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

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I. Summary

Marine birds annually congregate in large numbers along the coast of Alaska. The magnitude of these aggregations depends on the species involved, location and season of year. Coastal areas are used in summer by breeding, molting and foraging birds, in fall and spring by migrating birds, in winter by foraging, overwintering species and year-round by many birds that reside in or are endemic to Alaskan waters.

For the past two and one half years, the overall objective of this project was to quantify the seasonal distribution of birds in coastal habitats. A second objective was to determine which areas or habitats are critical to the welfare of marine birds. An area or habitat was termed "critical" if species preferred and were dependent upon it, if it was used by a large number of individuals, if the bird species were particularly vulnerable to oil development, or if it was used by an endangered species. Certain habitats or areas are critical at only short periods during the year, and therefore it has been a part of this project to determine what seasons are the most crucial for birds. In combination with the bird surveys, the coastline of Southcentral Alaska was subjectively classified into habitats from the high tide to storm-surge line.

Studies for the current reporting period were confined to Bristol Bay and Lower Cook Inlet. In May 1977, aerial surveys were conducted along the north coast of the Peninsula and northern Bristol Bay to determine bird distribution and abundance during spring migration. Protected waters, including bays, lagoons and river deltas along that coastline, were densely populated with a variety of staging birds. Every estuary appeared to provide enough variation in habitats that a slightly different species composition was found in each one. Nearshore subtidal, littoral and supratidal areas were all very important foraging and roosting areas for birds.

Brant were the most numerous bird recorded, and this species almost exclusively used eelgrass beds in Izembek Lagoon and other adjacent estuaries. The next most abundant species, Emperor Geese, preferred sandspits and mud/sand flats with associated intertidal areas from Cinder River to Izembek Lagoon. Both species could be quite vulnerable to oil spills. The world's population of the dark-color phase Brant and most of the world's population of Emperor Geese use the north side of the Alaska Peninsula during migration. An untimely, catastrophic spill could destroy both populations either directly or through habitat destruction.

Thousands of sea ducks also used the same estuaries in spring as Brant and Emperors and could likewise be greatly affected by oil. Dabbling ducks (over 90 percent Pintails) were most dense in Port Heiden, Ugashik Bay and Kvichak Bay where densities as high as 50 birds/$km^2$ were recorded. Shorebirds, although not as abundant in spring as in fall, were recorded in large numbers in several of the estuaries. Both dabbling ducks and shorebirds would most be affected in the event of an oil spill by destruction of food organisms in intertidal and supratidal areas.

It may be necessary to use drastic measures (e.g. dispersants) or develop suitable techniques to prevent oil from entering the highly productive estuaries on the north side of the Alaska Peninsula when oil development and tanker traffic warrant it.

Gulls were the only species group that were as abundant on exposed coastline as in protected waters. Densities reached approximately 26 birds/km of beach. Because little is known of their food habits in that region, predictions on how they may be affected by oil spills cannot be made.

Surveys in northern Bristol Bay went only as far as Kulukak Bay, but several areas of importance were noted. The floodplain at the mouth of the Kvichak River, which is inundated only by storm tides, contained a wide variety of birds, and densities reached 306 shorebirds/$km^2$ and 236 dabblers/$km^2$ on the 7 May survey. For the second consecutive year Scaup were numerous along the coast in the Flounder Flats area of Nushagak Bay. Densities of Scaup were the densest (11/km) of any bird species recorded along the North Bristol Bay coast on the 13 May survey. Black Scoters were the next most abundant species. Over 1100 were observed in one openwater transect 30 km long in Nushagak Bay. In Nushagak Bay at the same time, but not within the boundaries of the transect, were several flocks of over 10,000 King Eiders.

All these species would be greatly affected by an oil spill during a spring storm. If they were not killed directly by oil contamination, their food organisms on which they depend during migration could be destroyed. Depending on recovery times of the benthos on which birds feed, the effects on avian populations could be long lasting.

During the relatively mild winter of 1977-78, bird densities were low for most areas in Lower Cook Inlet except outer Kachemak Bay. Comparatively high densities of scoters, alcids, eiders and larids were found on both shoreline counts and pelagic transects in that region. High, nearshore densities extended beyond Anchor River on the east side of the inlet. This should be considered when decisions are made for location of onshore facilities during oil development. If current patterns and wind would push spilled oil around Anchor Point into outer Kachemak Bay, thousands of vulnerable birds would be affected.

Low densities of birds were found on three trans-inlet transects and only moderate wintering bird densities were found in Kamishak Bay. In a heavy ice year, fewer birds would likely be found in Kamishak Bay. Based on this winter's surveys only, it appears as if few wintering birds would be affected by oil spills or development in the middle or western sides of Lower Cook Inlet. If oil were spilled during winter months and deposited in Kamishak Bay, it may affect birds indirectly in other seasons by destroying their food organisms. Planned research will determine bird use of Kamishak Bay in the other seasons.

## II. Introduction

Productive coastal regions in Alaska provide ideal habitat for marine birds. Nearshore subtidal, intertidal and supratidal zones all supply

substantial food resources for avian populations. Coastal cliffs, talus slopes, coastal meadows, barrier islands and other physiographic features provide suitable nesting habitat, and migrating birds use river deltas, lagoons and intertidal mudflats for staging. Ice-free coastal waters are used by over-wintering birds, and in summer many nonbreeding and molting species forage nearshore.

Because this nearshore and littoral region is so crucial to Alaska's marine avifauna, it is essential to assess the magnitude of bird use of this area in time and space. Most previous bird surveys have been conducted in offshore, pelagic waters or in specific waterfowl concentration areas. Many were only qualitative in nature or limited in scope. King and McKnight (1969) tried specifically 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. The present study was designed to quantify bird use along the coast, in nearshore waters, and in supratidal regions.

