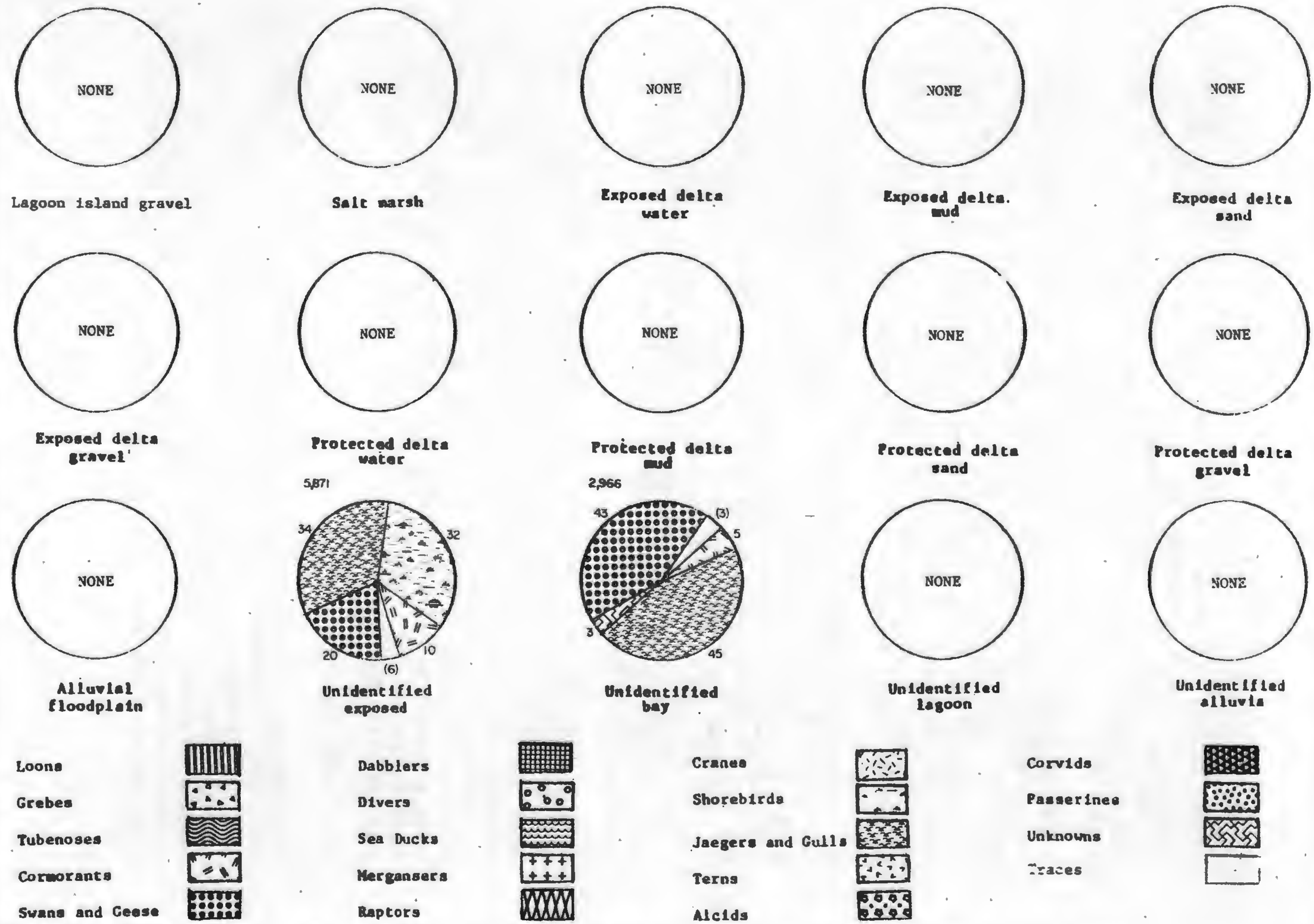


Fig. 177. Aleutian Shelf, Winter 1977. Marine bird usage of habitats as determined by aerial survey. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

One-fourth of the birds were on exposed inshore water habitat and sea ducks were the most abundant bird on that habitat. Eighty-six percent of the birds on exposed waters were sea ducks, 6 percent were alcids and 3 percent each were cormorants and geese. Bay waters contained 20 percent of the birds and again sea ducks were the most abundant (71%) bird group on the habitat. Others included alcids (15%), gulls (8%) and divers (2%).

Seventeen percent of the birds used exposed gravel beaches. Emperor geese and shorebirds comprised 53 and 45 percent of the birds on this habitat. On pelagic transects between islands, offshore waters were searched, and 9 percent of the birds were found on this habitat. Over 90 percent of the birds found were sea ducks, 4 percent were alcids and 1 percent tubenoses. Exposed rock beach was used by 4 percent of the birds and four species groups were most commonly found on it. These were geese (36%), shorebirds (31%), cormorants (16%) and gulls (14%).

The species group most frequently observed was sea ducks (45% of total) and they were primarily found on three habitats, exposed inshore water (48%), bay water (31%) and offshore water (20%). Over one-half the Emperor Geese, which were second in abundance with 18 percent of the total, were found on an exposed gravel beach. Most of the remainder had flushed from unspecified habitats in bays and along exposed habitats. Of the over 5,600 shorebirds observed on the survey, 55 percent used exposed gravel beaches, 34 percent were on unspecified exposed habitats and 9 percent on exposed rock beach. Only 1 percent were found in protected habitats.

Gull distribution was almost evenly divided between exposed and protected habitats. Fifty-seven percent were dispersed among all exposed habitats used by birds in the region on the winter survey. The remaining 43 percent were on bay habitats but most observations were not specified as to habitat type. Alcids were found on three habitats, bay water (64%), exposed inshore water (29%) and offshore water (7%). Over 1,500 cormorants were recorded, and they most frequently were found on exposed habitats. Only 21 percent were on bay habitats. As in other lease areas, rock was the preferred substrate of cormorants when they were not on the water.

VII. DISCUSSION

Bird Density - Although 33 bird surveys were conducted in this study and many birds were recorded, sample sizes were not large enough and surveys not uniform enough to statistically compare bird densities among regions, among different seasons within regions, or between the same seasons within regions. Nevertheless, obvious differences in bird densities existed between regions (Table 20), these can be interpreted and within the limits of the survey technique and compared to data gathered by others.

Table 20. Comparison of marine birds densities among regions in southcentral Alaska, by season. Data are based on aerial and boat surveys; survey trackline included both shoreline and pelagic areas. Values in Birds/km^2; T = trace, p = pelagic survey.

Region / Season / Species Grouping	NEGOA		KOD.	LOWER COOK INLET								S. AK. PEN.		N. AK. PEN.				N. BR. BAY		AL. AH.
	Sp	Su	Wn	Sp	Sp-p	Su	Su-p	Fa	Fa-p	Wn	Wn-p	Fa	Wn	Sp	Su-p	Fa	Wn	Sp	Su-p	Wn
Loons	1	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	1	T	T
Grebes	T	0	T	T	T	T	0	T	T	T	0	T	T	T	0	T	T	T	0	T
Tubenoses	0	0	0	0	T	1	2	T	1	0	T	0	T	0	402	T	0	0	0	T
Cormorants	1	1	1	T	T	3	T	3	T	1	T	3	3	T	T	1	T	2	15	4
Geese & Swans	2	0	T	7	0	T	0	3	0	T	0	227	3	60	0	268	3	7	0	17
Dabblers	7	0	4	15	T	3	0	15	T	2	0	14	T	11	0	23	T	9	0	1
Divers	7	0	5	23	T	1	0	1	T	4	0	4	1	2	0	1	T	12	0	1
Sea Ducks	9	49	20	38	12	38	17	14	3	15	3	10	18	26	1	97	33	10	10	43
Mergansers	1	0	T	1	T	T	T	T	0	T	0	T	T	1	0	T	T	1	0	T
Raptors	T	T	T	T	T	T	0	T	0	T	0	T	T	T	0	T	T	T	0	T
Cranes	T	0	0	T	0	T	0	0	0	0	0	0	0	T	0	0	0	T	0	0
Shorebirds	67	7	2	53	T	3	T	2	T	5	T	1	2	9	T	41	T	21	T	13
Gulls and Jaegers	45	284	2	52	2	70	4	26	2	3	1	17	9	31	16	19	13	13	6	11
Terns	7	32	0	T	T	T	T	0	0	0	0	0	0	1	T	T	0	1	T	0
Alcids	4	0	3	1	2	10	3	T	2	T	1	T	29	T	12	T	2	8	103	5
Corvids	T	T	1	T	0	T	0	1	0	1	0	T	T	T	0	T	T	T	0	T
Other Passerines	T	0	T	T	0	T	T	T	0	T	0	T	T	T	0	1	T	T	0	T
Other Birds	T	0	T	1	T	T	T	T	T	T	T	1	T	T	0	1	0	1	0	T
Total:	151	373	39	192	17	130	26	66	9	32	5	279	67	141	432	453	53	86	134	94

SPRING

Of four regions surveyed in spring, Lower Cook Inlet (LCI) supported the highest mean bird density (192 birds/km^2) and North-Bristol Bay (N-BB) the lowest (86 birds/km^2). Northeast Gulf of Alaska (NEGOA) and North-Alaska Peninsula (N-AP) had densities intermediate to the extremes (151 and 141 birds/km^2, respectively). Bird migration in spring generally follows similar patterns from year to year. It begins in April and lasts into June depending upon the species, the prevailing weather, and to a certain extent, the birds' age (non-breeding immature versus breeding adult). The only surveys conducted in April for this study were in LCI. All other spring surveys were in May. The high density for LCI may partially be a result of combining April and May surveys and, therefore, combining migration periods for more species of birds. There may be several reasons why observed bird densities in N-BB were realtively low. Many supratidal bird habitats were still frozen in early May (particularly in 1977), and habitat was not available to some birds. In addition N-BB is so close to prime staging areas farther south that birds migrating to the Yukon-Kuskokwim Delta and farther north do not require a stop to build fat reserves to reach nesting or more suitable staging habitat; or quantities of suitable staging habitat are not sufficient to stop large numbers of birds.

In spring, loons were found in large numbers (over 500) and in measurable densities (1 bird/km^2) only in NEGOA and N-BB. In both cases, these were mostly Red-throated and Arctic Loons. Grebes were never observed in abundance. I'm certain more were present, but were not recorded, because they dove at the approach of aircraft so were not counted. Goose densities were quite high (60 birds/km^2) in N-AP and quite low (2 birds/km^2) in NEGOA. Estuaries on N-AP are a major staging area for migrating Brant, Emperor and Canada Geese. They spend several weeks there before more northern areas open up in spring. It is not known how extensively estuaries in southern NEGOA are used in spring. Geese may continue up the coast to Controller Bay, Copper River Delta or areas farther north and west unless inclement weather stops them. Large numbers could then use areas like Dry Bay until improved weather permitted further migration. Most geese and dabblers migrate through NEGOA in the last half of April; therefore our May survey missed the peak of goose and dabbler migration. Because recorded densities were low, we could not determine which areas in NEGOA are used extensively by those bird groups.

We recorded substantially higher densities of sea ducks, divers and dabblers (38, 23 and 15 birds/km^2) in LCI than other regions in spring. This may be the result of the fact that more spring surveys were conducted in LCI, and the surveys covered a broader spectrum of the migration. However, LCI may serve as a crossroads for birds migrating overland to the north and those continuing along the ocean route for the Alaska Peninsula. Areas in Kachemak and Kamishak Bays provided ideal rest habitat for migrating diving and sea ducks.

Mergansers were recorded more frequently in spring. Densities of 1 merganser/km^2 were seen in each of the four regions in spring, the only season when measurable quantities were observed. Cranes were observed in trace amounts in all four regions. Most migrate on inland routes or overfly the coastal regions in spring.

Shorebird populations were densest in NEGOA and LCI (67 and 53 birds/km^2, respectively and least dense in N-BB and N-AP, 21 and 9 birds/km^2. Although all spring surveys were timed to coincide with shorebird migration, there were great differences in densities among regions. The logical interpretation is that shorebirds use the known migration corridor along the coast to major staging areas in Copper and Bering River Deltas. Some species, particularly Western Sandpipers, make a second stop in LCI. From there migration must proceed north and northwest to the Yukon-Kuskokwim Delta and beyond so that few shorebirds use the Alaska Peninsula for staging and only a part of the shorebird population uses N-BB. Some shorebirds using transoceanic routes do use estuaries in N-AP in spring.

Gull densities were relatively high (31-52 birds/km^2) in all regions in spring except N-BB where only 13 gulls/km^2 were found. However, if birds near colonies had been counted and the Walrus Islands had been surveyed, the gull density for N-BB would likely have been more comparable to other regions. Terns were most dense in NEGOA (7 birds/km^2) possibly because they are more concentrated along that coastline and disperse as they reach other parts of southcentral Alaska. North-Bristol Bay had the most dense alcid population, but this region also has the largest alcid breeding population of the four regions.

SUMMER

The only complete shoreline survey in summer was in LCI. In NEGOA there was only a partial survey and, therefore, data cannot be realistically compared. In both cases gulls and sea ducks were the most abundant bird groups. Many non-breeding scoters are found in both areas in summer. Gulls nest in large numbers in both areas, but most of the gulls observed in NEGOA were on beaches some distance from any colony. These were likely non-breeding birds that fed in the area and were counted while roosting on the beaches. Terns were abundant in NEGOA and uncommon in LCI. During over 2 months of on-the-ground or water survey work in Kamishak Bay only two terns were sighted. Apparently suitable habitat for terns is present only in the northern portion.

The only other study with comparable nearshore summer surveys for birds in southcentral Alaska was Dwyer et al. (1976). They found a mean density of 30 birds/km^2 in open water of Prince William Sound and a linear density of 70 birds/km^2 in shoreline habitats. Black-legged Kittiwakes, Marbled Murrelets, and Glaucous-winged Gulls were the most abundant species in open water. The same species and, additionally, Surf Scoters were abundant in shoreline habitats.

Summer pelagic survey techniques for this study differed enough so that comparisons between regions are not feasible. In LCI both boat and aerial surveys were conducted. Only 26 birds/km^2 were observed, and most of that number (17 birds/km^2) were sea ducks. Boat surveys were conducted between islands of the Walrus Islands in N-BB, and there alcids (murres) were the most abundant (103 birds/km^2). The mean density in that region was 134 birds/km^2. The summer aerial surveys in N-AP coincided with shearwater presence in the area and over 400 birds/km^2 were recorded. Most of these were shearwaters.

FALL

Three regions were surveyed in fall, two thoroughly, N-AP and LCI and one partially, South-Alaska Peninsula (S-AP). Mean densities were: 453 birds/km^2, N-AP; 279 birds/km^2, S-AP; and 66 birds/km^2, LCI. The N-AP fall density was the highest for all seasons in all regions. Estuaries along the Peninsula are prime staging habitat for migrating marine birds (particularly geese). Mean densities for four bird groups were highest in N-AP: geese 268 birds/km^2, sea ducks 97 birds/km^2, shorebirds 41 birds/km^2 and dabbling ducks 23 birds/km^2.

Geese in S-AP were nearly as abundant as in N-AP but only the southern three sections were surveyed. These sections are adjacent to Izembek Lagoon and Bechevin Bay and all contain eelgrass beds that are attractive to several waterfowl species. Geese primarily concentrated in three areas (Kinzarof, Thin Point/Old Man's and Big Lagoons) in S-AP and had a mean density of 227 bird/km^2. Brant, Emperor and Canada Geese were the major species. LCI supported densities of only 3 geese/km^2 in fall and most of those were found in Tuxedni Bay. Brant and Emperor Geese were not found in LCI in fall.

Gulls were the only birds that occurred in higher densities in LCI than in the other regions and the margin of difference was not great. There were 26 gulls/km^2 in LCI, 19 in N-AP and 17 in S-AP. In LCI there was a decrease in overall bird density from 192 birds/km^2 in spring and 130 birds/km^2 in summer to 66 birds/km^2 in fall. Major decreases resulted from the departure of sea ducks, gulls and alcids from the region.

Shorebirds were much more abundant in N-AP than in LCI or S-AP in fall (41 vs 2 and 1 birds/km^2, respectively). Certain species (e.g. Dunlin) likely build sufficient fat stores on N-AP estuaries in fall to enable them to bypass staging areas in LCI (Gill 1978). These same N-AP staging areas were used much less in spring by shorebirds than they were in fall (9 vs 41 birds/km^2).

The only other nearshore survey in southcentral Alaska to determine bird densities in fall was by King and McKnight (1969) in Bristol Bay. Their technique was to fly a saw-tooth pattern along the coast out to 19 km from shore. Most of their observations were in offshore waters but 80 percent of the birds were within 10 km of shore. They reported 124 birds/km^2, almost one-half of those were scoters.

WINTER

Winter shoreline bird densities were relatively high in Aleutian Shelf (AlSh) (94 birds/km^2), intermediate in S-AP (67 birds/km^2) and N-AP (53 birds/km^2) and low in Kodiak (39 birds/km^2) and LCI (32 birds/km^2). Although survey conditions were poor during the AlSh survey, many birds were recorded, particularly sea ducks (43 birds/km^2), Emperor Geese (17 birds/km^2), shorebirds (13 birds/km^2) and gulls (11 birds/km^2).

Sea ducks were the most abundant wintering bird recorded in all regions except S-AP, and in that area the survey technique utilized likely made alcids appear more dense than sea ducks even though they weren't. Predominantly offshore islands were flown in S-AP where many alcid colonies were located. Eiders were the most numerous sea duck in the two Bering Sea regions and scoters predominated in the three Gulf of Alaska regions. Diving and dabbling ducks were most dense in Kodiak and LCI while geese (Emperor's) prevailed in the three western regions.