Emphases of studies for this report period were in Bristol Bay and Lower Cook Inlet. Objectives of the bird surveys were to determine seasonal density distribution, migratory routes, chronology of migrations, breeding locales and critical habitats for all bird species utilizing the littoral zone within the study areas. In Lower Cook Inlet this study was also to determine winter distribution and abundance of marine birds in relation to ice conditions and other environmental parameters.

Oil and gas development with various related activities has 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 gets into estuaries or on 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 spills, and this, in turn, will have deleterious effects on birds if it is continued for long periods of time.

This study will help determine seasonal abundance of birds and enable the establishment of priorities for critical avian habitats. Those 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

Little quantitative information is available on marine bird use of coastal habitats within the regions of Alaska that were studied during this report period (Bristol Bay and Lower Cook Inlet). Past knowledge of birds in these areas was summarized in earlier reports of Research Unit #3 (Arneson 1976a, 1977a). Most available information from past expeditions and surveys consists only of species lists of birds observed, data on game ducks and geese or pelagic distribution and abundance of birds.

In the Bristol Bay region, more recent and thorough data are available for Cape Peirce (Petersen and Sigman 1977) and the Port Moller-Nelson

Lagoon area (Gill et al. 1977). These studies recorded specific information on bird use of coastal areas and were not restricted to any species group. Both migration and habitat use of nearby marine waters was monitored. Emphasis of the Nelson Lagoon study was on seasonal use by shorebirds and waterfowl, and the Cape Peirce study stressed colonial nesting seabirds and sea ducks.

Less bird information is available for the second region - Lower Cook Inlet - under study by this Research Unit during the report period. Most recently, Erikson (1977) summarized data from bird studies conducted in 1976. Baseline seasonal information on bird distribution and abundance for both pelagic and shoreline areas was gathered. Only one survey per season was completed for shoreline and pelagic regions, in all but the Kachemak Bay area where several surveys were conducted during migration.

## IV. Study Area

During this report period, the areas of study included Bristol Bay and the north side of the Alaska Peninsula from 1 April 77 to 30 September 77 (Figures 1 and 2). From 1 October 77 to 30 March 78 research was confined to Lower Cook Inlet (Figure 3). In addition, incidental bird observations were summarized from Cape St. Elias in the Northeast Gulf of Alaska and Tugidak Island at the south end of Kodiak Island.

In Bristol Bay, coastal areas surveyed included exposed sandy beaches; protected bays, lagoons and embayments; river deltas; coastal floodplains; mud and sand flats; creek mouths; sand and gravel islands and sandspits. The bank of the beach is typically low with a sand/gravel substrate. Lowland areas are generally covered with a sedge/grass complex, drier areas contain upland heath, and ground cover on beach fringes and barrier islands is beach rye. The Walrus Islands, on the other hand, are mostly rocky with frequent high cliffs and talus slopes. The entire coast is essentially treeless.

By contrast, the coastline of Lower Cook Inlet is bordered by spruce forest in most areas. The shoreline is more varied with lowlands and cliffs, rock and mud/sand flats, straight and indented coastline with several long beaches, bays and river mouths. Much of the survey work was in open water of Kamishak Bay, a relatively shallow area with volcanic Augustine Island in its center. Current patterns within Lower Cook Inlet tend to congregate large quantities of debris into Kamishak Bay, and it is therefore assumed that oil spills will also eventually end up in Kamishak.

## V. Methods

Bristol Bay: For the first time in this project a helicopter was used for shoreline counts and pelagic transects. As in the past, observers enumerated birds on both sides of the aircraft. During shoreline counts the shoreside observer covered the area to high tide, and the seaside observer looked out to 200 meters from the aircraft. In supratidal lowlands, a total count of birds was attempted. We flew at an altitude of approximately 30 meters and at about 100 km/hr.

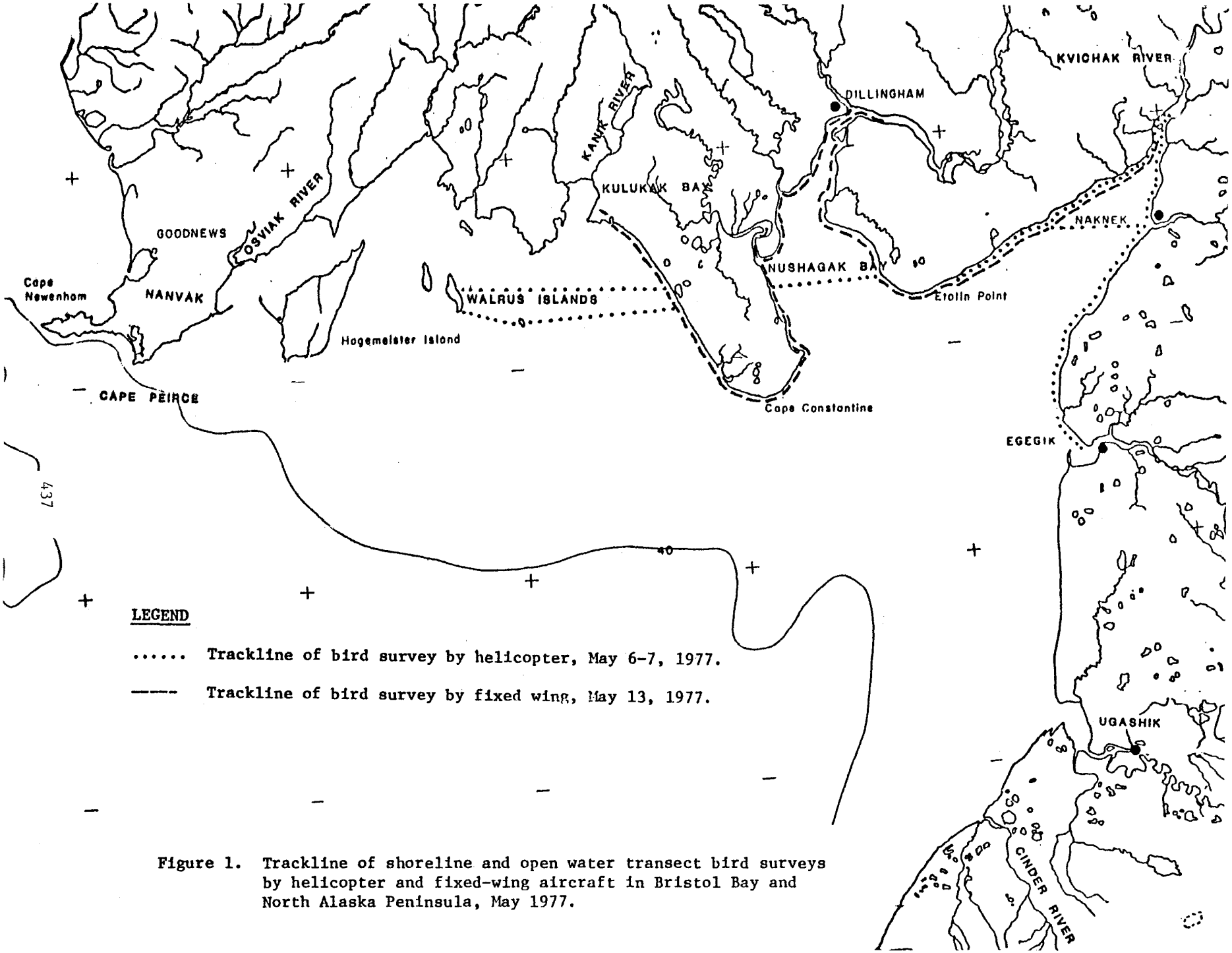


Figure 1. Trackline of shoreline and open water transect bird surveys by helicopter and fixed-wing aircraft in Bristol Bay and North Alaska Peninsula, May 1977.

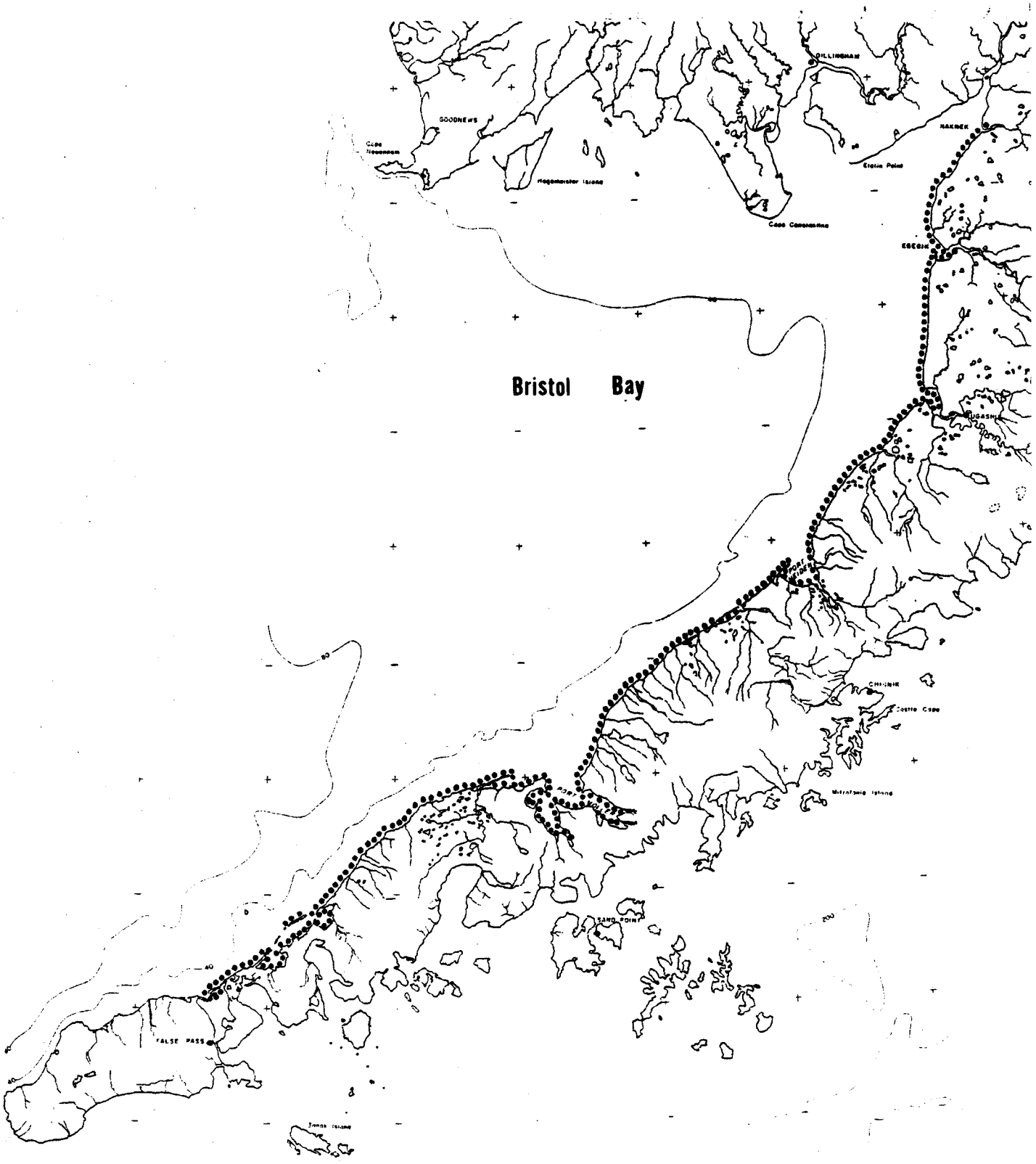


Figure 2. Trackline of bird surveys by fixed-wing aircraft, North Alaska Peninsula, May 11-12, 1977.