Wintering shorebirds were found in all regions, the most (13 birds/km^2) in AlSh and the least (trace) in N-AP. Estuaries in N-AP were not searched in winter, and shorebirds may have been found there. However, shorebirds often use rocky habitats in winter and little of that habitat is present in N-AP. Presumably, Rock Sandpipers were the major wintering shorebird. Shorebirds were one bird group that was difficult to observe unless they flushed and, therefore, it was likely that many more were present than were actually recorded.

Gulls were the second most abundant wintering bird, but densities were greatly reduced from those in other seasons. As Black-legged Kittiwakes and other gulls moved offshore to winter, shoreline gull densities were reduced to as low as 2 birds/km^2 in Kodiak and a high of 13 birds/km^2 in N-AP. The low number in Kodiak was surprising. On the east coast of the United States, Kadlec and Drury (1968) found that Herring Gulls concentrated at major food sources near cities or at fishing ports. Perhaps on Kodiak most gulls were concentrated in or near the town of Kodiak and because we did not have a count unit there, our counts were low. Trapp (1977) found over 2,000 gulls in a total of 259 km^2 (8 gulls/km^2) in his survey in 1977, whereas we found about 1,800 gulls in 857 km^2 in 1976. However, we surveyed the entire Archipelago and Trapp (1977) only surveyed Kodiak Island. We found low gull densities on Afognak-Shuyak Islands. The 8,600 gulls recorded on N-AP were scattered all along the exposed sand beaches. Localized food sources such as the canneries in Kodiak are not found in N-AP, and the gulls were dispersed for feeding in winter. The net result of this may be a lower survival rate as suggested by Drury (1979) for the N-AP gulls.

The recorded high alcid density in S-AP was an aberration resulting from the survey type used, and the extremely low density (trace) in LCI can be explained similarly. Alcids were observed on the offshore transects in S-AP but not on shoreline counts of LCI because most were farther offshore. Few were seen on the west side of LCI but many alcids including murres, murrelets and Pigeon Guillemots were found in outer Kachemak Bay.

Corvids had measurable densities (1 bird/km^2) only in the two regions where Northwestern Crows were common (Kodiak and LCI). As corvids left spring and summer nesting areas, they became more abundant as scavengers along coastal beaches in fall and winter.

In other winter surveys in southcentral Alaska, techniques differed and results were not directly comparable to this study. From a boat, Dwyer et al. (1976) determined a linear density of 40 birds/km^2 along the shoreline and an offshore density of 20 birds/km^2 in Prince William Sound. Sea ducks, gulls and cormorants were the most abundant bird groups on the shoreline, and sea ducks, gulls and alcids predominated in open water. Trapp (1977) found 101 birds/km^2 in his aerial survey of Kodiak Island compared to 39 birds/km^2 for this report. Boat surveys by U.S. Fish and Wildlife Service in 1973 and 1975 around Kodiak found 129 and 147 birds/km^2, respectively (U.S. Fish and Wildlife Service 1973, 1975). Sea, diving and dabbling ducks were the birds most often found by Trapp (1977), whereas alcids and sea ducks were the most abundant birds recorded on the boat cruises.

Survey Technique Evaluation

It has been mentioned several times in this report that density data were not comparable because sampling techniques differed. Elaboration of this statement is warranted. Six types of aerial surveys were used in this study and surveys by others mentioned in the text were different as well. Physiography of the shoreline, number of observers available, and whether aircraft of opportunity were utilized, all helped determine what kind of technique was used. The preferred situation and the technique most used in this study included two observers and a pilot. Coverage was on both sides of the aircraft and approximately a 400 meter strip along the coast was searched for birds. In this case, the area covered was about double that by one observer. Most birds were observed on the shoreside of the aircraft but occasionally large rafts of birds were on the oceanside of the aircraft both within and beyond the 200 meter transect width. When surveying extensive supratidal areas, two observers were better able to accurately census the birds present.

When one observer was used on shoreline counts, the majority of birds were likely recorded because most birds were found on the beach or on nearshore waters. If a specified width was being surveyed so that a density in birds/km^2 was obtained, the density value would be much higher than in the technique where two observers were used.

Boat surveys add other biases when attempting shoreline counts. More offshore species would be recorded, birds on supratidal habitat may be missed and birds that dive from aircraft may be sighted from a boat.

Because of the observation differences inherant to the various survey techniques, data from different types of surveys are not directly comparable. For example, in this study a stratified-random sampling scheme with two observers was used on the Kodiak Archipelago. Large areas within bays, including open water, were surveyed. We found 39 birds/km^2. Trapp (1977) used one observer and flew parallel to the shore around the coast of Kodiak Island only. His observations of 101 birds/km^2 is not directly comparable to the 39 birds/km^2 recorded in this study. Each is a good index if surveys are duplicated using the same technique as the previous one. Density values must be properly interpreted and not taken out of context of the type of survey conducted by those who wish to use the data for comparative purposes.

In an evaluation of waterfowl surveys on the east coast, Stott and Olson (1972) questioned the usefulness of aerial surveys to determine trends in wintering populations of sea ducks. Their preferred method was ground censusing with a spotting scope. In comparing the two techniques, they reported that aerial censuses found only 20 to 81 percent of the birds that ground counts did. The situation in New Hampshire is markedly different from that in Alaska. Stott and Olson (1977) surveyed 35 km of coastline (one observer was used on aerial surveys) and had a paved road the entire distance for ground surveys. In this study, survey stations were almost that long but all were in remote areas without roads. In our case, aerial surveys were essential and provided a useful tool as an index for coastal bird populations, but techniques to determine the indices should be standardized.

<u>Spring Migration, Cape St. Elias</u>

Several aspects of the spring bird migration past Cape St. Elias on Kayak Island need further discussion. Large numbers of certain groups of birds bypass the northern portion of NEGOA and Prince William Sound by migrating westerly from the Cape. These birds may not be affected by oil development in northern NEGOA. Other bird groups stop at Kayak Island to rest and feed or migrate diurnally back and forth past the Cape. These birds definitely could be affected by certain oil development related problems. Inclement weather stops many migrating birds and they concentrate in large numbers in southern NEGOA. When weather improves there is an immediate rush of migrating birds past the Cape. There, too, birds could be affected if oil was spilled when they were concentrated or habitat was lost because of development.

The magnitude of the loon migration past Kayak Island was much greater than expected. During the peak of migration, when an estimated 10,000 loons per day passed the Cape, many stopped to feed in rafts in nearshore waters. In May and June hundreds to tens of thousands of shearwaters fed in offshore waters surrounding the Cape. Aquatic birds like these two groups are highly susceptible to contamination by oil.

Some species groups, particularly dabbling ducks, would appear in great numbers during the improved weather after a storm. Because they appeared so quickly, it likely meant that they had waited out the storm in nearby coastal habitats. If this phenomenon occurs every spring, the locations of their stopovers must be found so that adequate protection can be given to the habitat.

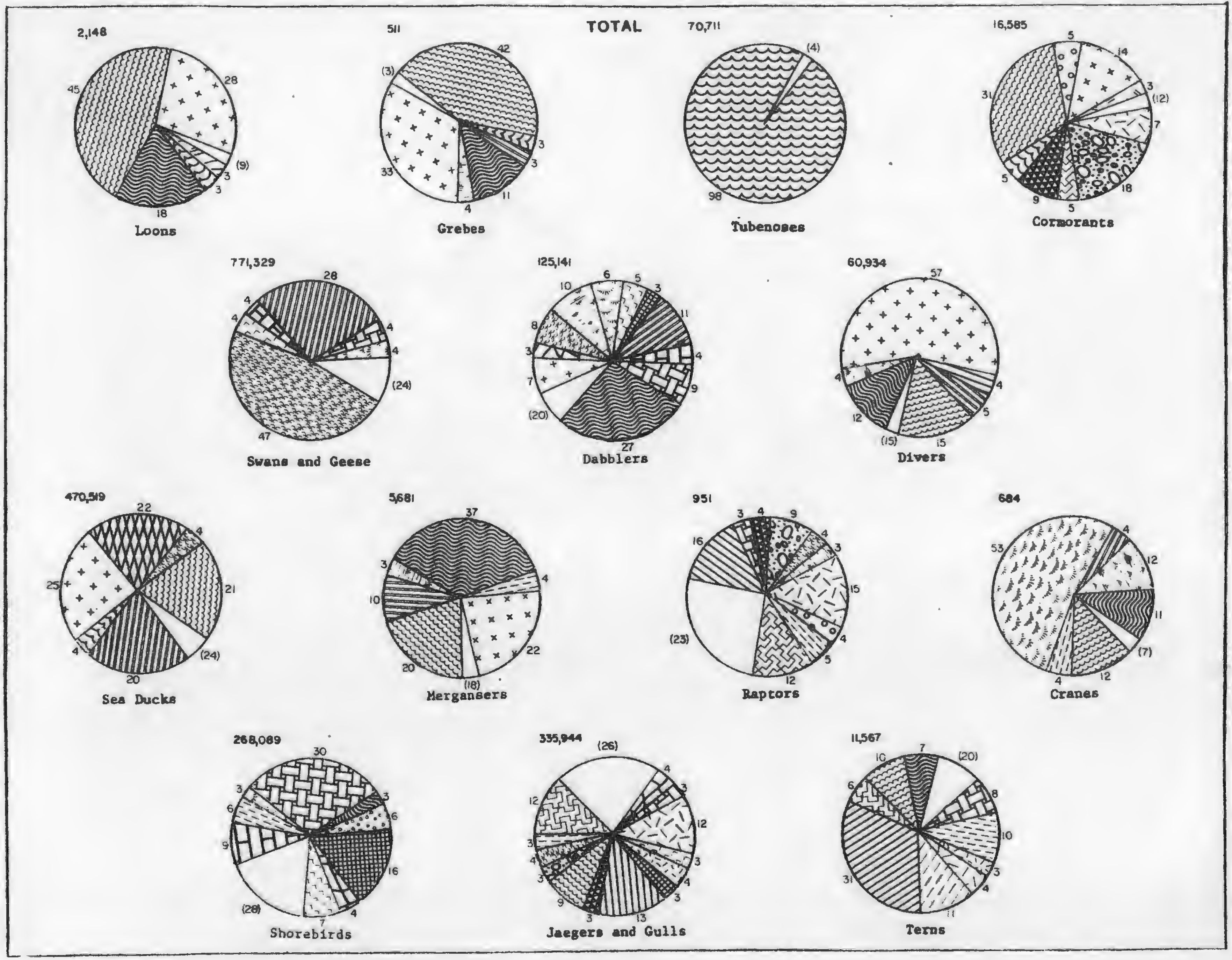
Thousands of Black-legged Kittiwakes moved back and forth past the Cape morning and evening for 2 months in spring 1977 and 1978. The exact cause of these diurnal movements was not determined. They moved northerly toward colonies in the morning and away from colonies toward exposed sand beaches in the direction of Cape Suckling in the evening. Whether they moved toward nocturnal feeding grounds and returned to the colony in the day or flew to bathing and roosting sites along the beach in the evening was not determined. Whatever the reason, the large population of birds remained vulnerable to oil pollution for this 2 month period by utlizing coastal habitats.

Murres and puffins from nearby colonies frequently rafted on waters around the Cape and diurnal movements of up to 10,000 murres were observed at the Cape in April. These murres may represent migrating birds from outside NEGOA. Both puffins and murres, because of their aquatic habits, are highly vulnerable to oil spills.

Habitat Usage

Although mentioned previously, the determination of habitat availability for each survey region could not be done for this report. Also, the amount of observation time spent in each habitat type was not recorded on bird surveys. In some surveys all habitat types of the region were searched for birds and in others only a few habitats. Therefore, the data presented on birds' use of habitats merely reflects where we found birds at the time of the survey. An absolute habitat preference by birds could not be determined; instead our data reflect relative habitat selection by birds in those habitats that were searched in this study. Combined information on habitat use by birds is shown in Figs. 178 and 179.

In most cases, the recorded habitat usage data for all birds combined (Table 21) reflected both the habitats which were normally found in the region and what habitats were surveyed within the region. However, several patterns in habitat usage were evident. The best data are available for Lower Cook Inlet because surveys were conducted in all seasons of the year, and similar areas were covered in the surveys. From spring and summer through fall and winter in LCI there was a gradual increase in the percentage of birds using lagoon habitats (Table 21). This amounted to a change from 2 to 15 percent of the birds. Conversely, there was a decrease from 7 to 1 percent in the birds found in exposed delta habitats from spring through winter. In salt marshes and protected delta habitats, most birds were found during migration periods, sping and fall, and in both cases the percentages were identical, 4 percent of the birds in salt marshes in spring and fall and 11 percent of the birds on protected delta in spring and fall. Exposed habitats were used by the most birds in summer and fall (44% and 42%, respectively) and bay habitats received most use in winter and spring (48% and 50%, respectively). Sampling wasn't sufficient in other regions to determine definite seasonal habitat changes within a region.


TOTAL
2,148
45 28 (9) 3 3 18
Loons
511
42 (3) 3 3 11 4 33
Grebes
70,711
(4) 98
Tubenoses
16,585
5 14 3 (12) 7 18 5 9 5 31
Cormorants
771,329
28 4 4 (24) 47 4 4
Swans and Geese
125,141
6 5 3 11 4 9 27 (20) 7 3 8 10
Dabblers
60,934
57 4 5 15 (15) 12 4
Divers
470,519
22 4 21 (24) 20 4 25
Sea Ducks
5,681
37 4 22 (18) 20 10 3
Mergansers
951
3 4 9 4 3 15 4 5 12 (23) 16
Raptors
684
53 4 12 11 (7) 12 4
Cranes
268,089
30 3 6 16 4 7 (28) 9 6 3
Shorebirds
335,944
(26) 4 3 12 3 4 3 13 3 9 3 4 3 12
Jaegers and Gulls
11,567
7 (20) 8 10 3 4 11 31 6 10
Terns

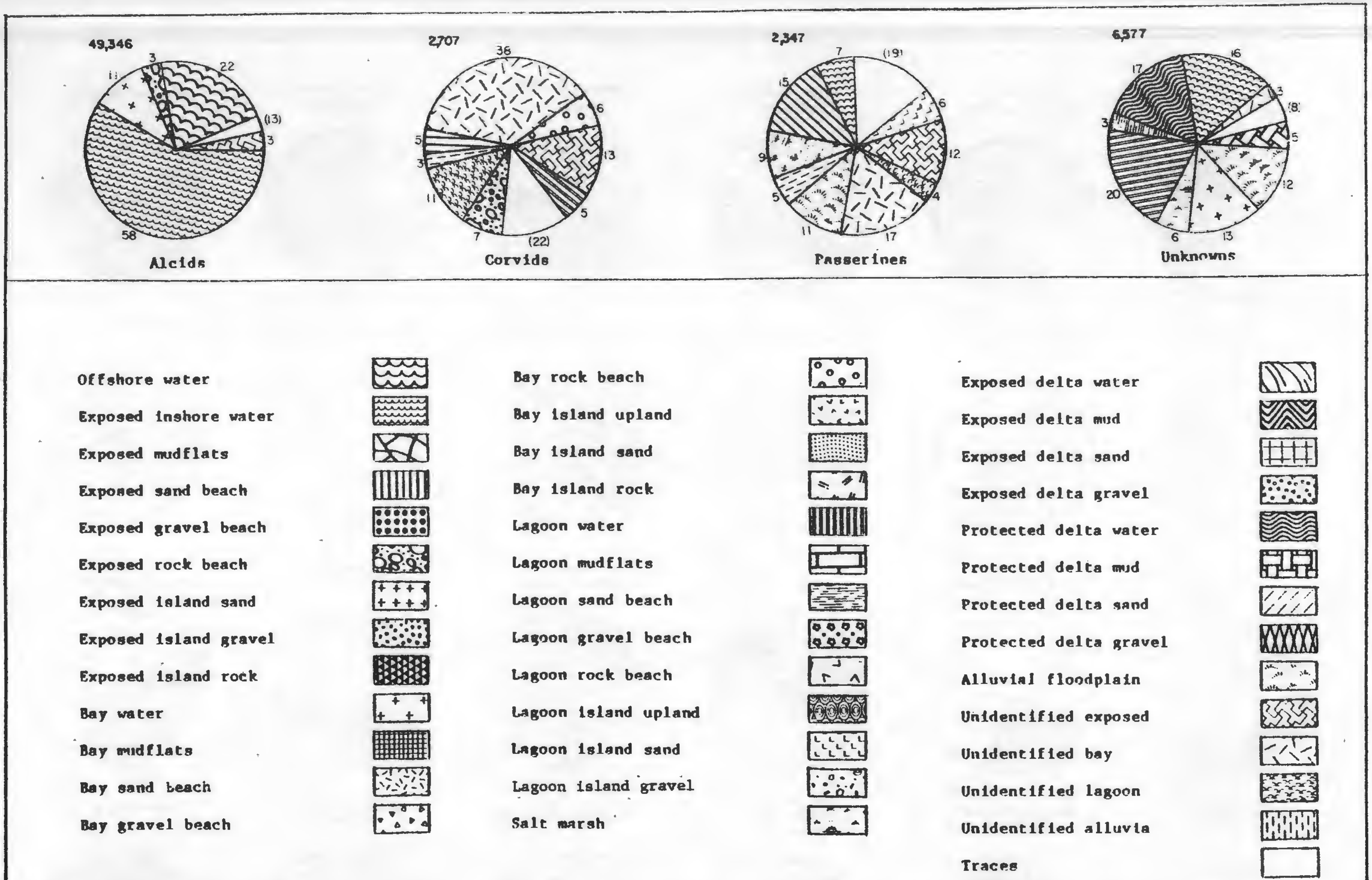
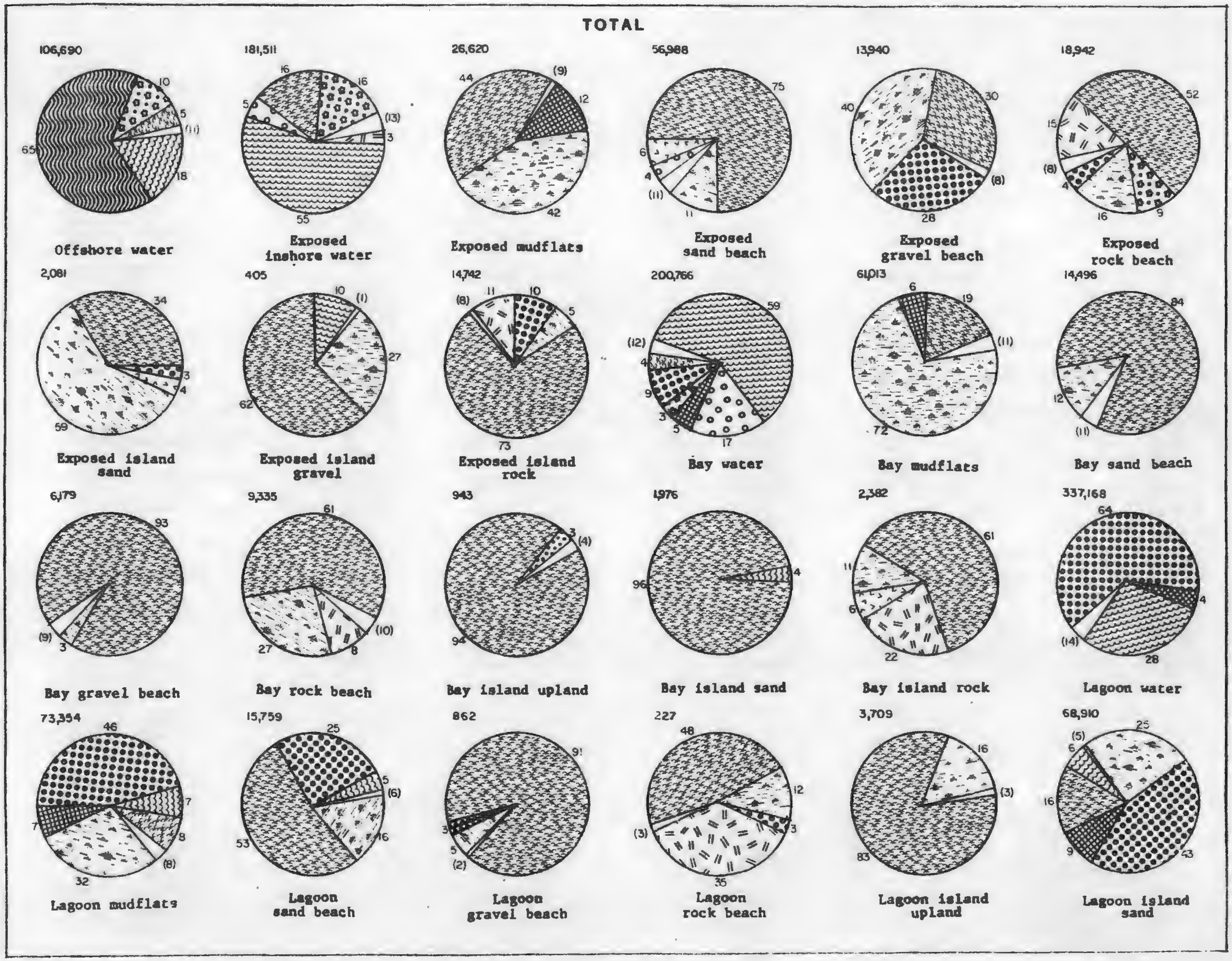


Fig. 178. Entire Study Area Total, 1975-1978. Habitat preference of marine birds as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of habitat types in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.


TOTAL
106,690
Offshore water
181,511
Exposed inshore water
26,620
Exposed mudflats
56,988
Exposed sand beach
13,940
Exposed gravel beach
18,942
Exposed rock beach
2,081
Exposed island sand
405
Exposed island gravel
14,742
Exposed island rock
200,766
Bay water
61,013
Bay mudflats
14,496
Bay sand beach
6,179
Bay gravel beach
9,335
Bay rock beach
943
Bay island upland
1976
Bay island sand
2,382
Bay island rock
337,168
Lagoon water
73,354
Lagoon mudflats
15,759
Lagoon sand beach
862
Lagoon gravel beach
227
Lagoon rock beach
3,709
Lagoon island upland
68,910
Lagoon island sand

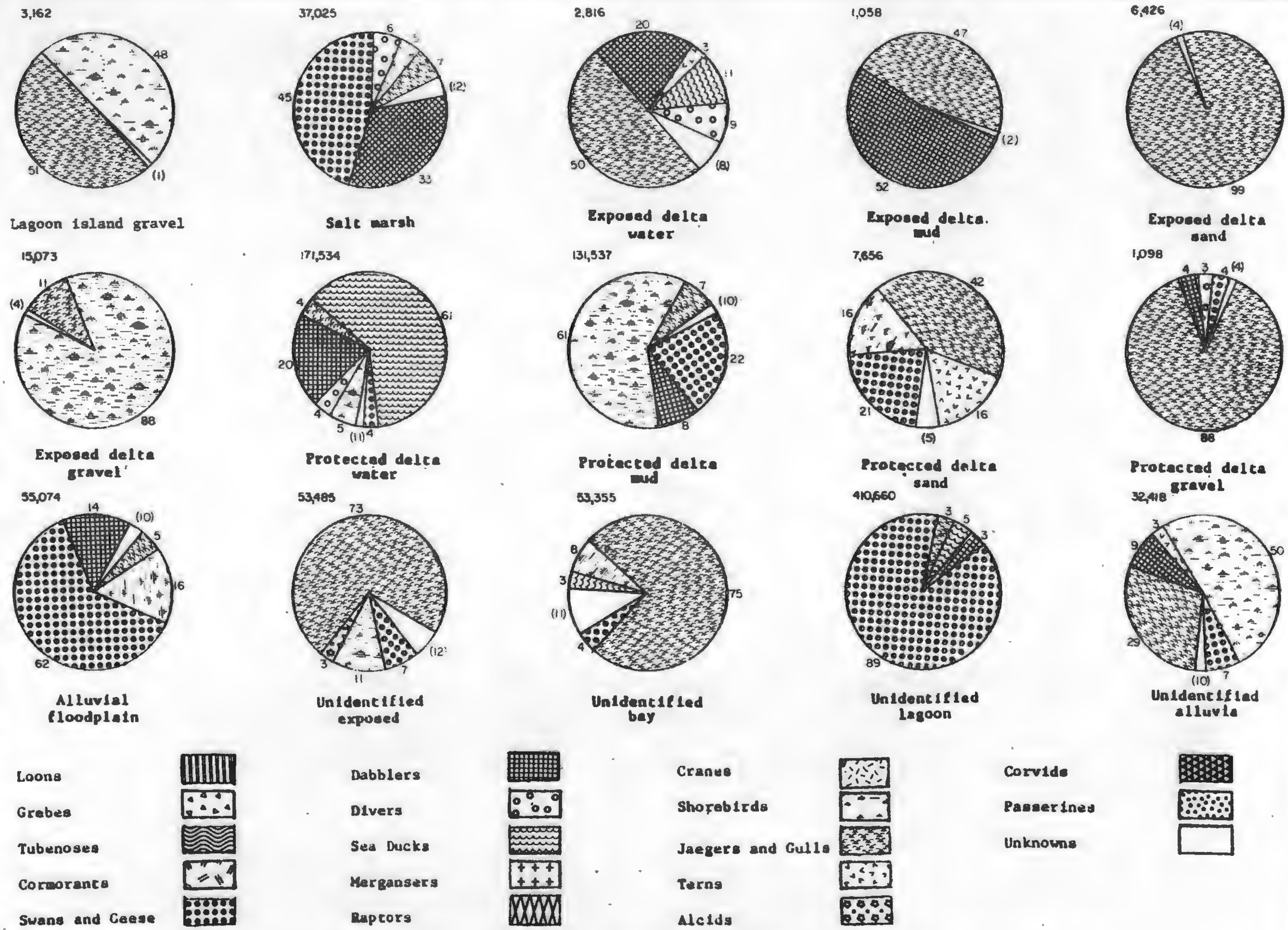


Fig. 179. Entire Study Area Total, 1975-1978. Marine bird usage of habitats as determined by aerial surveys. Percent of birds in each habitat type is shown at perimeter of circle; the number of bird groups in the trace (<3 percent) category is in parenthesis. Numbers at upper left are sample size.

Table 21. Comparison of seasonal and regional use of bird habitats in southcentral Alaska as determined by aerial surveys. Numbers represent percent of the total marine birds found in the survey area for each habitat type.

	NEGOA		KOD	Lower Cook Inlet				S AK Pen.		N AK Pen.			Br. Bay	Al. Sh.
Habitat Type	Sp	Su	Wn	Sp	Su	Fa	Wn	Fa	Wn	Sp	Fa	Wn	Sp	Wn
Offshore Water					5				7	Tr		6	4	9
Exposed Inshore Water	13	12	4	16	16	20	28	3	68	5	2	31	22	25
Exposed Mudflats	5			2	2	12	Tr			2	Tr		1	
Exposed Sand Beach	7	76	1	1	Tr	1	1	Tr	2	5	Tr	13	7	1
Exposed Gravel Beach	1			Tr	2	3	1			Tr		Tr	Tr	17
Exposed Rock Beach	2	8	Tr	Tr	5	3	1		5	Tr	Tr	Tr	3	4
Exposed Island Sand	Tr			1	Tr				Tr	Tr		Tr		
Exposed Island Gravel				Tr	Tr	Tr			Tr					
Exposed Island Rock	4			1	4	1	Tr		7				Tr	Tr
Bay Water	9	4	78	20	20	20	32	3	5	3	4	3	7	20
Bay Mudflats	9			17	4	2	6			Tr	Tr		2	
Bay Sand Beach	2	Tr	Tr	Tr	6	1			Tr	1		Tr	Tr	
Bay Gravel Beach	Tr		Tr	Tr	2	3	Tr		Tr	Tr	Tr		Tr	Tr
Bay Rock Beach	1	Tr	Tr	Tr	3	2	Tr		Tr	Tr	Tr		1	Tr
Bay Island Upland	Tr		Tr	Tr	Tr					Tr				
Bay Island Sand	Tr		Tr		Tr					1				
Bay Island Rock			1	Tr	1	1								Tr
Lagoon Water	Tr		5	1	1	6	12	79	1	28	21	32	1	Tr
Lagoon Mudflats	1			Tr	2	4	1	Tr		12	4	1	Tr	
Lagoon Sand Beach	Tr			Tr	Tr	Tr		2		3	1	Tr	Tr	
Lagoon Gravel Beach				Tr	Tr	Tr				Tr	Tr		Tr	
Lagoon Rock Beach			Tr	Tr	Tr	Tr	Tr			Tr	Tr		Tr	
Lagoon Island Upland	2									Tr	Tr	Tr		
Lagoon Island Sand	Tr									8	5	Tr		
Lagoon Island Gravel										1	Tr			
Salt Marsh	Tr		1	3	Tr	4		5	1	2	2	1	2	
Exposed Delta Water	Tr			Tr	1	1	Tr		Tr	Tr		Tr	Tr	
Exposed Delta Mud				Tr	Tr	1							Tr	
Exposed Delta Sand	1			Tr	Tr	Tr	1		1	2		4	Tr	
Exposed Delta Gravel	7			7	Tr	Tr	Tr						Tr	
Protected Delta Water			2	3	1	6	1		Tr	8	11	1	19	
Protected Delta Mud	27			1	1	2	Tr			10	6	1	4	
Protected Delta Sand	3		Tr	Tr	Tr	1				1	Tr	1	Tr	
Protected Delta Gravel	Tr			Tr	Tr	1				Tr				
Alluvial Floodplain	2		Tr	6	1	1				1	3		4	
Unidentified Exposed	Tr		1	6	15	1	2	2	2	Tr	1	2	4	15
Unidentified Bay	2		4	12	4	2	10	3	Tr	1	1	2	1	7
Unidentified Lagoon	Tr		1	Tr	Tr	1	2	3		2	38	2	2	
Unidentified Alluvium	3		Tr	Tr	4	1	Tr			4	Tr	Tr	15	

In comparing seasonal use of habitats among the regions, it was evident that birds used protected delta habitats much more frequently in spring and fall than in winter. From 11 to 42 percent of the birds were found on protected deltas in spring and fall and only 3 percent or less were found there in winter. Exposed delta habitats and salt marshes were used by few birds in all seasons. Other apparent trends likely reflected habitat availability or area surveyed.

Assuming that, in general, birds select similar habitats no matter which region they are in, data from all surveys were combined to get a "mean" habitat preference. By doing this, sampling biases may have been negated. Over 2 million birds were observed on all surveys, and the habitats on which they were found (excluding offshore water) in descending order of usage were: lagoon/embayment (44%), protected delta (19%), exposed (18%), bay/fjord (17%), salt marsh (2%) and exposed delta (1%).

About 0.5 million birds were on the four unidentified habitats. On unidentified exposed habitats most (73%) of the birds were gulls, on unidentified bay 75 percent were gulls, on unidentified lagoon 89 percent were geese and on unidentified protected delta 50 percent were shorebirds and 29 percent gulls.

On five identified habitats (excluding offshore water) there were 100,000 or more birds present. Four of these habitats were water. The most used habitat was lagoon water where 22 percent (337,168) of the birds were found. This was followed by bay water (13%), exposed water (12%) and protected delta water (11%). Protected delta mudflats supported 9 percent of the birds.

Species composition on these most used habitats varied somewhat but waterfowl were found on all five. On lagoon water 64 percent of the birds were geese and 28 percent sea ducks. Four waterfowl groups comprised the majority of birds on bay water. Most (59%) were sea ducks; 17 percent were divers, 9 percent geese and 5 percent dabblers. Sea ducks comprised 55 percent of the birds on exposed inshore water, and gulls and alcids each represented 16 percent of the total. Protected delta water was used most by sea ducks (61%) and dabblers (20%) while protected delta mud was used by shorebirds (61%) and geese (22%).

In looking at what habitats individual species groups used when all surveys were combined, we found that loons and grebes selected similar habitats. Most were on exposed inshore water followed by bay water and protected delta water for both groups. On a species basis, Common Loons were found most on bay water; Arctic Loons were found equally on bay, exposed delta and protected delta water; Red-throated Loons used exposed inshore water and protected delta water (Table 22). Red-necked Grebes used exposed inshore and protected delta water while Horned Grebes used exposed inshore and bay water.

Table 22. Relative use of coastal habitats by common marine bird species or groups as determined from aerial surveys in southcentral Alaska, 1975-1979. Numbers represent percent of the total for given species and includes birds combined from all surveys.

1 - Offshore Water
2 - Exposed Inshore Water
3 - Exposed Mudflats
4 - Exposed Sand Beach
5 - Exposed Gravel Beach
6 - Exposed Rock Beach
7 - Exposed Island Sand
8 - Exposed Island Gravel
9 - Exposed Island Rock
10 - Bay Water
11 - Bay Mudflats
12 - Bay Sand Beach
13 - Bay Gravel Beach
14 - Bay Rock Beach
15 - Bay Island Upland
16 - Bay Island Sand
17 - Bay Island Rock
18 Lagoon Water
19 - Lagoon Mudflats
20 - Lagoon Sand Beach
21 - Lagoon Gravel Beach
22 - Lagoon Rock Beach
23 - Lagoon Island Upland
24 - Lagoon Island Sand
25 - Lagoon Island Gravel
26 - Salt Marsh
27 - Exposed Delta Water
28 - Exposed Delta Mud
29 - Exposed Delta Sand
30 - Exposed Delta Gravel
31 - Protected Delta Water
32 - Protected Delta Mud
33 - Protected Delta Sand
34 - Protected Delta Gravel
35 - Alluvial Floodplain
36 - Unidentified Exposed
37 - Unidentified Bay
38 - Unidentified Lagoon
39 - Unidentified Alluvia
n = Number of Birds in Sample