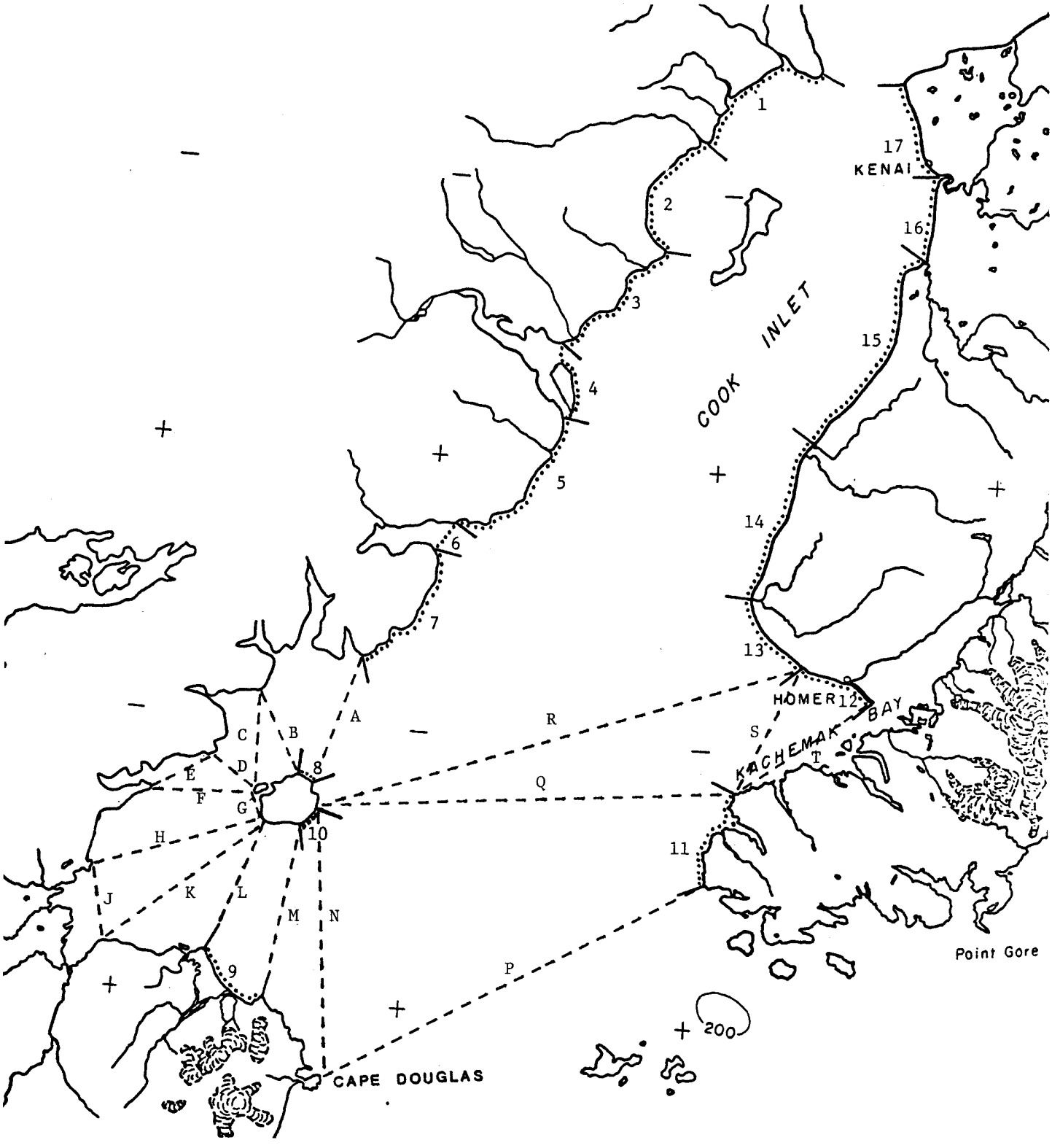


Figure 3. Trackline of shoreline stations and pelagic transects for bird surveys flown in Lower Cook Inlet, Winter, 1977-78.

While crossing over bays, pelagic transects were conducted looking 200 meters out both sides of the aircraft.

Similar shoreline survey techniques were used while completing the remainder of the survey in a fixed-wing aircraft.

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

In June and July, in conjunction with a reconnaissance of the Walrus Islands, pelagic bird surveys were conducted between islands by an observer recording all birds within 100 meters on either side of the Avon raft. Numbers of birds by species or group and their activity were recorded on cassette recorders for one-minute intervals along the entire distance between islands.

We cruised the shoreline of all islands by raft, and bird observations along the coast were recorded. When colonies were encountered, we stopped and often anchored to record specific information about the colony. Black-legged Kittiwake and cormorant nests were counted. Individuals were counted for Pigeon Guillemots, Parakeet Auklets, Horned Puffins and Tufted Puffins, and estimates of population size were made for Common Murres. Other bird information was recorded and photographs were taken of many of the colonies.

Lower Cook Inlet: Shoreline survey techniques described above were used from West Foreland to Oil Point, along portions of Kamishak Bay, and from Homer Spit to East Foreland. Line-of-sight pelagic transects were flown in Kamishak Bay, across the Inlet, and in Outer Kachemak Bay, with observers looking 100 meters from each side of the aircraft. Minute intervals along the transect were recorded by stopwatch so that approximate locations of birds were known.

## VI. Results

Bristol Bay - Spring surveys: Coastal surveys during May 1977 in Bristol Bay/Alaska Peninsula were broken into four segments for analysis and comparison. Species composition of total birds observed for the four surveys is presented in Table 1 and the combination distance and area surveyed is given at the bottom. When surveys of stations followed the coastline, a distance was recorded and densities are given in birds/km. When total coverage of an supratidal or water area was attempted, an area was recorded and densities are given in birds/$km^2$. Bird summarizations, therefore, are given in either density format depending on the sampling technique utilized.