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	n
CoLo	3	28								59								2								1					6					1				99
ArLo	3	14								29																1	25				25								Tr	203
RTLo	1	52								10		1						1								1	Tr				34							Tr		590
RNGr	1	33							1	22								2								9					33									129
HoGr	1	52								43																					6									89
NoFu	93	4								2																											1	1		120
Shea	98	1								Tr																											Tr	Tr		70,572
FTSP	78	11								11																														18
DCCo	7	27		6		41			3	17	Tr	Tr		2			Tr	Tr								Tr					Tr					Tr	Tr		Tr	1,213
PeCo	30	10				48				4				1			7										Tr													350
Swan		6		1						1	2							2								29	1				46	1	1		10	1			Tr	692
CaGo		Tr	Tr		Tr	Tr			Tr	Tr	Tr	Tr						21	10	Tr			Tr			8	Tr				1	5	Tr		16	Tr	Tr	37	Tr	167,007
Bran		Tr		Tr					Tr	1		Tr					Tr	35	3							Tr	Tr				Tr	Tr			Tr	Tr	Tr	51	Tr	432,581
EmGo		1		Tr	2	Tr	Tr		Tr	6	Tr	Tr	Tr			Tr		20	3	2				19		Tr					2	14	1	Tr	1	2	1	32	Tr	154,126
WFGo		1									4							2													16	8			31			1	35	278
SnGo		Tr										Tr						Tr								22					Tr				64	3			5	6,369
Mall		3	2	Tr	Tr	Tr				17	1	Tr						21	1					3		13	Tr	1			17	2	Tr	Tr	6	1	1	12	2	17,325
Gadw										8	1							4	3							22					25	6	16		4			1	11	300
Pint		1	Tr	Tr					Tr	2	4	Tr						10	6	Tr				13	Tr	8	Tr				22	7	Tr		5	Tr	1	18	3	43,059
GWTe		1	24	Tr	Tr					10	4		Tr					11	10							7	Tr				25	2			5	Tr			1	4,017
AmWi		2	1							10	1	Tr		Tr				19	2							2					41	16	Tr		4	Tr	Tr		2	3,034
NoSh		Tr	Tr							14	1							2								15	1				39	2			15		2		7	705
Scau	1	18	Tr	5		Tr				54	2	Tr						2								3	Tr		Tr		13	Tr			Tr	Tr		Tr	Tr	46,757
Gold	Tr	3				Tr				75								14								6					3			Tr			Tr			9,493
Buff	Tr	19								56								22								4	Tr				7				1					1,596
Olds	5	45	Tr	Tr						61								5								Tr	Tr				3					Tr		Tr		16,900
Harl	Tr	49		1	Tr	2				45	Tr			Tr				2								Tr	Tr				1					1				11,996
StEi	Tr	4								15	Tr							33	4	Tr				3		Tr					28							13		116,480
CoEi	16	31	Tr	Tr	1	Tr		Tr	Tr	25		Tr	Tr	Tr		Tr		8	Tr					2		1	Tr				14				Tr	Tr			Tr	15,075
KiEi	62	23		Tr						12								3													Tr					Tr				6,358
WWSc	24	31								40								2													2						Tr			10,106
SuSc	10	19		1					Tr	61								7									Tr				1									23,693
BlSc	4	31	Tr	1		Tr				25	Tr		Tr					4	Tr							Tr	Tr				35	Tr				Tr			Tr	43,899
CoMe		10		Tr					1	20		13						3								1					47						1		2	285
RBMe	Tr	23	Tr	2						21	Tr		1	Tr		Tr		6	Tr							4	1				39	Tr			Tr	Tr	Tr	Tr	3	4,022
BaKa		3	1	17	2	10	Tr		5	1	1	3	2	5	Tr		2	1	1	2	Tr	Tr	1	Tr		3			Tr		Tr	2	1	Tr	2	10	16	4	4	870
MaMu				11						4																7					7	21	4		21				25	28
Ptar										5																11									73		1		10	105
SaCr		12	Tr	Tr														4	1							12					11	Tr			53	Tr		Tr	3	683
BlOy		3				20			31	2	Tr		2	6	Tr		26																		2	6				767
Plov		1	9	29		Tr					5																				1	5		Tr	1	1	47		2	1,283
Turn		Tr		5	1	31					Tr	5		22								Tr				1					1		Tr		14	6	3	1	6	1,116
Whim						70					5																				10	5							19	29
Yell		40																								6						14			6				33	63
RoSa			3		5	67		14				4		1							4	2														Tr	1			832
Surf		19			4	7			18					51					1			Tr														Tr				743
Dowi			3	8						1																2						63				3			20	127
Phal	9	30		1						3								12								12					27					2			4	510
Jaeg	7	7	1	3					1	10		6	1					2								1	1				33	16	6		3	1	6	2	19	196
GlGu	4	10	2	11	1					1	1	1							5	2							1				15	5				19	11	6	4	81
GWGu	2	5	1	7	2	3	Tr	Tr	2	3	2	2	1	1	Tr	1	1	3	2	3	Tr	Tr	2	5	Tr	1	Tr	Tr	1	Tr	1	6	1	Tr	Tr	15	13	10	2	89,482
HeGu	Tr	9	6	22	3	5				1	1	15	Tr	2			Tr	Tr											Tr		3	2	3		Tr	Tr	14	Tr	12	1,930
MeGu	1	6	14	11	1	1			Tr	6	7	2	1	Tr		Tr		2	2	Tr		Tr	Tr	1		1	Tr	Tr	Tr	Tr	7	7	1	1	5	6	9	2	10	13,015
BoGu		2		10						3	1		Tr					52		Tr						Tr					17	1			Tr	2	3		8	412
Kitt	3	11	6	3	Tr	Tr	Tr		9	2	5		3	6			Tr	1		2	Tr		Tr	Tr		Tr	Tr				1	Tr	Tr	Tr		23	27	1	Tr	82,280
SaGu	9	5								2																2					27	5				14	9	21	7	119
Tern	1	10	Tr	31	Tr	Tr	1			2	Tr	3	Tr	Tr				1	1	1				1		1	1		Tr	Tr	7	8	11	Tr	1	6	4	2	10	11,567
Mole	48	26								10								13																						237
Murr	24	64				4				8	Tr							Tr																						38,709
PiGu	11	41		3		2				34				1				1		Tr											Tr					6				1,940
HoPu	11	56			Tr	1				28							3																			Tr				1,291
TuPu	11	30				Tr			4	3							2																			38	12			3,824
SeOw																												30				40			10	10			10	10
SnBu				15	2	Tr		1				Tr	1											8		8						2			3	21	34	6		992
BBMa		3				9			13	7		6	3	6																						13	34	4	1	68
CoRa		3	Tr	24	2	1			1	5	Tr	2	2	1	Tr			2	2	2	Tr	Tr				2			1		1	1	1		6	10	17	7	7	444
NWCr		Tr		1	1	8	Tr			1		Tr	1	7				5	1	Tr	1	Tr				2					Tr			1		14	42	12	3	2,195

Almost all tubenoses were on offshore water. Cormorants used exposed inshore water, exposed rock beach, bay water and exposed island rock. Swans primarily used protected delta water and salt marshes while geese used lagoon habitats. Brant, Canada and Emperor Geese were the most abundant birds in the study (all three species numbered over 100,000 birds), and all three used lagoon water and mudflats the most. The majority were found in North-Alaska Peninsula where lagoon and embayment habitat is plentiful. Brant were primarily restricted to lagoon water where eelgrass was found. Canada Geese used alluvial floodplains and Emperors used lagoon island sand and protected delta mud. Almost all Snow Geese were on alluvial floodplain.

Dabbling ducks were the most ubiquitous of waterfowl. They were found most abundantly on protected delta water, lagoon water and salt marshes but were found in measurable quantities on eight other habitats. Only subtle differences in habitat selection by the six most common dabbler species were evident. Pintails frequented lagoon island sand much more than other dabblers, Green-winged Teal were often on exposed mudflats and American Wigeon were more abundant on protected delta water and mud.

Over half the diving ducks were on bay water habitats. Most of the remainder used exposed inshore and protected delta water. Scaup, the most abundant diver, mirrored this habitat selection. Goldeneyes used exposed inshore water very little and three-fourths were found on bay water. Twenty-two percent of the Buffleheads used lagoon water, much more than the two other common diver species. Stott and Olson (1973) found in New Hampshire that Buffleheads almost exclusively used protected estuaries but goldeneyes were found in both exposed shoreline and protected waters.

There was an almost equal distribution of sea ducks among four water habitats: bay, protected delta, exposed inshore and lagoon. Analysis by individual species reflected a much different distribution, however, most Oldsquaws and Harlequin Ducks were found on exposed inshore and bay waters. Steller's Eiders were least abundant on exposed inshore and bay water and most abundant on lagoon and protected delta water. Common Eiders used all water habitats including offshore water while King Eiders were found most on offshore water, less on exposed inshore water, still less on bay water and were rare on lagoon and protected delta water. Of the scoters, White-wings were found most on exposed waters, Surfs in bay water and Blacks were the most abundant of the three in protected delta water.

Mergansers, both Common and Red-breasted, used the following habitats in decreasing order of abundance: protected delta water, bay water, exposed inshore water and lagoon water.

Bald Eagles, by a the most numerous raptor, were found on 32 of the 39 original habitat types. They were found most often on exposed sand beaches where they normally were feeding on carrion or roosting on driftwood. Eagles frequently used exposed rock beaches also. Others were scattered over a variety of habitats.

Less than 700 Sandhill Cranes were counted in all surveys and over one-half of these used alluvial floodplains. Most of the remainder were flying along the exposed coast in migration or were on salt marsh and protected delta water habitats.

Because many species of shorebird were observed (although not always identified) and each had its own habitat preferences, shorebirds were recorded on all but a few habitats. They were the second most widespread species group. As a group, they were found most often on protected delta mud, bay mudflats and lagoon mudflats. Habitat selections by species differed markedly. Black Oystercatchers used exposed island rock, bay island rock and exposed rock beach most often. Of identified habitats, plovers were found most on exposed sand beach, however, many used bay habitats that were not specified to substrate type during the survey. Most turnstones, Whimbrels and Rock Sandpipers used exposed rock beach. Bay rock beach was used by over half of the Surfbirds, and dowitchers were found on protected delta mud. Phalaropes utilized exposed inshore water and protected delta water. The preceding discussion does not take into consideration the thousands of shorebirds identified as only small, medium or large. It reflects only those positively identified to species which was a small portion of the total.

The only bird group found on all habitats was the gull/jaeger group. Nearly half the gulls were recorded on exposed habitats, particularly sand beaches and inshore water. About one-fourth were in bay habitats and the rest were dispersed in other habitats. The ubiquitous distribution of gulls in marine habitats is a boon to their survival in the face of increased coastal zone development (oil, gas and other). This and the gulls opportunistic feeding behavior may help populations reach a magnitude detrimental to other colonial nesting seabirds. The most common gulls in southcentral Alaska were Glaucous-winged Gulls, Black-legged Kittiwakes and Mew Gulls. On shoreline habitats there was not much difference among the three species as to which habitats they selected, except that kittiwakes were most frequently found on rocky habitats and Mew Gulls on sandy habitats. Glaucous-winged Gulls were found in small percentages on all habitats. Only about 200 jaegers were recorded on the surveys, and over one-half of these were on protected delta habitats.

Along the coast, terns were found most often on exposed sand beaches or flying over exposed inshore water, and a large percentage used protected delta sand, mudflats and water. Few were observed in bays and even fewer were in lagoons. However, most terns were recorded on spring surveys, and summer habitat selection may be different.

Most alcids selected exposed inshore waters, offshore waters and bay waters. Few were found in any other habitat. Nevertheless, murres and Tufted Puffins were not observed in bay waters as much as Pigeon Guillemots and Horned Puffins. Murres and Tufted Puffins restricted themselves to exposed or offshore waters. Fewer Pigeon Guillemots were observed on rock habitats than expected.

Twenty-eight habitats were used by corvids, but because Northwestern Crows are limited in their distribution, Common Ravens used the widest variety of habitats. Exposed sand beaches were the most common single habitat selected by Common Ravens. Most habitats of Northwestern Crows were not specified but over one-half used bay/fjord habitats. Crows outnumbered ravens five to one, and few Black-billed Magpies were sighted along the coast.

Snow Buntings were the most numerous "other passerine" that could be identified. They were most commonly seen along exposed, sandy beaches feeding in stands of beach rye. Many small sparrows were observed that could not be identified and likely many more were present, but not observed.

Impacts of Oil and Gas Development

Many previous studies have discussed the effects of oil on marine birds, particularly in regard to acute oil spills from tankers. A list of these references is found in Vermeer and Vermeer (1974 a,b). More recently, reports have been prepared pertaining to marine birds in Alaska waters. Trapp (1979) discussed threats to habitats that man has caused, or may have caused, on breeding seabirds in Alaska. He singled out the 70 most important seabird colonies in Alaska for discussion and developed a scoring system to determine relative importance of the colonies. ADFG (1978a and 1978b) summarized information on what effects oil and gas development may have on birds and other organisms in Northern Gulf of Alaska and Lower Cook Inlet. An excellent summary of most impacts that oil and gas development may have on biota including birds is provided in Hamilton et al. (1979). Although Lower Cook Inlet is emphazised, the information is applicable to all parts of Alaska. Suggested mitigation procedures are also included. Blackburn and Jackson (in press) presented an evaluation of potential impacts of oil and gas development in Lower Cook Inlet on pelagic and demersal fish. This study included summaries of how various aspects of oil development could affect many forage species used by birds and, therefore, one can infer indirectly how birds may be affected. Because these reports thoroughly summarize direct or indirect effects of oil and gas development on marine birds, discussion in this section will be restricted to results of this study.

King and Sanger (1979) devised a rating scheme for assessing the vulnerability of 176 marine-oriented birds to oil spills in the northeast Pacific region. The scheme was based on range, population, size, habits, mortality and season of exposure of marine birds, and a numerical index of relative vulnerability was presented for all species. An index to the relative susceptibility of marine habitats to oil spills based on experience from oil spills in other parts of the world was adopted by Hayes et al. (1977). This index is based on geomorphology and not the biota present in, or on, the substrate. Indices from these reports were then applied to the bird populations assessed in this study. A mean oil vulnerability index (OVI) from King and Sanger (1979) was calculated for species groups used in this report by summing the index values for species frequently observed in southcentral Alaska and dividing by the number of species (Table 23). Except for raptors (Bald Eagles) all the highest ranked birds were those that spend much time on water. Species groups low on the list are those that either are very abundant and, therefore, have a lower OVI or they are less frequently found on marine habitats.

The 39 bird habitat types delineated in this report were arranged in increasing order of vulnerability to oil spills (Table 24) based in part on the oil spill vulnerability index of Hayes et al. (1977). This susceptibility index (Table 24) was not based on bird usage of the habitat but on the probability of contamination, the retention of oil in the substrate and an assumed rate of oil degradation. The two sections on water (Nos. 3 and 7 in Table 24) were not considered in the index by Hayes et al. (1977) but were ranked according to personal communications with G. H. Ruby. Ranking for water habitats is not for birds on the water but for the habitat itself.

Discretion must be used when applying these relative indices to determine the importance of coastal Alaskan habitats in relation to oil development. The index of Hayes et al. (1977) pertains largely to acute oil spills from platform blowouts or tanker leaks. Dames and Moore (1979a) discussed the importance of knowing what biological assemblages are in the substrate versus knowing only what substrate is present. The vulnerability of biological assemblages is not always directly related to geological characteristics. They also stated that occasionally the substrate in beach faces may differ from the substrate in adjacent low tide terraces. Applying the Hayes' susceptiblity index may, therefore, be erroneous or at least not detailed enough to discern these differences. The beach face may be sand, gravel, boulders or a combination of these and rate fairly high on Hayes' index but have low biological productivity. The adjacent intertidal terrace may be exposed mudflats (lower on Hayes' susceptiblity index) but be high in productivity. Birds normally would use the upper beach for roosting and would be less affected if oil soaked into the gravel or other substrate. However, they feed on the intertidal portion and would be greatly affected if forage species were killed by oil. The biological parameters must, therefore, be integrated with the geophysical at the time of initial surveys to get an accurate assessment of vulnerability to oil spills.

Table 23. Relative vulnerability of marine bird groups, in southcentral Alaska, to oil spills. Bird groups ranked by mean oil vulnerability index (OVI, see text).

Rank	Bird Group	$\bar{x}$ OVI	No. of Species
1	Alcids	77	(12)
2	Sea Ducks	70	(9)
3	Cormorants	59	(4)
4	Raptors	58	(1)*
5.5	Tubenoses	56	(6)
5.5	Mergansers	56	(2)
7	Loons	55	(4)
8	Divers	52	(7)
9	Geese & Swans	51	(7)
10	Gulls & Jaegers	44	(10)
11.5	Grebes	43	(2)
11.5	Terns	43	(2)
13	Shorebirds	42	(30)
14	Dabblers	36	(6)
15	Corvids	34	(2)**
16	Cranes	24	(1)

* Bald Eagle only; other raptors not applicable or rated.
** Black-billed Magpie not included.

Table 24. Assumed relative susceptibility of bird habitats to oil spills. Based in part on oil spill vulnerability index by M.O. Hayes (1977), and personal communication with C.H. Ruby. Arranged in order of increasing susceptibility* within the twelve classifications.

Lowest

1. Upland vegetation
   a. Dry coastal upland
   b. Bay/fjord island upland soil
   c. Lagoon/embayment island upland soil
   d. Exposed island upland soil

2. Exposed rock substrate
   a. Exposed delta rock
   b. Exposed coast rock beach
   c. Exposed island rock beach

3. Exposed marine waters
   a. Offshore waters
   b. Exposed delta water
   c. Exposed inshore water

4. Exposed sand substrate
   a. Exposed delta sand
   b. Exposed coast sand beach
   c. Exposed island sand beach

5. Exposed mud tideflats
   a. Exposed delta mud
   b. Exposed mud tideflats

6. Exposed gravel substrate
   a. Exposed delta gravel
   b. Exposed coastal gravel beach
   c. Exposed island gravel beach

7. Protected marine water
   a. Protected alluvial water
   b. Bay/fjord water
   c. Lagoon/embayment water

8. Protected sand substrate
   a. Protected alluvial sand
   b. Bay/fjord sand beach
   c. Bay/fjord island sand beach
   d. Lagoon/embayment sand beach
   e. Lagoon/embayment island sand beach

9. Protected rock substrate
   a. Bay/fjord rock beach
   b. Bay/fjord island rock beach
   c. Lagoon/embayment rock beach

10. Protected gravel substrate
   a. Protected alluvial gravel
   b. Bay/fjord gravel beach
   c. Bay/fjord island gravel beach
   d. Lagoon/embayment gravel beach
   e. Lagoon/embayment island gravel beach

11. Protected mud tideflats
   a. Protected alluvial mud
   b. Bay/fjord mud tideflats
   c. Lagoon/embayment mud tideflats

Highest

12. Protected sedge/grass marshes
   a. Protected alluvial vegetated floodplain
   b. Sedge/grass saltmarsh

* Criteria for habitat susceptibility are: probability of contamination, retention in the system/substrate and assumed rate of degradation.

Senner (1977) briefly discussed the definition of critical habitat and mentioned how nebulous the concept "critical" can be. His criteria for critical habitat included: number of individual organisms using a region, the relationship between an organism and the habitat in question and the likely effect on the organism if the habitat is degraded. Although not all these criteria were met in this study, a relative determination of "critical" habitats can be estimated keeping in mind the aforementioned limitations.

By combining information from the oil vulnerability index for bird groups, the susceptibility index for bird habitat and other available information, the relative importance of portions of the coastline to birds can be determined with a knowledge of species composition, distribution and abundance and their habitat usage. These "critical habitats" will be discussed by region, season, and what aspects of oil and gas development may be most harmful to birds.

Northeast Gulf of Alaska

In spring, loons had a high density on bay waters of Yakutat Bay. Both the oil vulnerability index (OVI) for loons and the oil susceptibility index (OSI) for bay water were of medium rating. Shore-based facilities in Yakutat Bay would likely be located on the south shore and, therefore, the greatest threat to loons congregating on the north shore would be catastrophic or chronic oil spills that damaged the birds themselves or there food resources.

Cormorants were densest at Kayak Island, a rocky, erosional shore rated as having low susceptibility by Ruby (1977). Although cormorants are vulnerable to oil, the residency time of oil reaching Kayak Island's exposed coast would not be long. Sources of oil would likely be large spills at platforms, pipeline leaks or tanker spills.

No dense concentrations of geese, dabbling ducks and diving ducks were found in the May survey of this study; however, estuaries south of Yakutat and the Copper-Bering River Deltas are used by all three groups. Habitats in the latter areas were marked highly susceptible by Ruby (1977), but he neglected to delineate the important protected estuarine tideflats and salt marshes south of Yakutat. Spilled oil would have high residency times in these areas and be detrimental to staging waterfowl for many seasons. Sea ducks were densest in Icy Bay in both spring and summer surveys. This is a proposed location for shore-based facilities, and habitats in the area have a medium to high OSI. Sea ducks, with a high OVI, would be affected by both chronic and acute oil spills as well as by disturbance from aircraft and boat traffic to onshore facilities.

Shorebirds, although rated low on the OVI scale, would be extremely vulnerable in the Controller Bay, Copper River Delta and Orca Inlet sections. The protected mudflats and mud-inhabiting forage organisms of shorebirds are highly susceptible to oil, and if this habitat is degraded, millions of migrating shorebirds will not be able to build sufficient fat reserves to sustain continued migration. It would be acute spills from present tract locations that would cause the severest damage if oil reached the mudflats.

Thousands of gulls use NEGOA in spring and summer, and most use habitats with a low or medium OSI rating. Their overall OVI is also relatively low. Large gulls use such a variety of habitats and are such catholic feeders that the overall impact of oil and gas development may be less for them. Their low-lying, exposed barrier island breeding sites could become contaminated if oil spilled during a spring tide accompanied by strong winds. Increased air traffic to Cordova, if the city is used for support facilities to offshore drilling, could increase stress on nesting gulls in the Copper River Delta area. Black-legged Kittiwakes, which breed on Martin and Wingham Islands, have more restricted feeding habits and habitat selections. They could become contaminated with oil on their sand beach roost sites or while feeding in nearby waters. Physical disturbance from support facilities near their colonies may affect breeding success.

Terns, with a low OVI, selected habitats rated high on the OSI scale in spring. They were found in protected bays and deltas from Icy Bay to Yakutat Bay and at the mouth of the Ahrnklin River. In summer they used exposed sand beaches but nest sites are found in protected areas. Nesting colonies would be disturbed with increased aircraft traffic, and birds could become contaminated from catastrophic oil spills.

Alcids, which rest on nearshore waters, especially near their colonies at Wingham and Martin Islands, could easily become oiled during an acute spill from any source. Their aquatic habits make them one of the most vulnerable groups even though the OSI for their favored habitat is low. Disturbance at colonies could be another cause of low productivity. If shore-based facilities were near colonies, physical disturbance would flush birds from cliffs allowing eggs to fall off and increasing chances of predation on eggs and chicks.

Kodiak

Sea ducks were by far the most abundant bird group recorded in the winter survey, and this group is rated second only to alcids in vulnerability to oil. They were densest in the Chiniak Bay area and were found on protected bay waters throughout the archipelago. Bay waters had a moderate OSI rate but shoreline substrate and prey organisms of sea ducks may be much more susceptible to oil spills. Krasnow et al. (1979) found that Black Scoters wintering in Chiniak Bay mostly ate blue mussels (*Mytilus edulis*) and Oldsquaws preyed upon a variety of benthic organisms. If spilled oil harms the food source, even though it does not remain in the bay water habitat for a long period, it will be detrimental to the thousands of wintering sea ducks.

Diving and dabbling ducks, the next most abundant birds, were also found in protected bays and lagoons. Their OVI is lower than sea ducks because they spend more time in freshwater habitats, but in winter freshwater habitats freeze forcing these ducks to saltwater. Bay and lagoon waters have a moderate OSI rating. Dabblers were also commonly found on salt marshes and at mouths of streams. Salt marshes, in particular, are susceptible to oil because of its long residence time in that habitat.

The other abundant wintering bird group, alcids, were found almost exclusively on protected bay waters, and the bays in which they were most conspicuous were Kiliuda, Ugak and Uyak. Murres, the most common alcid, are highly vulnerable to oil and if populations of their food organisms are reduced, the effects would be long lasting. Krasnow et al. (1979) found that murres (n=4) in winter primarily ate walleye pollock (*Theragra chalcogramma*) in Chiniak Bay.

Proposed sites for oil terminals and service bases on Kodiak/Afognak Islands were Three Saints and Kazakof Bays (BLM 1977). During this study, Three Saints Bay was surveyed in its entirety, and sea ducks, alcids and diving ducks were the most abundant wintering bird groups. These birds would be highly vulnerable to spilled oil, either acute or chronic, from base facilities. Shoreline substrates in Three Saints Bay were rated medium to high by Hayes (pers. comm) on his susceptibility scale. Only the head of Kazakof Bay was surveyed in winter 1976 and diving ducks were the predominant species. The heads of all bays consistently contain habitats with the highest OSI rating, are used by large numbers of birds, and should be protected in the event of an oil spill. Kalsin Bay and St. Paul Harbor, also proposed as onshore base sites, are located in the area of densest wintering bird concentrations on Kodiak. Degradation of habitats and disturbances from facilities would be detrimental to those bird concentrations.

Overall in the Kodiak Archipelago, Hayes and Ruby (1979) determined that 34 percent of the shoreline was sheltered rocky headlands, 22 percent sand and gravel beaches, 17 percent eroding wave-cut platforms, 15 percent gravel beaches and 9 percent straight, rocky headlands. Sheltered rocky headlands, gravel beaches and sand/gravel beaches have high to moderate susceptibility to oil. Eroding, wave-cut platforms and straight, rocky headlands have a low susceptibility according to Hayes' index. In the winter survey of Kodiak, only 3 percent of the birds were found on all five of these habitats, however, many were on adjacent waters, particularly in sheltered portions, and would be affected if spilled oil harmed benthic organisms residing in these substrates.

Lower Cook Inlet

More information was gathered in Lower Cook Inlet by this research unit than in other regions of the study area. More information about Lower Cook Inlet from other biological and physical disciplines was made available, and a more detailed outline of impacts of oil and gas development was requested. Therefore, more emphasis in this section will be placed on various aspects of development in several regions of Lower Cook Inlet. Discussion will be confined to possible effects to birds and their habitat as determined by this study. Other reports have adequately summarized effects on other organisms that are lower on the food chain than birds and which may be preyed upon by birds (Blackburn and Jackson in press., Hamilton et al. 1979 and Calkins 1979).

For example, entrainment by cooling systems will directly affect planktonic organisms but not birds. Drill cuttings and muds may make the water too turbid for pursuit-diving or plunging type birds to locate prey but otherwise do little to birds directly. Nevertheless, the muds may smother or contaminate benthic or planktonic organisms which are important food sources for birds.

Drilling Platforms: Both acute and chronic oil spills may occur on offshore platforms. Because not enough is yet known about the effects of chronic contamination in Alaska waters (although it has been suggested that this form of pollution may be more devastating than a catastrophic spill [Michael 1976]), a discussion of this source of pollution will not be undertaken.

Kachemak Bay - Although no platforms will be placed directly into Kachemak Bay, Dames and Moore (1979b) estimated that Kachemak Bay would be impacted by oil spills within 3 days of a hypothetical spill in the summer. The probability of exposure to oil in Kachemak Bay was 3 percent. Winds, and not current, were the driving force of the hypothetical spill because in the spring and summer, predominant winds are from the southwest (Hayes et al. 1977). No trajectory was predicted for winter months when prevalent winds are from the northeast and north. One would assume there would be a lower probability of oil entering Kachemak Bay in winter because of the prevailing northeast winds. It appeared from Dames and Moore's (1979b) figures that oil would pass through outer Kachemak Bay and enter the inner Bay.

Regardless of the season, if oil enters outer or inner Kachemak Bay serious damage could be done to bird populations. This region had either the highest, or one of the highest, bird densities in Lower Cook Inlet for all seasons in both pelagic and shoreline areas. Sea ducks, a highly vulnerable species group, were one of the dominant bird groups in all seasons and were found on both protected bay and exposed inshore waters. They, along with diving ducks, an abundant bird group in spring and winter, feed predominantly on benthic bivalves (Sanger et al. 1979) in mud or sand substrates.

Oil spills may not be as detrimental to gulls, the second most dense bird group in Kachemak Bay. They are ubiquitous in distribution and catholic in food habits and, therefore, their vulnerability is relatively low. Many were found at low tide on mudflats and fed upon barnacles, *Clinocardium*, crabs, and polychaetes (Dames and Moore 1979a), but food habit information for gulls in Lower Cook Inlet is sparse.

In spring shorebirds fed on protected mudflats of Mud Bay and Fox River Flats. These habitats are highly susceptible, and the prey species, *Macoma* and *Mya*, would be vulnerable to oil washing ashore. Dabblers, abundant only in the fall survey of Kachemak Bay, were found on bay, lagoon and river waters. According to Crow (1978), dabblers fed predominantly on plant material (*Puccinellia hultenii* and *Triglochin maritima*) and bivalves ("pink clams"). These food items are found on salt marshes and protected mudflats, both highly susceptible to oil spills.

During all of the year except summer outer Kachemak Bay had the highest pelagic densities of birds of all regions in Lower Cook Inlet. Alcids and sea ducks, the two most vulnerable groups, were the most abundant birds. Oil on these waters would harm large numbers of these birds. Because waters there are clear (versus turbid in many other parts of the Inlet) congregations of birds feed in this area. A winter concentration of up to 10,000 White-winged Scoters southwest of Bluff Point was documented (Erikson 1977) and has been observed in the same location during three winters. Black-legged Kittiwakes are also commonly observed feeding in Outer Kachemak in summer and fall. If they feed on sand lance (*Ammodytes hexapterus*) as they did at Chisik Island (Jones and Peterson 1979), any damage to sand lance populations by oil would also be harmful to kittiwakes.

<u>Lower Central Zone</u> - The Lower Central Zone of Lower Cook Inlet would contain most of the offshore drilling platforms and, therefore, have the greatest potential for acute oil spills. Although the extent of the shoreline in this zone is small, it was singled out as the most critical area in terms of time of impact of oil spilled from platforms and the probability of exposure to spilled oil. The exposed coast from Chinitna Bay to Oil Bay had few birds in all seasons and was rated in the lowest susceptibility categories for the substrate present (Hayes et al. 1977). Sea ducks in spring had the greatest density (21 birds/km^2) for that section of coast. In summer 1978, several feeding frenzies containing several hundred Black-legged Kittiwakes and many loons were observed along this coast. The kittiwakes may have been from the Chisik Island colony. Spilled oil would harm these birds and their food source as well.

Chinitna Bay, also in this zone, had a much richer avifauna than the exposed coast. Densities of about 100 birds/km^2, or more, were found in all seasons but winter. Extensive mudflats and salt marshes at the head of the bay provide ideal habitat for dabbling and diving ducks, shorebirds and gulls. Late April and May are the most critical periods, when shorebirds, diving and dabbling ducks stage in the area. Dames and Moore (1979a) found that *Macoma balthica* was the dominant species in the mudflats of Chinitna Bay, and this clam is a common food item of these birds. A colony of almost 1500 birds on Gull Island at the mouth of the bay would be vulnerable to oil throughout the summer. Tufted Puffins, the most abundant bird at the colony, frequently raft in the water around the island and would be particularly vulnerable.

Densities of birds in pelagic waters of the Lower Central Zone were relatively low. Sea ducks were abundant (58 birds/km^2) in summer, but most of these birds were comprised of a large flock of almost 4,000 scoters seen on a boat survey past Pomeroy Island. Other high densities in this zone were found in the portion nearest outer Kachemak Bay and Kennedy Entrance. Here, shearwaters and other species gathered in summer months. Both the scoters and shearwaters would be vulnerable to oil on the water as would their benthic and planktonic food organisms.

Kamishak Bay - Dames and Moore (1979b) did not single out areas in Kamishak Bay as high risk for boundary contact zones or probability of exposure to oil spills except on the eastern half of Augustine Island. However, their figures showed that Ursus Cove would likely be impacted and Amakdedori Beach accumulates much drift and would also likely receive oil in the event of a spill. Many vulnerable bird species congregate in Kamishak Bay in spring and summer. Alcids, the most vulnerable species group, are abundant only in summer. Tufted and Horned Puffins and Pigeon Guillemots are common breeders on islands and suitable rocky, shoreline habitats throughout Kamishak Bay. Common murres breed in abundance only on McNeil Islet in the southwest corner of the Bay. These species would be harmed by oil on the water but would be less threatened by oil contamination of shoreline habitats unless the oil affected prey organisms.

Sea ducks were found to be the bird group in Kamishak Bay most likely threatened by oil. They were abundant in spring and summer and they would be more vulnerable than most species because in summer they molt and would be flightless for a few weeks and, thus, would be unable to avoid spilled oil. In spring, sea duck concentrations were from the mouth of Douglas River to Akumwarvik Bay, at Chenik Head and in Bruin Bay. In summer, densest concentrations were in the vicininty of Iniskin Bay and in Akumwarvik Bay. Much of the time, they were on water over intertidal or immediately subtidal to exposed and protected mudflats and eroding, wave-cut platforms. Although the exposed habitats are not highly susceptible to oil spills, the sea ducks using the habitats would be vulnerable. Little work has been done on food habits of birds in Kamishak Bay, but scoters collected in summer 1978 were predominantly eating pelecypods (*Nucula tenius, Musculus discors* and *Macoma balthica*) and Harlequin Ducks ate gastropods (*Littorina saxatilis* and *L. sitkana*). Sea ducks were the most common wintering bird group in Kamishak Bay but were found in much lower densities and were clustered in various parts of southern Kamishak.

Two other bird groups would be sensitive to spring oil spills in Kamishak Bay. Scaup were abundant in all bays, and they also joined sea ducks in exposed areas. Shorebirds, too, used intertidal mudflats in many of the bays. All small bays within the Kamishak

Bay region were given a high OSI rating by Hayes et al. (1977). Oil would not be easily flushed from the protected mudflats, and it is likely that mortality of pelecypods and other invertebrates fed upon by birds would be heavy. A flock of over 10,000 shorebirds was also found on exposed delta gravel during spring migration. This habitat has a medium susceptibility to oil and food organisms present in the substrate were unknown.

Glaucous-winged Gulls were the only other common bird in Kamishak Bay. They were distributed throughout the Bay, were found on a variety of habitats, and fed in a variety of ways on, presumably, a variety of foods. Some of the habitats were highly susceptible to oil and others were of low susceptibility. The gulls fed on mudflats at low tide, surface-plunged to seize small fish and scavenged on spawned out salmon. Three gulls collected contained *Crangon septumspinosa, Clinocardium* sp., and several fish species including *Ammodytes hexapterus*, an unidentified gadid and a greenling (*Hexagrammos* sp.). Hundreds of non-breeding gulls summered in Kamishak Bay and roosted on intertidal sand, gravel and rock throughout the coastline of the bay. Black-legged Kittiwakes were found in relative abundance only near McNeil Cove and did not breed in Kamishak Bay. The widespread distribution of most gull species in Kamishak Bay would likely mean they would be vulnerable to oil spills in the long-term, and more able to rebound from losses with immigration from areas not damaged.

Kennedy Entrance - Dames and Moore (1979b) considered the shoreline from Dangerous Cape to Cape Elizabeth in Kennedy Entrance to be the secondmost susceptible area to oil spills in Lower Cook Inlet. Spills from proposed nearby wells would be driven quickly ashore by the frequent southwest winds of spring and summer (their model did not include winter data). Only the bays had a high OSI rating by Hayes et al. (1977). Much of the shoreline is exposed rocky habitat. The Barren Islands, an area used by over one-half million seabirds in summer (Bailey 1976), were not studied in this research unit. The extent of winter bird use in the Barren Islands is unknown except for pelagic surveys of Research Unit No. 337. Discussion of impacts in this region will be based on shoreline surveys and a pelagic transect across the mouth of Cook Inlet.

In spring, bird densities along the shoreline of Kennedy Entrance were low. Little typical staging habitat for birds is present. However, in summer, densities of gulls, shearwaters and cormorants increased markedly. The situation for gulls is similar to that mentioned in previous regions. They were found on a variety of habitats and are, therefore, less vulnerable. This was the only region in which shearwaters were found in abundance. They appeared in late spring and remained into the fall. They were found almost exclusively on pelagic waters. Oil may pass quickly through areas used by shearwaters unless a prolonged blowout occurs. Shearwaters are moderately vulnerable to oil spills and would likely be affected if the spill occurred during their peak of abundance in Kennedy Entrance. Over 100 birds/km^2 were recorded in offshore waters of Kennedy Entrance by Erikson (1977). Erikson (unpubl. data) found that shearwaters in this area were eating sand lance, and suggested that any damage to their food source would force shearwaters to forage elsewhere in the Gulf of Alaska. Cormorants, spending most of their life on inshore water and, therefore, highly vulnerable to oil spills, reached their greatest Lower Cook Inlet densities in Kennedy Entrance. Several sites with high cormorant densities in the Chugach Islands may be far enough removed from oil spill trajectories to be vulnerable to oil. Summer and fall is the time when most cormorants would be affected in this region. Their exposed rock roost sites would be less affected because oil would have a low residence time on exposed surfaces.