Because identical stations were intentionally flown on both the helicopter survey in early May and the fixed-wing survey several days later, a

Table 1. Species list of birds observed on four aerial surveys of North Alaska Peninsula and North Bristol Bay, May 1977.

| Species | N. AK Pen. 6 May Total No. | N. AK Pen. 10-12 May Total No. | N. Br. Bay 7 May Total No. | N. Br. Bay 13 May Total No. |
|---|---|---|---|---|
| Loon-unid | 2 | 12 | | 1 |
| Sm Loon | 2 | 33 | 12 | 79 |
| Lg Loon | 3 | 6 | 2 | 5 |
| Co Loon | 1 | 3 | | 2 |
| Ar Loon | 4 | 20 | 1 | 4 |
| RT Loon | 4 | 45 | 9 | 60 |
| Grebe-unid | 6 | 5 | 2 | 3 |
| RN Grebe | 3 | 19 | | 10 |
| Ho Grebe | 1 | 4 | 2 | 16 |
| Cormorant-unid | 2 | 38 | 1 | 10 |
| Sm Cormorant | | 6 | 2 | 2 |
| DC Cormorant | | 7 | | 71 |
| Swan | 9 | 160 | 9 | 24 |
| Dark Goose | 87 | 198 | 333 | 69 |
| Canada Goose | 485 | 106 | 373 | 328 |
| Brant | | 54,733 | | 16 |
| Emp Goose | 2 | 31,057 | | 76 |
| WF Goose | 3 | 19 | 80 | 53 |
| Snow Goose | 60 | 324 | 60 | 215 |
| Duck-unid | 52 | 191 | 9 | 704 |
| Dabbler | 1,279 | 6,122 | 3,935 | 1,200 |
| Mallard | 56 | 163 | 21 | 47 |
| Gadwall | 4 | 135 | 2 | 3 |
| Pintail | 1,551 | 5,842 | 3,020 | 936 |
| GW Teal | 35 | 97 | 19 | 2 |
| Am Wigeon | 38 | 23 | 6 | 9 |
| No Shoveler | 30 | 179 | 14 | 39 |
| Diver | 49 | 34 | 23 | 126 |
| Redhead | | | | 4 |
| Canvasback | | | | 4 |
| Scaup | 580 | 1,711 | 451 | 4,880 |
| Gr. Scaup | 2 | 55 | 11 | 14 |
| Goldeneye | 12 | 21 | 4 | 20 |
| Bufflehead | 6 | 14 | 5 | 15 |
| Sea Duck | 36 | 2,955 | 20 | 52 |
| Oldsquaw | 25 | 999 | 312 | 191 |
| Harlequin | | 301 | | 113 |
| Eider | | 410 | | |
| St. Eider | | 23,272 | | 26 |
| Lg Eider | | 271 | 24 | 29 |
| Co Eider | | 1,201 | | 44 |
| Ki Eider | 4 | 30 | 217 | 29 |
| Scoter | 23 | 1,785 | 861 | 113 |
| WW Scoter | | 81 | 69 | 3 |
| Su Scoter | | 2 | 2 | 10 |
| Bl Scoter | 274 | 6,137 | 1,509 | 597 |

Table 1. (continued)

| Species | N. AK Pen. 6 May Total No. | N. AK Pen. 10-12 May Total No. | N. Br. Bay 7 May Total No. | N. Br. Bay 13 May Total No. |
|---|---|---|---|---|
| Merganser | 35 | 58 | 4 | 24 |
| Co Merganser | | | 4 | |
| RB Merganser | 164 | 202 | 93 | 395 |
| Hawk-unid | | 1 | | 2 |
| Bald Eagle | 2 | 47 | 2 | 2 |
| Ma Hawk | 2 | | 2 | 2 |
| Falcon-unid | | 1 | | 2 |
| Ptarmigan | 10 | 4 | 4 | 12 |
| SH Crane | 55 | 118 | 41 | 34 |
| Sm Shorebird | 1,098 | 4,715 | 6,694 | 3,534 |
| Phalarope | 2 | 18 | | 89 |
| Med Shorebird | 1,533 | 2,366 | 1,740 | 413 |
| Plover | 623 | 1 | 14 | 2 |
| AG Plover | | | 10 | |
| BB Plover | 503 | 5 | 1 | |
| Turnstone | | 158 | | |
| Bl Turn | | 37 | | 5 |
| Co Snipe | 2 | | 2 | |
| Rock Sand | | 71 | | 489 |
| Dowitcher | 15 | 2 | | |
| Lg Shorebird | 7 | 426 | 51 | 10 |
| Whimbrel | | 4 | | |
| Yellowlegs | 1 | 3 | 17 | 3 |
| Mixed Shorebird | 82 | 1,510 | 2,020 | 2,734 |
| Jaeger | 1 | 13 | 1 | 8 |
| Par Jaeger | 2 | 2 | 7 | |
| LT Jaeger | | | | 1 |
| Gull | 440 | 20,236 | 358 | 856 |
| Lg Gull | 133 | 7,232 | 627 | 1,026 |
| Gl Gull | 8 | 36 | 1 | 6 |
| GW Gull | 260 | 6,551 | 722 | 99 |
| He Gull | 5 | 2 | 2 | 1 |
| Sm Gull | 11 | 310 | 75 | 97 |
| Mew Gull | 1,646 | 1,107 | 265 | 419 |
| Bon Gull | 16 | | | |
| Kittiwake | 7 | 5,308 | 7 | 1 |
| Sab Gull | | 21 | | 1 |
| Tern | | 1,360 | 1 | 343 |
| Ar Tern | 3 | | | |
| Alcid-unid | 1 | 1 | 2 | |
| Murre | 1 | 33 | 182 | 2 |
| Pi Guillemot | | 6 | | |
| Sn Owl | | 1 | | |
| SE Owl | 1 | 1 | | 1 |
| Passerine | 6 | 137 | | 70 |
| Raven | 6 | 34 | 4 | 8 |
| TOTAL | 11,411 | 191,054 | 24,378 | 20,947 |
| Distance/Area in Survey | 102.2km<br>69.4km$^2$ | 1294.2km<br>873.4km$^2$ | 80.2km<br>126.4km$^2$ | 378.7km<br>99.9km$^2$ |

comparison was made of changes in species composition and densities for both North Bristol Bay and North Alaska Peninsula (Table 2).