Because the bays bordering Kennedy Entrance remain ice-free in winter, they were a wintering area for sea and diving ducks. The sea ducks began arriving in fall and remained in exposed inshore and bay waters until spring. Because of the high probability that oil would enter Port Graham and Koyuktolik Bay (Dames and Moore 1976b), sea ducks with a high vulnerability rating would be impacted. Finally, alcids, although not abundant on shoreline surveys, rest in abundance on Flat Island where Erikson (1977) estimated over 1,800 pairs of Tufted Puffins were breeding. This island colony is in the path of high risk trajectory for oil spills and, therefore, would be severely damaged if the spill occurred from April to September.

Kalgin Island - Because much of this region contains turbid water from glacial streams in Upper Cook Inlet, the Kalgin Island area does not host many feeding seabirds. The area contains the largest seabird colony in Lower Cook Inlet (except for the Barren Islands) on Chisik Island, but low bird densities north of the colony indicated the birds must forage south of this region. The trajectory model of Dames and Moore (1979b) predicted that Chisik Island and areas just north of Chisik would be impacted by oil spills. If not their foraging areas, the birds themselves stand a high risk of being affected. Species in the colony are those highly vulnerable to oil, Horned and Tufted Puffins, Common Murres and Black-legged Kittiwakes. The customary habit of these birds to sit on the water below nesting sites, make them vulnerable to oil on the water.

Much of this region was not included in the geomorphology study by Hayes et al. (1977), but Tuxedni Bay was, and it was given a high rating for oil susceptibility. In spring, these susceptible mudflat habitats were used by diving, sea and dabbling ducks and shorebirds, and in fall, geese and dabbling ducks were the predominant birds of Tuxedni Bay. Oil entering this bay would affect both the birds and the invertebrates on which they feed.

Oil spills may also come ashore on Kalgin Island. Swamp Creek on the east side of the island is the area most used by birds and also isa habitat that is most susceptible to oil spills. Dabbling ducks and geese were the most numerous birds during spring migration. The birds themselves are not as vulnerable as the habitat on which they stage at Swamp Creek.

Three other areas in this region have high OSI ratings and were used by large numbers of birds but were not in locations of high probability of exposure to oil in Dames and Moore (1979b). Mudflats and salt marshes of Bachatna Flats in Redoubt Bay supported densities of over 200 shorebirds, geese and dabbling ducks/km^2 in spring. The mouths of the Kenai and Kasilof Rivers are also staging habitat for geese, dabblers and cranes. Using Hayes et al.'s (1977) susceptibility rating, the mudflat areas are only moderately susceptible to oil spills, but the adjacent salt marshes would be highly susceptible. Because it is one of few areas used by migrating Snow Geese in spring, the Kenai River flats should be termed critical habitat for these birds. Gulls, too, used Redoubt Bay and the Kenai and Kasilof River mouths but rely heavily on cannery wastes for food and would be most affected if oiled on their roost sites on sand/gravel beaches. Sea ducks were abundant only in the area from Anchor Point to Ninilchik, but this area may be impacted from oil spilled by offshore platforms in the north portion of the lease area.

Bird densities in offshore waters of this region were low in all seasons. Birds from the Chisik Island colony may be traveling as far as 60 km to forage in outer Kachemak Bay and would not be vulnerable to oil spills in offshore waters of the northern portion of Lower Cook Inlet.

Shelikof Straits - This region was not studied as a part of the Lower Cook Inlet lease area. Limited data were gathered on the Alaska Peninsula side in winter 1977 and on the Kodiak Archipelago in winter 1976 and are discussed under those sections. A review of present knowledge of birds in Shelikof Straits was presented in Easton and Spencer (1979). They indicated a paucity of baseline data on birds in this region so that impacts from oil spills are unknown.

Potential Shore-Based Facilities Tanker Terminals

Kachemak Bay - In BLM's development scenario, oil terminal, LNG and production treatment facilities were suggested for the Anchor Point area as was a support base in Homer. Some of the adverse effects of installation of these facilities include habitat destruction during construction, physical disturbance by increased boat and aircraft traffic in the area, chronic, small oil spills during loading operations and thermal pollution from LNG plants. If the site is located on coastal floodplains near the mouth of Anchor River, some marine bird habitat will be destroyed. Although this is not a major staging or nesting area, various species of waterfowl and shorebirds do use these habitats. The greatest amount of bird use in this area comes from sea ducks feeding in nearshore waters in spring. Erikson (1977) suggested that the heaviest use of this area was in winter. Physical disturbance would likely have a severe impact on sea duck use. Tankers and support vessels travelling to and from terminals would flush birds from their feeding grounds. Because Kachemak Bay has the highest density of marine birds in all seasons for Lower Cook Inlet, the increase in traffic to Anchor Point (either from Homer by helicopters or across outer Kachemak Bay by tankers) may displace birds from traditional feeding areas, or at least increase stress on birds during periods when this may be detrimental to bird populations. Chronic oil spills or other pollution from onshore terminals may have the greatest long-term effects on birds. Due to the proximity of the Anchor Point site to the rich waters of outer Kachemak Bay, any contaminants drawn south into the Bay would affect the entire food chain below birds and, eventually birds would be affected. If closed cooling systems are used at these sites, no direct effects to birds will result. However, some of their prey species may be affected. Thermal pollution from an open cooling system may attract birds to where they would be more concentrated and, therefore, more vulnerable to oil or other pollution. No reports on the effects of thermal pollution on birds in northern waters were found.

Kennedy Entrance - The greatest threat from onshore facilities located in the Port Graham to Port Chatham area would be if pollution (oil, thermal, or other contaminants) entered outer Kachemak Bay and affected marine birds or their food organisms in that area. In waters adjacent to onshore sites, only a few bird groups would be affected. In summer, shearwaters may be adversely impacted by increased tanker traffic to the terminal. Assuming that ballast is properly disposed of into onshore cleaning facilities, physical disturbance caused by the tankers would be the greatest impact. Cormorants, sea ducks and diving ducks may be physically disturbed on inshore waters near terminals in fall and winter, or contaminated if small spills occur at the terminal. Other bird groups use waters near proposed terminal sites but in smaller numbers. Erikson (1977) documented Port Chatham as a goose staging area. Brant fed in eelgrass beds at the head of the bay in spring 1976, but the annual magnitude of annual use by geese is unknown. Increased helicopter traffic to terminal sites may stress Tufted Puffins nesting on Flat Island.

Kalgin Island Area - A production treatment site has been suggested for the north shoreline of Tuxedni Bay, with an overland pipeline to an existing terminal at Drift River. Construction of the facilities would likely have minimal impact on marine birds. However, low level pollution from hydrocarbons and other contaminants into waters near the site could have substantial impact on birds using Tuxedni Bay and Chisik Island. The same discussion for chronic and acute oil spills at drilling platforms applies to onshore facilities. Thousands of birds use Tuxedni Bay in spring, summer and fall, and if food organisms for birds are reduced by chronic pollution, the effects on birds would be substantial. If crew changes at the site required helicopter traffic, a corridor must be established to avoid disturbing seabird colonies at Chisik and Duck Islands. The overland pipeline to Drift River would not impact marine birds. Similarly, the proposed pipeline from Anchor Point to Nikiski would not affect marine birds unless a leak occurred into rivers draining into Lower Cook Inlet.

Pipelines:

Kachemak Bay - The actual pipeline laying operations would have minimal impact on birds. There would be temporary physical disturbance, sediments would be resuspended temporarily and some food organisms of birds would be destroyed. Once production started, a break in the pipeline or chronic leaks from the line would be extremely damaging to the abundant avifauna of outer Kachemak Bay. Details on species composition and critical time periods have already been mentioned in a previous section.

Lower Central Zone - Pipeline laying operations would not substantially affect birds of this zone. Bird densities were low in all seasons throughout the area except for waters adjacent to outer Kachemak Bay and in the vicinity of Chinitna Bay. Spills from pipeline breaks were discussed under drilling platforms. Small, chronic leaks in the leased portion of this zone would be less damaging than those nearer concentration areas for birds.

Kennedy Entrance - A similar discussion, as mentioned above, for pipe laying operations would be true for Kennedy Entrance. Spills from pipeline breakage would be similar to those covered under drilling platform spills.

Kalgin Island Area - The laying of pipe to the Redoubt Point area would cause only temporary disturbance to birds. Discussions of oil spill damage to birds under the drilling platform section apply in the case of pipeline breaks.

Tanker Routes (Tanker Spills Along Routes) See section on drilling platforms for the effects of acute oil spills in each of the regions of Lower Cook Inlet.

Physical Disturbance (Aircraft & Boat Traffic) This topic was discussed under the potential shore-based facilities section. In general, boats continually moving through concentrations of birds on traditional feeding areas may displace them to less productive feeding areas or cause stress detrimental to the birds. If the frequency of the traffic is low, little damage would result. Helicopter traffic is most stressful to birds and invariably causes them to flush. Corridors need to be established around colonies and concentration areas.

South-Alaska Peninsula

No offshore lease sales are planned for this region, except in the Shelikof Straits area, which extends from Cape Douglas to Wide Bay. However, the region could be impacted by development in the southern portion of the Kodiak lease area or if pipelines cross the Alaska Peninsula from the Bering Sea lease areas. Specific locations for onshore facilities are not presently known. Discussion will deal only with the impact having the potential of causing the greatest damage (acute oil spills) under existing conditions. Information from other investigators on habitat susceptibility and nearshore benthos is lacking.

Too few data were gathered in south-Alaska Peninsula for this study to be able to adequately predict effects of oil spills. Only partial surveys were flown in fall and winter. Fall surveys of the southern three sections in the region revealed that geese were the most numerous bird group. Although geese have only a moderate OVI rank, they could be seriously affected because the habitats they use for staging are highly susceptible to oil spills. They fed primarily in lagoons on eelgrass which is found on intertidal mudflats or shallow water areas. Salt marshes, another habitat of high susceptiblity, were frequently used by dabbler and diving ducks. Any oil reaching areas where these birds fed or roosted would remain for several years, preventing further use by these birds. Sea ducks were mainly found on exposed waters where oil would harm the birds as it floated toward shore, but where longevity of oil was short. Gulls were on a variety of habitats in fall and impact on them would be minimal in many areas. Spilled oil moving through False Pass poses the greatest threat to gulls during fall in the southern part of this region. Few other highly vulnerable birds were recorded in this survey.

Few shoreline habitats were searched in the winter survey to determine which bird species would be affected by oil development. The species groups most vulnerable to oil, alcids and sea ducks, were the two groups found in greatest numbers. Most alcids (murres) were on the water near known murre colonies and would be vulnerable to oil as long as it remained in the area or if their food populations were diminished by the oil. Sea ducks were scattered throughout the region which is ice-free in winter and would be similarly affected by oil spills. Emperor Geese were most abundant in the Shelikof Strait section. They would be affected if oil contaminated their food sources, including marine algaes, barnacles and blue mussels, on exposed rocky shores where the birds were most frequently found. Cormorants, too, were found along exposed rocky shores throughout the region, but the birds themselves would likely be as vulnerable to oil as their food (largely fishes) because of the cormorants' propensity for water. Black-legged Kittiwakes joined murres on the water near colonies and, as such, would be susceptible to oil on the water. Most of the habitats with the highest OSI rating were not searched in this survey.

North-Alaska Peninsula

As with many of the regions in this study, no specific information on locations of onshore facilities, pipeline corridors or tanker traffic lanes was available for North-Alaska Peninsula. Discussion will be limited to effects on birds and their habitats from acute oil spills. Less variety of coastal habitats is found in this region compared to other regions in the study area and, in general, habitats are either exposed sand and gravel beaches or protected lagoons and embayments. The former has a low susceptiblity to oil and latter is highly susceptible. The estuaries also had the highest bird densities in fall of any area studied in southcentral Alaska. Any oil and gas development in this region would have to insure the utmost protection for these estuaries. Only the most numerous bird groups will be discussed, and they will be arranged in order of decreasing vulnerability to oil.

Suitable habitat for nesting alcids (the most vulnerable bird group) is scarce in the region, and this group was abundant only in waters around colonies on Amak Island and Sea Lion Rock in summer. Few were observed inshore in other parts of North-Alaska Peninsula and would not, therefore, be impacted by oil. Sea ducks, on the other hand, were abundant inshore in all seasons of the year. Although many were found on the less susceptible exposed habitats (particularly at promontories along exposed coasts), the greatest concentrations were just inside lagoon and embayment mouths near sand and gravel spits. It is likely they fed on benthic molluscs in the mud and sand of the lagoons, embayments, bays and river deltas. In any season, oil entering these estuaries could affect thousands of sea ducks. For Steller's Eiders the impact would be for a large portion of the North American population.

Cormorants, like alcids, have little suitable nesting and roosting habitat in this region. They were most abundant in the southern portion of North-Alaska Peninsula and would, therefore, be vulnerable only in that region. Their preferred rocky habitats would not be greatly harmed and comparatively few individuals would be affected by oil development. Shearwaters, however, moved into pelagic waters around Amak Island by the hundreds of thousands in summer and could be severely impacted by a large oil spill. More information on this group will likely be presented in the final report of Research Unit No. 337. Mergansers were abundant only in spring and at that time primarily used fluviatile waters that are presumably less susceptible to spilled oil than many habitats.

Moderately vulnerable diving ducks were most common from Egegik north in spring and in Herendeen Bay in fall. Several of the habitats in which they were commonly found (salt marsh, protected alluvial, lagoon and bay waters) are relatively susceptible to oil damage. Diving ducks frequently fed on water over intertidal mudflats, both exposed and protected. If populations of their food organisms, which are often benthic bivalves, are diminshed by oil contamination, diving ducks would be affected on their spring and fall migration staging areas.

The mean OVI of 51 (Table 23) for geese and swans suggests only a moderate vulnerability to oil. Low vulnerabilities for Canada, White-fronted and Snow Geese were combined with moderate vulnerabilities for swans and high vulnerabilities for Brant and Emperor Geese to get the mean. Estuaries on North-Alaska Peninsula are used by the entire North American populations of Emperor Geese and Black Brant (*Branta bernicla nigricans*), both rated 70 OVI points by King and Sanger (1979). Not only do the geese using North-Alaska Peninsula lagoons have a high vulnerability rating, but they also were the group found in greatest densities in both spring and fall and were using habitats that are highly susceptible to oil contamination. The major migration staging area for Brant is Izembek Lagoon where the geese feed on eelgrass. Emperor Geese also eat eelgrass when at Izembek Lagoon but eat other vegetation (marine algae and heath berries) and benthic invertebrates in other lagoons. Canada Geese were found in all estuaries from Swanson Lagoon to Egegik Bay in fall and also at the mouth of the Kvichak River in spring. These geese were found most commonly where salt marsh habitats were abundant. They frequently grazed on halophytic vegetation but also fed on berries in the tundra and flew to marine waters and mudflats for roosting. The population of Snow Geese returning from Wrangel Island in Siberia in the fall normally stages at Ugashik Bay and vicinity. The importance of the North-Alaska Peninsula estuaries to migrating geese cannot be overemphasized. When the value of these estuaries to unique and large populations of sea ducks is added to that of geese, the necessity of protecting the estuaries from degradation by contamination, disturbance, or habitat destruction is multiplied.

Gulls were found in moderate densities throughout the North-Alaska Peninsula region in all seasons and on a wide variety of habitats. Frequently they were observed on flat, sandy beaches which have a low OSI on the Hayes et al. (1977) scale. Black-legged Kittiwakes nested on sandstone bluffs at Cape Seniavin and were observed bathing and roosting on nearby river mouths. Foraging areas were not found. In winter, only large gulls remained but in relatively high densities. Oil development may affect a portion of the population but the overall impact would, presumably, be minimal.

Terns were abundant only in spring surveys but were observed in all offshore sections in summer. By the October surveys, they had left the area. Their use of exposed habitats in spring would make them less vulnerable to impacts by oil pollution in that season. Their summer distribution and habitat use were not discerned in this study.

In spring, shorebirds were most numerous in the northern portion of North-Alaska Peninsula on exposed mudflats. For that reason, impacts of oil and gas development would be less. In fall, the region was utlized more heavily by staging shorebirds. At this time, they frequented all estuaries along the coast. Many fed on intertidal mudflats in lagoons or near river mouths. Gill (1978) reported that Dunlin spent approximately 110 days in Nelson Lagoon building necessary fat reserves to sustain them on a trans-Gulf of Alaska migration to Oregon and California. If oil destroys food required for this flight, serious damage could be done to that and other species of shorebird.

In spring, dabbling ducks, like shorebirds, were most abundant on the northern portion of North-Alaska Peninsula (from Port Heiden to Kvichak River), and in fall dabblers were common in all estuaries of the region. The habitats they preferred in all seasons were those with the greatest susceptibility to oil contamination, salt marshes, protected intertidal mudflats, alluvial floodplains and waters of lagoons and rivers. Dabbling duck populations have a low OVI because they are numerous and widespread in North America. However, certain subpopulations would be threatened if important staging areas were inundated with oil that lasted several years. By adding dabbling ducks and shorebirds to the list of birds using North-Alaska Peninsula estuaries for a necessary migration stop to build fat reserves before continuing migration, it magnifies the importance of these areas and the critical need for their protection.

North-Bristol Bay

No offshore oil and gas lease sales are presently scheduled for the vicinity of the North-Bristol Bay region. Effect of development would likely come from oil spills in lease areas to the southwest. Only those species using the coast in spring and the Walrus Islands in summer were documented in this study.