Data for the survey from the Naknek River to Bechevin Bay on 10-12 May are summarized in Tables 3 and 4. This includes a comparison of "protected" versus "exposed" areas along the Alaska Peninsula coast and a comparison of the bird densities among estuaries in the region (data for Kvichak Bay are from the 6 May 1977 helicopter survey). Table 5 lists bird densities for protected and exposed areas of North Bristol Bay.

Subdivisions used in the analysis of both regions are shown in Figure 4. Exposed stations of North Alaska Peninsula are Nos. 2,4,6,8,10,12,17 and and of North Bristol Bay are Nos. 2,3,7 and 8. The remaining stations in each region were classified "protected." More detailed bird data for these stations are available.

Bristol Bay - Summer surveys: A reconnaissance of the Walrus Islands was conducted in summer 1977 in anticipation of future bird colony studies in that area. Because the proposed sale of oil lease tracts in Bristol Bay was indefinetly postponed, future studies in the area were curtailed. A detailed summary of the survey in the Walrus Islands has been completed (Arneson 1977b) and tables of the results of boat transects and colony population estimates are in Appendix I.

Lower Cook Inlet - Winter surveys: Three bird surveys were conducted during the 1977-78 winter: early winter, 22 November 1977; mid-winter, 12 January 1978; and late winter, 3 March 1978. Table 6 shows the relative abundance of birds between nearshore and pelagic areas from these surveys. Total numbers of each species or group are listed in Table 7. Seventeen shoreline stations and 18 pelagic transects were flown. Relative abundance and distribution of birds as a result of these surveys are depicted in Figures 5 to 10.

To compare bird abundance within divergent regions of Lower Cook Inlet, shoreline stations were grouped into three sections: Stations 1-7, Northwest side; Stations 8-10, Kamishak; Stations 11-17, East side (refer to Figure 3). Pelagic transects were also grouped into three sections: Transects A-N, Kamishak; Transects P-R, Across Inlet; Transects S and T, Outer Kachemak. The most abundant bird species groups from shoreline surveys are compared between regions and surveys in Table 8 and from pelagic surveys in Table 9. Data were combined from the three surveys to give overall winter densities and percent composition in Tables 10 and 11 for shoreline and pelagic areas, respectively.

## VII. Discussion

Bristol Bay: The magnitude and dynamics of bird use of coastal areas in Bristol Bay during spring migration were revealed in surveys conducted in May 1977. Protected waters including estuaries and river deltas supported thousands of geese, sea ducks, gulls and dabbling ducks. Shorebirds, although abundant, did not reach the numbers that they presumably do during fall migrations. Chronology of migration and distribution within the region varied from species to species.

Table 2. A comparison of bird densities in two surveys several days apart of identical stations in both North Bristol Bay and North Alaska Peninsula, May, 1977.

| | North Bristol Bay | | | | North Alaska Peninsula | |
|---|---|---|---|---|---|---|
| | 7 May 77 | | 13 May 77 | | 6 May 77 | 10 May 77 |
| | Birds/km | Birds/km$^2$ | Birds/km | Birds/km$^2$ | Birds/km | Birds/km$^2$ |
| Loons | 0.3 | | 0.6 | 0.2 | 0.2 | Tr |
| Grebes | 0.1 | | 0.3 | 0.3 | Tr | |
| Cormorants | Tr | | Tr | | Tr | 0.1 |
| Swans | 0.1 | 0.1 | Tr | 0.3 | | |
| Geese | 0.5 | 27.4 | 0.2 | 2.5 | 0.7 | |
| Unidentified Ducks | 0.1 | | 1.8 | 8.1 | Tr | |
| Dabblers | 0.9 | 235.8 | 0.3 | 26.8 | 5.3 | 0.2 |
| Divers | 3.5 | 1.2 | 17.2 | 8.7 | 8.5 | 2.3 |
| Sea Ducks | 2.2 | | 6.3 | | 2.1 | 2.6 |
| Eiders | 0.3 | | 0.2 | | | |
| Scoters | 1.8 | | 5.5 | | 1.6 | 1.9 |
| Mergansers | 1.3 | 0.5 | 0.8 | 0.2 | 2.4 | 0.8 |
| Eagles, etc. | Tr | 0.1 | 0.1 | | Tr | Tr |
| Ptarmigan | Tr | 0.1 | | 0.2 | | |
| Cranes | | 1.4 | | 0.1 | | |
| Total Shorebirds | 16.9 | 306.1 | 1.0 | 77.7 | 51.4 | 0.3 |
| Small Shorebirds | 3.0 | 207.4 | 0.3 | 34.6 | 14.9 | 0.3 |
| Med. Shorebirds | 1.7 | 55.7 | 0.6 | 2.0 | 36.0 | 0.1 |
| Large Shorebirds | | 2.3 | | 0.1 | 0.1 | |
| Mx. Shorebirds | 12.2 | 40.7 | | 40.9 | 0.5 | |
| Jaegers | Tr | Tr | Tr | | Tr | |
| Gulls | 20.2 | 16.2 | 5.3 | 17.9 | 33.4 | 31.7 |
| Terns | Tr | | 0.3 | 1.5 | Tr | 0.1 |
| Alcids | | | | | | Tr |
| Owls | | | | Tr | | |
| Corvids | | 0.1 | 0.1 | | | Tr |
| Other Passerines | | | Tr | 0.1 | | |
| TOTAL | 44.4 | 589.1 | 34.3 | 144.7 | 104.5 | 38.2 |

Table 3. Bird densities in protected and exposed coastal areas of North Alaska Peninsula, May 10-12, 1977.