The most vulnerable species, alcids, were abundant in only the section from Cape Peirce to Cape Newenham, sites of major seabird colonies. In 1976 murres were already present on 28 April and Tufted Puffins arrived on 17 May (Petersen and Sigman 1977). These birds would be vulnerable to oil when rafted in the water below nesting cliffs and when foraging at sea. Their eggs or young would be affected if adults brought oil back to the nests on their feathers.

Sea ducks were not abundant in most of North-Bristol Bay. Densities were greatest in Nushagak Bay and west of Kulukak Bay. Possibly many sea ducks bypass the upper portion of Bristol Bay and migrate north across the bay from North-Alaska Peninsula staging areas. However, several flocks of a few thousand King Eiders were observed in Nushagak Bay on 8 May 1977 outside the survey transect. Black Scoters predominated along the coast. Large quantities of oil on bay and nearshore waters would pose the greatest threat to these birds.

Concentrations of diving ducks (primarily scaup) were recorded in successive spring seasons in the Flounder Flats area of Nushagak Bay. The area was obviously an important staging area, and if oil damaged populations of prey species, or the spill occurred in May and drifted into the bay while scaup were present, serious damage could be done. Mud was the likely substrate under the water from foraging diving ducks. Mudflats in protected areas would retain oil long enough to affect birds for several successive seasons.

Nanvak Bay was the only area where geese occurred in dense concentrations. Oil entering that confined area would damage an important staging area. In other sections, geese were found on alluvial floodplains where the longevity of oil would be great if it got into sedge/grass meadows during a flood tide.

Black-legged Kittiwakes and Mew and Glaucous-winged Gulls were at nesting colonies in large numbers by the May surveys. Away from breeding locations, gulls were in moderate or low densities yet were found in all sections, and as in other regions, used a variety of habitats. Mew Gulls would be affected if oil reached the alluvial floodplains on which they established breeding territories. The vulnerability of kittiwakes would be greatest on exposed inshore waters where the birds rafted or if their food supply were adversely affected by oil. The impact of oil pollution would be greatest for gulls at Cape Peirce, Cape Newenham and the Walrus Islands.

On their migration to more northerly breeding areas, shorebirds used North-Bristol Bay in relatively large numbers. The majority used alluvial mudflats and floodplains. These habitats would be damaged for extended periods if inundated with oil because they are difficult to clean and natural processes would act slowly in these areas. Assuming that these staging areas are necessary to build sufficient energy stores in shorebirds to continue their spring migration, an oil spill could severly affect those populations.

Like shorebirds, dabbling ducks were most dense at the mouth of Kvichak River and they used vulnerable alluvial habitats along with shorebirds. The same discussion about oil impacts as in the preceding paragraph applies here. The probability of oil reaching these habitats has not been calculated.

Other aquatic bird groups of lower densities could be affected if oil reached North-Bristol Bay. Cormorants were on inshore waters near nesting sites and mergansers and loons staged in moderate densities on inshore and fluviatile waters. Oiling of these birds would be common if an acute spill occurred nearshore. Perhaps the toxic, aromatic compounds would be gone from oil travelling a long distance to this area and food organisms of these birds would not be as greatly affected.

Aleutian Shelf

The Aleutian Shelf region, as defined in this study, could be potentially affected by oil and gas development in the St. George Basin lease area, the old Aleutian Shelf lease area south of Umnak and Unalaska Islands and the newly created North Aleutian Shelf lease area north of Unimak Island. Development scenario have not yet been constructed to show where onshore impacts will be. Facilities would likely be placed in this region only for the south Aleutian Shelf lease area and that sale has been indefinitely postponed. Therefore, the likely impacts will be from acute oil spills from the two northern lease areas and increased disturbance resulting from the use of Unalaska Village as a staging area. Time and money constraints allowed only one survey in the region. Winter was chosen because the islands are ice-free in winter, and it was assumed that this area was used by many wintering birds. Also, the severity of storms in winter would increase the likelihood of catastrophic impacts from oil.

Sea ducks were the only bird group abundant in all sections. Most were recorded on exposed inshore waters, a habitat with a low OSI. Exposure time to sea ducks would be relatively short as oil should not remain long on exposed water. Sea ducks found on bay water (the second most frequently used habitat) would be exposed to oil for longer periods of time. The food habits of these birds have not been studied in this region, but they likely eat benthic crustaceans and pelecypods as in other areas. Any oil damage to their prey populations would force these sea ducks to other wintering areas.

The other highly vulnerable seabirds, alcids, were not abundant on nearshore waters during this winter survey. If this is an annual situation, impacts from oil development on alcids would be low. In this season, alcids are more abundant in offshore waters. An estimated 100,000 murres died in a "wreck" from severe storms in outer Bristol Bay in 1970 (Bailey and Davenport 1972), which indicated that many murres were present in offshore waters in winter.

Emperor Geese were recorded in moderate numbers on exposed rocky coasts throughout the region. High numbers were present on northwest Unmak and extremely high densities occurred on Samalga Island. The habitat used by these birds in winter has a low OSI. The birds, too, may be somewhat protected if rebounding wave action prevents most oil from splashing the birds and their feeding areas. Oil contamination of their intertidal food organisms would cause the most long-term harm to wintering goose populations. Oil splashing ashore onto roosting or feeding birds would directly harm the geese.

Large gulls (few small gulls were recorded) were equally abundant in protected and exposed habitats and were moderately dense throughout the region. Greatest concentrations were on Samalga Island. As in other regions, the versatility of gulls in food habits and widespread distribution on various habitats would lessen the impact of oil development on this group.

Shorebirds were abundant in only two locations, on the gravel beaches of Samalga Island and on gravel or rock on the south side of Ummak Island. Presumably, most shorebirds were Rock Sandpipers. Longevity of oil on their exposed habitats is short which would reduce chances of oil-bird contact. A greater threat would be the destruction of prey items through oil contamination. Most Rock Sandpipers winter no farther south than Alaska and damage to wintering habitats could severly impact this uncommon species.

The only other high bird densities were for dabbling and diving ducks on the beach of Samalga Island. Because geese, sea ducks, shorebirds and gulls also reached highest densities on this island, it should unequivocally be classified critical wintering habitat for marine birds, and necessary steps should be taken to protect it from any oil and gas impacts. Surrounding waters and intertidal rocks were also used by many harbor seals and sea otters.

If Dutch Harbor/Unalaska is used for a staging facility for offshore development, there will be substantial increases in helicopter and boat traffic in Unalaska Bay. From ground observations, it was apparent that gurry from active crab canneries has artifically inflated numbers of certain marine bird species near town. Other birds were normally distributed throughout the bay. Physical disturbance will likely displace the more shy species and place some stress on those remaining.

VIII. CONCLUSIONS

Northeast Gulf of Alaska

During the early May survey, shorebirds and gulls were the predominant species groups. The area from Cape Suckling to Cordova had the highest densities of birds and requires the greatest degree of protection from possible impacts of oil and gas development. Shorebirds primarily used protected mudflats, a habitat that is highly susceptible to oil spills. Large gulls used a variety of habitats and, therefore, may be less vulnerable to spilled oil. Alcids would be vulnerable on water near their colonies at Wingham and Martin Islands. More information needs to be gathered during the waterfowl migration period, especially in estuaries south of Yakutat.

Spring migration corridors past Cape St. Elias indicated that some species bypass staging areas at Copper River Delta. Other species used waters around the Cape for feeding and resting and would, therefore, be vulnerable to oil spilled in spring.

During limited summer surveys, gulls were abundant on sand beaches from Icy Cape to Cape Suckling. Non-breeding sea ducks were found in greatest numbers in Icy Bay. No coastal bird survey work has been done in fall and winter in NEGOA, and such surveys are necessary to adequately assess potential impacts of oil and gas development.

Kodiak

Sea ducks were the most abundant wintering marine bird on all but the Afognak/Shuyak section of the Kodiak Archipelago. In that section, diving ducks, the second most numerous species overall, predominated. Low densities of alcids and gulls were also found. Because most of the birds were found in protected bay/fjord habitats, oil contamination reaching these waters would affect over 80 percent of the birds wintering on inshore habitats.

Lower Cook Inlet

During spring coastal surveys, shorebirds were the most abundant bird group and gulls were second in abundance. Gulls were densest in summer and fall while sea ducks predominated in winter. Almost half the gulls in spring and over one-fourth the gulls in summer were Black-legged Kittiwakes associated with the Chisik Island colony. Other gulls were scattered throughout the Inlet in a variety of habitats. Sea ducks were one of the most abundant groups in all seasons. They are very vulnerable to catastrophic oil spills and the habitats and food organisms they select are also highly susceptible to damage from oil. Therefore, they are a group that likely will be highly affected by adverse impacts of oil and gas development.

Both inner and outer Kachemak Bay had one of the highest bird densities for all seasons. In winter, birds concentrated in this area while few were found on the west side of Lower Cook Inlet. Because birds concentrated near Anchor Point, a lower probability of impact from oil and gas development would result if onshore facilities were placed at Cape Starichkof or more northern areas.

Kamishak Bay was important to sea ducks, diving ducks and shorebirds in spring and to sea ducks in summer. North of Tuxedni Bay birds were abundant only at river deltas and salt marshes. These habitats are highly susceptible to oil because of the long retention time.

In offshore waters of Kennedy Entrance, the species group most vulnerable to adverse impact of oil and gas development (excluding Barren Island colonies) would be shearwaters during summer. Sea ducks were the most abundant bird in offshore waters throughout Lower Cook Inlet in all seasons.

South-Alaska Peninsula

Although little bird survey work was conducted in this region, the lagoons of Cold and Morzhovoi Bays were found to be very important to staging geese in fall. Exposed habitats in winter contained several concentrations of murres near islands where they breed in summer. Sea ducks were the only other commonly observed species group on exposed habitats in winter. Both alcids and sea ducks are highly vulnerable to oil spills.

North-Alaska Peninsula

Estuaries on North-Alaska Peninsula were found to have the greatest bird densities of any region in the southcentral Alaska study area. In spring, geese, sea ducks, gulls and dabbling ducks were found in abundance. In fall, the same species groups were found plus shorebirds. Longevity of spilled oil in these estuaries would likely be of a duration to affect bird populations for several years. Several unique bird species use these estuaries exlusively for migration staging and a major portion or all of the North American or world populations would be affected if oil entered the estuaries.

Shearwaters were extremely abundant in offshore waters at the southern end of the Peninsula in summer. In winter, sea ducks were found in both lagoon and exposed inshore habitats and most gulls used exposed sand beaches. Few other bird groups were observed in measurable quantities during winter.

North-Bristol Bay

This region had lower bird densities in spring than other regions of the study area. It is likely on the edge of the migration corridor for shorebirds flying toward breeding grounds. Relatively low waterfowl densities may mean that many ducks and geese fly over Bristol Bay when heading for northern staging and nesting areas. However, Flounder Flats was very important to scaup on two susessive spring surveys. Protected delta habitats were those most used by birds. Sea birds from large colonies at Capes Peirce and Newenham and the Walrus Islands were not censused in these aerial surveys.

Aleutain Shelf

Exposed inshore habitats were found to be important wintering habitat for sea ducks, Emperor Geese, Rock Sandpipers and large gulls in the eastern Aleutian Islands. Samalga Island was the section supporting the highest bird densities and merits special protection from adverse impacts of oil and gas development. Inclement weather precluded comprehensive surveys to further substantiate the importance of this region to wintering marine birds.

Species composition and abundance of birds change quickly during spring and fall migrations, and this fact must be taken into consideration when interpreting survey data. One survey per season provides an inadequate data base upon which to make concrete conclusions about bird densities and habitat usage. Coastal bird survey techniques must be identical to allow direct comparison of results. It would be helpful to standardize coastal survey techniques in future studies. Also, habitat availability as well as habitat preferences of birds should be recorded in all surveys.

The substrate of a habitat *per se* is not an absolute indicator of susceptibility to oil spills for birds. Consideration must be given to biological productivity of birds' prey organisms in the substrate types and to the various uses of the substrates (feeding, roosting, nesting).

The relative vulnerability to oil spills of each bird species or group varies markedly. Population size and distribution, reproductive potential, and propensity for marine waters all play a role. In this study, the bird groups with the highest calculated index for potential damage from oil spills were alcids and sea ducks.

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Table A1. Definitions of some habitats used in this study.

	Water Types
Protected shoreline:	Indented coast where shoreline is three or more times the width of the opening.
Bay[1]:	A large estuary with a relatively high degree of flushing.
Lagoon[1]:	A relatively shallow estuary with very restricted exchange with the sea and no significant fresh water inflow.
Embayment[1]:	A relatively small and shallow estuary with rather restricted flushing and significant freshwater inflow.
Fjord[2]:	A long, narrow deep inlet from the sea between steep cliffs and slopes. (Characterized by having an underwater sill and shallower water near the mouth - Author.)
Unprotected shoreline:	Coastal shoreland exposed to open ocean with a high energy beach.
Brackish pond or lake:	A body of water within the coastal floodplain that is influenced by saltwater during storm tides.
Fresh water pond or lake:	A body of water containing no measureable salt water and found above the coastal floodplain.
	Physiographic Feature
Coastal floodplain:	The area of shorelands extending inland from the normal high tide line to the maximum storm water level.
Salt chuck:	An intertidal estuary with a restricted outlet, with or without fresh water inflow.
	Other definitions are self-explanatory.

[1]From Clark, J. 1974. Coastal Ecosystems. Ecological Considerations for Management of the Coastal Zone. The Conservation Foundation. Washington, D.C. 178pp.

[2]From Morris, W. Ed. 1970. The American Heritage Dictionary of the English Language. American Heritage Publishing Company, Inc. and Houghton Mifflin Company. New York. page 497.

Table A2. Number of birds in each species group within regions of southcentral Alaska by season as determined from aerial, coastal bird surveys in 1975 - 1978.

Species Group	NECOA		Kodiak	Lower Cook Inlet								S. AK. Pen.		North Alaska Peninsula				N. Br. Bay		Al. Sh.
	Sp	Su	Wn	Sp	Su-p*	Su	Su-p*	Fa	Fa-p*	Wn	Wn-p*	Fa	Wn	Sp	Su-p*	Fa	Wn	Sp	Su-p**	Wn
Loons	523	6	96	115	9	165	2	91	12	100	7	58	27	135	2	138	35	584	1	28
Grebes	20	0	5	108	2	8	0	85	1	11	0	3	11	38	0	37	17	123	0	34
Tubenoses	0	0	0	0	5	1,006	550	3	217	0	6	0	5	0	68,798	82	0	0	0	39
Cormorants	485	32	963	1,542	81	2,617	0	2,872	16	681	37	418	1,253	57	63	1,293	292	1,714	521	1,503
Geese and Swans	1,759	0	131	7,802	0	86	0	2,659	0	2	0	29,711	1,336	87,253	0	623,965	2,154	7,235	0	7,236
Dabblers	5,660	0	3,208	16,652	30	2,314	0	13,144	4	1,502	0	1,857	191	15,597	0	54,605	5	10,131	0	238
Divers	6,042	0	4,465	26,309	16	1,141	0	1,105	85	3,174	0	564	246	2,507	0	1,899	108	12,872	0	278
Sea Ducks	7,619	2,996	16,975	42,493	4,724	38,523	147	12,187	708	12,697	1,879	1,258	7,031	37,832	131	226,465	21,181	10,143	372	18,233
Mergansers	815	0	207	1,252	1	316	0	315	0	253	0	26	21	1,031	0	109	15	1,238	0	73
Raptors	190	11	164	51	2	59	0	41	0	55	0	25	93	58	0	62	41	27	0	69
Cranes	80	0	0	251	0	13	0	0	0	0	0	0	0	173	0	0	0	167	0	0
Shorebirds	58,049	442	1,343	69,531	17	3,067	2	1,645	16	4,640	3	177	971	13,184	29	95,864	15	22,394	6	5,659
Gulls and Jaegers	39,061	17,231	1,814	59,495	732	62,764	338	23,050	520	2,386	406	2,250	3,716	44,335	2,720	45,220	8,628	13,607	208	4,681
Terns	6,411	1,926	0	15	7	434	31	0	0	0	0	0	0	1,359	28	1	0	1,354	1	0
Alcids	3,687	0	2,936	610	794	9,674	255	211	394	365	397	7	11,711	43	2,115	246	1,146	8,719	3,645	1,938
Corvids	25	3	590	129	0	85	0	709	0	786	0	8	71	40	0	63	73	44	0	78
Other Passerines	65	0	23	2	0	230	0	42	0	28	0	4	20	143	0	1,461	150	112	0	67
Other Birds	53	0	106	980	49	159	32	168	9	399	3	93	1	273	0	3,353	0	774	0	125
Total	130,544	22,647	33,026	218,337	6,489	122,661	1,357	58,327	1,982	27,079	2,738	36,459	26,704	204,058	72,604	1,054,863	33,860	91,238	4,754	40,279
No. of Surveys	1	1	1	5	2	2	1	2	2	3	3	1	2	2	2	2	3	3	1	1
Total area (km^2)	863	61	857	1138	389	979	153	891	223	846	538	131	399	1451	171	2328	642	1067	36	427

* Aerial pelagic surveys
** Boat pelagic survey

Table A3. Sample sizes of birds observed on coastal aerial and boat surveys in south central Alaska, 1975 - 1978. Data arranged by region and season.