| | Protected | | Exposed | | Total | |
|---|---|---|---|---|---|---|
| | Birds/km | Birds/km$^2$ | Birds/km | Birds/km$^2$ | Birds/km | Birds/km$^2$ |
| Loons | Tr | 0.1 | 0.1 | Tr | Tr | 0.1 |
| Grebes | Tr | Tr | Tr | 0.1 | Tr | Tr |
| Cormorants | Tr | Tr | 0.1 | | Tr | Tr |
| Swans | Tr | 0.2 | | 0.3 | Tr | 0.2 |
| Geese | 34.7 | 71.6 | 0.5 | 0.6 | 21.1 | 67.8 |
| Unidentified Ducks | Tr | 0.1 | tr | 1.0 | Tr | 0.2 |
| Dabblers | 4.6 | 10.1 | 0.1 | 13.5 | 2.8 | 10.3 |
| Divers | 1.0 | 0.7 | 0.7 | 2.9 | 0.9 | 0.8 |
| Sea Ducks | 20.7 | 17.5 | 13.1 | 1.1 | 17.7 | 16.6 |
| Eiders | 13.0 | 15.5 | 4.3 | 0.3 | 9.6 | 14.7 |
| Scoters | 6.5 | 0.6 | 4.7 | 0.7 | 5.8 | 0.6 |
| Mergansers | 0.1 | 0.1 | 0.2 | 0.4 | 0.1 | 0.1 |
| Eagles, etc. | Tr | Tr | Tr | Tr | Tr | Tr |
| Ptarmigan | | Tr | | | | Tr |
| Cranes | Tr | 0.1 | | 0.3 | Tr | 0.1 |
| Total Shorebirds | 2.6 | 6.8 | 1.0 | 24.5 | 1.9 | 7.8 |
| Small Shorebirds | 0.7 | 3.5 | 0.5 | 22.9 | 0.6 | 4.5 |
| Med. Shorebirds | 1.5 | 1.5 | 0.3 | 1.5 | 1.0 | 1.5 |
| Large Shorebirds | 0.1 | 0.4 | Tr | Tr | Tr | 0.4 |
| Mx. Shorebirds | 0.4 | 1.4 | 0.2 | | 0.3 | 1.3 |
| Jaegers | Tr | Tr | | Tr | Tr | Tr |
| Gulls | 19.7 | 14.8 | 25.6 | 1.5 | 22.1 | 14.1 |
| Terns | 0.6 | 0.5 | 1.0 | 0.7 | 0.7 | 0.5 |
| Alcids | Tr | | 0.1 | | Tr | |
| Owls | | Tr | | Tr | | Tr |
| Corvids | Tr | Tr | Tr | | Tr | Tr |
| Other Passerines | Tr | 0.2 | Tr | | Tr | 0.1 |
| TOTAL | 84.1 | 122.8 | 42.5 | 46.9 | 67.5 | 118.7 |
| Distance/Area | 777.4km | 826.2km$^2$ | 516.8km | 47.2km$^2$ | 1294.2km | 873.4km$^2$ |

Table 4. Densities of bird groups using littoral or supratidal regions in estuaries of North Alaska Peninsula, May 1, 1977.

| | Kvichak Bay | | Egegik Bay | | Ugashik Bay | |
|---|---|---|---|---|---|---|
| | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ |
| Loons | 0.2 | Tr | 0.2 | | 0.1 | 0.3 |
| Grebes | Tr | 0.2 | | | | Tr |
| Cormorants | | | 0.2 | 0.3 | | |
| Swans | | 0.2 | Tr | | Tr | 0.2 |
| Geese | 1.1 | 11.6 | 0.1 | | 0.3 | 2.7 |
| Unid. Ducks | 0.3 | | 0.2 | | Tr | 0.8 |
| Dabblers | 3.9 | 50.1 | 1.7 | 1.1 | 2.4 | 27.0 |
| Divers | 10.0 | 1.2 | 9.1 | 0.2 | 1.8 | 1.0 |
| Sea Ducks | 0.6 | 5.4 | 16.9 | 0.5 | 8.4 | 0.1 |
| Eiders | | 0.1 | 3.5 | | 1.6 | |
| Scoters | 0.1 | 4.7 | 13.4 | 0.5 | 6.7 | 0.1 |
| Mergansers | 2.8 | 0.7 | 0.1 | 0.2 | 0.1 | 0.2 |
| Eagles, etc. | tr | 0.1 | | | | Tr |
| Ptarmigan | | 0.1 | | | | |
| Cranes | | 1.2 | 0.1 | | | 0.3 |
| Total Shorebirds | 30.0 | 5.7 | 5.0 | | 5.5 | 6.0 |
| Small Sh. | 10.4 | 1.1 | 1.7 | | 2.7 | 3.6 |
| Med. Sh. | 19.5 | 3.3 | 0.4 | | 1.2 | 2.2 |
| Lg. Sh. | Tr | 0.1 | | | | 0.3 |
| Mx. Sh. | | 1.3 | 3.0 | | 1.6 | Tr |
| Jaegers | Tr | | | | Tr | Tr |
| Gulls | 24.3 | 4.3 | 9.7 | 0.6 | 9.6 | 4.5 |
| Terns | Tr | | 0.2 | 0.2 | 0.2 | 0.8 |
| Alcids | | 0.1 | | | | |
| Owls | | Tr | | | | Tr |
| Corvids | | 0.1 | | | | Tr |
| Other Passerines | | 0.2 | | | | 0.4 |
| TOTAL | 73.2 | 82.1 | 43.6 | 3.7 | 28.5 | 44.4 |
| Distance/Area Surveyed | 47.4Km | 39.7Km$^2$ | 33.4Km | 16.1Km$^2$ | 64.8Km | 131.0Km$^2$ |

Continued

Table 4. Continued.