Lease Area	NEGOA		KODIAK	LOWER COOK INLET								S. AK. PENIN.		N. AK. PENIN.				N. BRISTOL BAY		ALEUTIAN SHELF
Season	Spring	Summer	Winter	Spring		Summer		Fall		Winter		Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Winter
Type	Shoreline	Shoreline	Shoreline	Shoreline	Pelagic	Shoreline*	Pelagic	Shoreline	Pelagic	Shoreline	Pelagic	Shoreline	Shoreline	Shoreline	Pelagic	Shoreline	Shoreline	Shoreline	Pelagic**	Shoreline
Survey Time (hrs:min.)	13:06	2:02	9:51	10:10	7:15	82:32	2:78	12:17	5:18	13:26	7:48	unk.	9:52	14:17	6:51	unk.	8:30	15:33	8:33	5:19
Area (km^2)	863	61	857	1138	309	979	153	891	223	846	538	131	480	1451	171	2328	642	1067	36	427
Species or Group (4 letter code)																				
CoLo	38	-	-	20	-	19	-	4	-	-		2	-	4	-	-	-	3	-	-
LgLo	3	-	-	-	-	1	-	8	4	19	6	-	23	9	-	48	26	5	-	24
ArLo	24	-	-	3	-	63	-	1	-	-	-	1	1	24	-	1	-	78	-	-
RTLo	154	-	-	14	-	26	-	-	-	-	-	5	-	49	1	9	-	237	1	-
AnLo	105	3	1	9	3	28	-	38	2	3	-	-	-	35	-	17	5	97	-	-
Loon	197	2	95	69	6	28	2	20	6	79	3	50	1	14	1	63	6	160	-	4
RNGr	8	-	-	1	-	3	-	25	-	-	-	-	1	22	-	7	10	40	-	4
HoGr	9	-	-	13	-	-	-	-	1	-	-	-	1	5	-	-	-	56	-	4
Greb	3	-	5	94	2	5	-	60	-	11	-	3	9	11	-	30	7	27	-	26
Fulm	-	-	-	-	-	-	56	-	12	-	6	-	5	-	-	4	-	-	-	39
Shea	-	-	-	-	5	1,006	496	-	194	-	-	-	-	-	68,774	78	-	-	-	-
FTSP	-	-	-	-	-	-	-	3	11	-	-	-	-	-	1	-	-	-	-	-
Petr	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Tube	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
BCCo	42	-	-	38	-	717	-	143	-	-	-	-	12	11	-	-	-	206	-	12
LgCo	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PeCo	-	-	-	-	-	250	-	-	-	-	-	-	-	-	-	-	-	-	85	-
RFCo	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
BaCo	32	32	23	76	3	55	-	124	4	13	1	-	10	6	48	10	292	475	390	44
Corm	394	-	940	1,428	78	1,594	-	2,805	12	668	36	410	1,232	40	15	1,203	276	1,033	46	1,665
GBHe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	67	-	-	-	-
Swan	13	-	-	122	-	45	-	-	-	-	-	-	5	179	-	147	5	97	-	-
CaGo	1,164	-	-	4,245	-	19	-	2,633	-	-	-	14,307	-	391	-	163,707	-	841	-	-
Bran	40	-	-	380	-	7	-	-	-	-	-	9,678	-	54,733	-	367,678	-	3,065	-	-
EmGo	-	-	131	-	-	-	-	-	-	2	-	5,686	1,331	31,059	-	106,349	2,149	383	-	7,236
WFGo	33	-	-	-	-	15	-	25	-	-	-	-	-	22	-	-	-	183	-	-
BRGo	473	-	-	29	-	-	-	-	-	-	-	28	-	283	-	2,090	-	371	-	-
SnGo	36	-	-	3,026	-	-	-	1	-	-	-	-	-	384	-	3,047	-	275	-	-
Mall	473	-	2,412	3,381	-	261	-	3,319	1	1,436	-	1,145	176	219	-	3,247	2	164	-	88
Gadw	32	-	12	7	-	2	-	16	-	-	-	-	-	139	-	79	-	6	-	7
Pint	721	-	14	4,436	-	366	-	641	-	-	-	550	-	7,415	-	24,026	-	4,290	-	-
GWTe	150	-	-	1,144	-	73	-	1,347	-	-	-	15	-	132	-	846	-	90	-	-
EuWi	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AmWi	549	-	2	902	-	173	-	834	-	-	-	-	-	61	-	445	-	68	-	-
NoSh	161	-	-	196	-	30	-	18	-	-	-	-	-	209	-	2	-	89	-	-
Dabb	3,373	-	768	7,505	30	1,409	-	6,749	3	66	-	147	15	7,422	-	23,360	3	3,426	-	163
Redh	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
RNDu	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canv	22	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
GrSc	-	-	40	-	-	1	-	8	-	-	-	-	-	57	-	5	-	39	-	-
Scau	3,398	-	327	24,030	15	1,132	-	876	85	3,174	-	75	2	2,314	-	1,293	10	12,560	-	21
Gold	884	-	3,364	1,290	1	4	-	177	-	2,738	-	434	206	33	-	160	26	37	-	139
Buff	127	-	406	370	-	4	-	5	-	296	-	30	38	20	-	50	-	32	-	98
BlDu	1,609	-	3	611	-	-	-	39	-	3	-	25	-	83	-	431	72	192	-	20
Olds	232	-	4,251	4,126	113	14	1	62	18	2,313	405	2	588	1,026	-	342	1,143	996	6	1,270
Harl	136	-	1,613	1,316	100	2,731	-	705	-	810	6	366	300	308	-	374	201	1,101	30	1,356
StEi	-	-	1,322	31	15	-	-	9	65	25	145	70	196	23,272	-	85,204	3,966	292	-	1,642
CoEi	-	-	208	1,477	1,675	2,771	103	335	108	714	491	5	40	1,196	1	4,933	55	479	-	484
KiEi	-	-	495	-	70	-	-	-	-	60	9	-	110	34	-	30	986	603	1	3,960
SpEi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
LgEi	-	-	-	-	-	-	-	-	120	-	-	-	233	276	-	1,228	2,925	54	-	663
Eide	-	-	1,028	11	463	1	-	195	7	167	39	-	38	414	-	2,297	8,392	667	1	138
WWSc	358	132	503	3,416	21	3,164	1	199	9	212	117	9	126	81	39	746	73	141	232	391
SuSc	1,664	292	647	4,772	3	10,041	2	2,306	60	2,047	14	2	82	2	3	69	2	12	2	26
BlSc	167	4	2,085	9,399	71	336	40	535	-	799	62	129	914	6,358	-	16,842	498	4,372	3	1,155
UWSc	-	-	-	-	-	87	-	-	-	-	-	-	74	-	-	-	1	-	-	-
Scot	4,212	2,366	2,694	11,523	1,013	18,200	-	6,626	304	6,509	335	68	2,147	1,890	88	34,976	1,131	1,376	95	3,105
SeDu	632	2	1,861	6,422	1,180	818	-	1,157	17	1,006	61	401	2,183	2,981	-	79,364	3,808	336	2	4,016
CoMe	70	-	39	126	-	-	-	16	-	8	-	-	-	4	-	-	4	15	-	3
RBMe	579	-	33	789	1	296	-	236	-	98	-	-	21	425	-	92	7	1,183	-	47
Smew	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Merg	164	-	135	341	-	20	-	43	-	149	-	26	-	402	-	27	6	38	-	23
Duck	53	-	105	975	37	158	-	161	-	399	1	93	1	239	-	3,304	-	797	-	120
KEMe	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BaEa	177	10	139	45	1	56	-	39	-	54	-	25	93	50	-	54	41	14	-	69
Eagl	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MaHa	9	1	-	4	-	3	-	1	-	-	-	-	-	2	-	7	-	6	-	-
Gyrf	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-
Falc	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	2	-	-
Rapt	-	-	-	2	1	-	-	1	-	1	-	-	-	1	-	-	-	3	-	-
Ptar	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	49	-	37	-	5
SaCr	79	-	-	251	-	13	-	-	-	-	-	-	-	173	-	-	-	167	-	-
SePl	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SpSa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	6	-	-
LeSa	-	-	-	-	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WeSa	480	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NoPh	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Phal	112	1	-	-	4	10	2	-	1	-	-	-	-	20	28	-	-	303	-	-
SmSh	17,601	-	779	29,818	1	2,296	-	155	-	444	3	132	-	5,790	-	64,978	-	11,392	-	6

Table A3. (cont.)

Lease Area	NEGOA		KODIAK	LOWER COOK INLET								S. AK. PENIN.		N. AK. PENIN.				N. BRISTOL BAY		ALEUTIAN SHELF
Season	Spring	Summer	Winter	Spring		Summer		Fall		Winter		Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Winter
Type	Shoreline	Shoreline	Shoreline	Shoreline	Pelagic	Shoreline*	Pelagic	Shoreline	Pelagic	Shoreline	Pelagic	Shoreline	Shoreline	Shoreline	Pelagic	Shoreline	Shoreline	Shoreline	Pelagic**	Shoreline
GoPl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
BBPl	166	-	-	1	-	4	-	-	-	-	-	-	-	508	-	-	-	2	-	-
Plov	-	-	-	-	-	-	-	-	-	-	-	-	-	624	-	-	-	17	-	-
RuTu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
BlTu	424	-	-	-	-	17	-	15	-	-	-	-	-	37	-	-	-	443	-	-
Turn	-	-	-	-	-	-	-	-	-	-	-	-	-	158	-	-	-	16	-	-
Snip	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	5	-	-
Yell	26	-	-	1	-	-	-	1	-	-	-	-	-	4	-	8	-	23	-	-
Wala	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RoSa	25	-	6	-	-	86	-	-	-	10	-	-	110	71	-	-	-	489	-	15
Duml	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Surf	320	-	-	143	-	219	-	61	-	-	-	-	-	-	-	-	-	-	-	-
Dowi	103	-	-	-	-	4	-	-	-	-	-	-	-	17	-	-	-	3	-	-
MeSh	11,852	441	170	29,908	12	143	-	1,403	15	3,567	-	-	471	3,941	1	20,830	15	3,832	6	5,339
BlOy	14	-	242	19	-	139	-	-	-	-	-	20	190	-	-	-	-	-	-	99
Whim	-	-	-	1	-	15	-	-	-	-	-	-	-	4	-	-	-	-	-	-
MaGo	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Godw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
LgSh	3,242	-	-	159	7	6	-	-	-	1	-	-	-	415	-	704	-	98	-	-
MuSh	23,556	-	124	470	-	3	-	-	-	598	-	25	-	1,592	-	7,344	-	5,365	-	-
PuJa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
PaJa	49	9	-	-	-	-	-	-	-	-	-	-	-	4	-	2	-	26	-	-
LTJa	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	1	-	-
Jaeg	25	3	-	1	-	2	-	-	-	-	-	-	-	-	5	-	-	36	-	-
GlGu	2	-	-	1	-	-	-	-	-	6	-	-	2	44	3	-	5	12	-	6
GWGu	5,375	126	591	9,051	508	13,083	63	4,743	96	446	236	1,519	1,314	6,955	919	31,066	4,720	3,041	9	2,426
HeGu	1,597	5	-	92	-	80	-	123	1	1	2	-	-	7	-	12	-	10	-	-
CrGu	-	-	-	-	-	1	-	13	-	-	-	-	-	-	-	-	-	-	-	-
IgGu	667	1,920	171	6,736	-	348	-	131	60	245	55	10	146	7,558	-	927	1,167	1,736	23	1,076
MeGu	2,429	498	106	3,827	14	868	-	2,928	14	473	51	106	51	2,756	-	733	12	1,808	-	57
BoGu	90	-	-	9	-	1	-	6	-	-	-	-	-	17	-	270	-	19	-	-
Kitt	13,257	1,165	1	28,922	72	25,163	165	2,126	104	-	2	319	917	5,326	1,048	1,312	3	2,115	166	2
SaGu	-	3	2	1	-	-	-	1	1	-	-	4	2	21	8	55	-	22	-	-
OWGu	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SmGu	27	1,541	20	290	-	318	-	1,674	36	79	4	115	46	336	-	2,217	7	13,607	-	11
Gull	16,502	11,961	844	12,565	78	22,100	110	11,305	128	1,136	38	177	1,038	21,293	736	8,626	2,704	3,825	3	1,103
ArTe	540	39	-	-	4	235	24	-	-	-	-	-	-	3	-	-	-	437	-	-
AlTe	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tern	5,871	1,884	-	15	1	199	7	-	-	-	-	-	-	1,356	28	1	-	917	1	-
MaMu	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mula	-	-	18	9	5	121	11	7	2	21	30	-	-	1	-	-	-	-	-	-
PaAu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-
CrAu	-	-	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aukl	-	-	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SDAl	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	435	-	-	157
SmAl	9	-	259	14	78	4	13	42	8	231	25	7	5	2	196	91	264	5	-	147
CoMu	-	-	-	-	-	99	-	-	-	-	-	-	-	-	-	-	-	-	6	-
Murr	3,550	-	2,431	18	541	4,416	199	90	351	58	325	-	11,700	34	1,880	113	422	7,968	3,498	1,013
PiGu	15	-	34	325	58	712	-	29	16	11	11	-	5	6	-	1	3	402	60	27
HoPu	103	-	-	1	2	917	7	-	-	-	-	-	-	-	-	-	-	4	36	-
TuPu	-	-	-	242	100	3,353	21	-	-	-	-	-	-	-	39	-	-	25	20	-
Puff	10	-	-	-	-	48	-	-	6	-	-	-	-	-	-	-	-	323	-	-
LgAu	-	-	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MeAl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
LDAl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	4
LgAl	-	-	37	1	4	2	3	3	11	36	1	-	-	-	-	40	-	-	-	437
Alci	-	-	-	-	-	-	1	40	2	8	5	-	-	-	-	1	-	2	-	152
BnOw	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
SEOw	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-	3	-	2	-	-
BeKi	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TrSw	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
BkSw	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ClSw	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swal	58	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WaPi	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dipp	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CoRa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SaSp	1	-	-	-	-	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CCSp	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FoSp	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spar	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	3	-	-	-	-
SnBu	-	-	-	1	-	13	-	1	-	-	-	-	20	-	-	936	-	-	-	21
Frin	-	-	-	1	-	2	-	2	-	-	-	-	-	-	-	29	-	-	-	1
BBMa	-	-	20	9	-	5	-	6	-	16	-	1	11	-	-	-	-	-	-	-
CoRa	9	-	8	13	-	49	-	7	-	22	-	7	28	40	-	63	73	44	-	70
NWCr	16	5	562	107	-	31	-	696	-	748	-	-	37	-	-	-	-	-	-	-
Robi	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VaTh	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pass	62	-	22	-	-	39	-	38	-	27	-	4	-	143	-	493	150	111	-	45
Bird	-	-	-	-	-	-	-	6	8	-	-	-	-	-	-	-	-	-	-	-
LgBi	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
SmBi	-	-	-	-	12	-	32	-	1	-	2	-	-	-	-	-	-	-	-	-
Total:	130,544	22,647	33,026	218,337	6,489	122,661	1,357	58,327	1,982	27,079	2,738	36,459	26,704	206,058	73,866	1,054,863	33,860	91,238	4,717	40,279

* Includes boat and walking surveys.
** Boat survey

Table A4. Relative index, by season, of bird densities for selected marine species from shoreline surveys in southcentral Alaska.

Species *	NEGOA		Kod.	Lower Cook Inlet				S. AK. Pen.		N. AK. Pen.			Br. Bay	Al. Ah.
	Sp	Su	Wn	Sp	Su	Fa	Wn	Fa	Wn	Sp	Fa	Wn	Sp	Wn
RTLo	t	o	o	t	t	o	o	t	o	t	t	o	t	o
RNGr	t	o	o	t	t	t	o	o	t	t	t	t	t	t
Shea	o	o	o	o	+	o	o	o	o	o	t	o	o	o
DCCo	t	o	o	t	t	t	o	o	t	t	o	o	t	t
CaCo	+	o	o	+	t	+	o	+++	o	t	+++	o	t	o
Bran	t	o	o	t	t	o	o	++	o	++	+++	o	+	o
EmGo	o	o	t	o	o	o	t	++	+	++	+++	+	t	++
Mall	t	o	+	+	t	+	+	+	t	t	+	t	t	t
Pint	t	o	t	+	t	t	o	+	o	+	++	o	+	o
Scau	+	o	t	++	+	t	+	t	t	+	+	t	++	t
Gold	+	o	+	+	t	t	+	+	t	t	t	t	t	t
Olds	t	o	+	+	t	t	+	t	+	t	t	+	t	+
Harl	t	o	+	+	+	t	t	+	t	t	t	t	+	+
StEi	o	o	+	t	o	t	t	t	t	++	++	+	t	+
CoEi	o	o	t	+	+	t	t	t	t	t	+	t	t	+
WWSc	t	+	t	+	+	t	t	t	t	t	t	t	t	t
SuSc	+	+	t	+	++	+	+	t	t	t	t	t	t	t
BlSc	t	t	+	+	t	t	t	t	+	+	++	t	+	+
RBMe	t	o	t	t	t	t	t	o	t	t	t	t	+	t
BaEa	t	t	t	t	t	t	t	t	t	o	t	t	t	t
SmSh	++	o	t	++	+	t	t	t	o	+	++	o	++	t
MeSh	++	+	t	++	t	+	+	o	+	+	++	t	+	++
LgSh	+	o	o	t	t	o	t	o	t	+	t	o	t	t
GWGu	+	+	t	+	++	+	t	+	+	+	++	+	+	+
McGu	+	+	t	+	t	+	t	t	t	+	t	t	+	t
BLKi	++	++	t	++	++	+	o	+	+	+	+	t	+	t
ArTe	+	++	o	t	t	o	o	o	o	t	t	o	+	o
Murr	+	o	+	t	+	t	t	o	++	t	t	t	+	+
PiGu	t	o	t	t	t	t	t	o	t	t	t	t	t	t
HoPu	t	o	o	t	t	o	o	o	o	o	o	o	t	o
TuPu	o	o	o	t	+	o	o	o	o	o	o	o	t	o
CoRa	t	o	t	t	t	t	t	t	t	t	t	t	o	t
NWCr	t	t	t	t	t	t	t	o	t	o	o	o	o	o

o = no birds t = less than 1 bird/km^2 + = 1 to 10 birds/km^2 ++ = 11 to 100 birds/km^2 +++ = 101 to 1000 birds/km^2

* Only represents individuals identified to species (e.g. only 43% of the scoters were identified to species).