| | Cinder River | | Port Heiden | | Seal Islands | |
|---|---|---|---|---|---|---|
| | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ |
| Loons | 0.1 | 0.1 | 0.1 | 0.1 | | Tr |
| Grebes | | | Tr | 0.1 | | Tr |
| Cormorants | | | | | | |
| Swans | | 0.5 | | 0.2 | | 0.1 |
| Geese | | 8.5 | 152.5 | 49.0 | | 47.3 |
| Unid. Ducks | | 0.1 | | | | |
| Dabblers | 3.1 | 15.4 | 43.9 | 21.8 | | 8.8 |
| Divers | 0.8 | 0.5 | 0.6 | 1.2 | 0.2 | 0.4 |
| Sea Ducks | 1.4 | 3.2 | 23.3 | 1.4 | 1.2 | 24.5 |
| Eiders | 0.6 | 1.4 | 1.2 | Tr | 0.3 | 21.3 |
| Scoters | 0.8 | 0.5 | 9.1 | 1.2 | 0.2 | 1.2 |
| Mergansers | | 0.1 | | 0.2 | 0.2 | 0.2 |
| Eagles, Etc. | Tr | | Tr | Tr | | Tr |
| Ptarmigan | | | | Tr | | Tr |
| Cranes | | 0.1 | | 0.5 | | |
| Total Shorebirds | 15.2 | 21.9 | 2.7 | 11.0 | | 5.6 |
| Small Sh. | 0.8 | 11.4 | 1.3 | 3.5 | | 3.1 |
| Med. Sh. | 14.2 | 2.4 | 0.5 | 4.4 | | 2.1 |
| Lg. Sh. | 0.2 | 2.0 | 1.0 | 0.4 | | |
| Mx. Sh. | | 6.0 | | 2.7 | | 0.4 |
| Jaegers | Tr | Tr | | | | |
| Gulls | 10.1 | 6.7 | 13.2 | 16.2 | 44.5 | 34.5 |
| Terns | | 0.6 | Tr | 1.0 | 15.9 | 0.5 |
| Alcids | | | | | | |
| Owls | | | | | | |
| Corvids | | Tr | Tr | 0.1 | | Tr |
| Other Passerines | | Tr | | 1.0 | | |
| TOTAL | 32.1 | 59.7 | 236.3 | 103.9 | 62.1 | 122.0 |
| Distance/Area Surveyed | 33.1Km | 149.3Km$^2$ | 44.6Km | 70.7Km$^2$ | 10.9Km | 85.6Km$^2$ |

Continued

Table 4. Continued.

| | Port Moller Complex | | Izembek Lagoon | | Bechevin Bay |
|---|---|---|---|---|---|
| | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ | Birds/Km |
| Loons | Tr | | | | |
| Grebes | Tr | | | | |
| Cormorants | Tr | | Tr | | |
| Swans | Tr | | 0.1 | | |
| Geese | 22.6 | 476.1 | 60.5 | 118.8 | 0.2 |
| Unid. Ducks | Tr | | Tr | | |
| Dabblers | 2.1 | 1.8 | 2.7 | 0.4 | |
| Divers | 0.6 | 1.6 | 0.1 | 0.5 | 0.1 |
| Sea Ducks | 38.4 | 39.2 | 6.6 | 31.2 | 1.9 |
| Eiders | 26.4 | 34.4 | 6.1 | 28.6 | |
| Scoters | 11.4 | | 0.1 | 0.6 | 0.8 |
| Mergansers | 0.1 | 0.4 | Tr | Tr | |
| Eagles, Etc. | 0.1 | 0.1 | | Tr | Tr |
| Ptarmigan | | | | | |
| Cranes | | | | | |
| Total Shorebirds | 1.8 | 5.4 | 1.3 | 0.7 | |
| Small Sh. | Tr | 1.3 | 0.9 | 0.5 | |
| Med. Sh. | 1.5 | 4.1 | 0.4 | 0.2 | |
| Lg. Sh. | Tr | | | | |
| Mx. Sh. | 0.2 | | | | |
| Jaegers | Tr | | | Tr | |
| Gulls | 29.5 | 175.3 | 11.8 | 11.8 | 14.0 |
| Terns | 0.3 | 4.3 | 0.6 | | |
| Alcids | Tr | | Tr | | |
| Owls | | | | | |
| Corvids | Tr | 0.1 | Tr | | |
| Other Passerines | Tr | | Tr | | |
| TOTAL | 95.6 | 704.4 | 83.9 | 163.5 | 17.0 |
| Distance/Area Surveyed | 324.6Km | 15.8Km$^2$ | 211.3Km | 357.7Km$^2$ | 39.4Km |

Table 5. Bird densities in protected and exposed coastal areas of North Bristol Bay, May 13, 1977.

| | Protected | | Exposed | | Total | |
|---|---|---|---|---|---|---|
| | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ | Birds/Km | Birds/Km$^2$ |
| Loons | 0.1 | 0.1 | 0.7 | | 0.4 | 0.1 |
| Grebes | 0.1 | 0.1 | Tr | | 0.1 | 0.1 |
| Cormorants | | 0.1 | 0.4 | | 0.2 | 0.1 |
| Swans | | 0.1 | Tr | 0.7 | Tr | 0.2 |
| Geese | 0.6 | 5.3 | Tr | 13.4 | 0.3 | 6.3 |
| Unid. Ducks | 0.4 | 3.0 | 2.0 | 0.8 | 1.1 | 2.7 |
| Dabblers | 0.6 | 22.3 | 0.3 | 8.9 | 0.4 | 20.7 |
| Divers | 7.2 | 4.2 | 16.0 | 28.3 | 11.5 | 7.2 |
| Sea Ducks | 1.4 | | 4.8 | 4.0 | 3.1 | 0.5 |
| Eiders | Tr | | 0.6 | 1.6 | 0.3 | 0.2 |
| Scoter | 1.3 | | 2.5 | 1.5 | 1.9 | 0.2 |
| Morgansers | 1.0 | 0.1 | 1.0 | 1.2 | 1.0 | 0.3 |
| Eagles, etc. | Tr | Tr | Tr | | Tr | Tr |
| Ptarmigan | | 0.1 | | | | 0.1 |
| Cranes | Tr | 0.1 | | 2.1 | Tr | 0.3 |
| Total Shorebirds | 0.8 | 79.7 | 0.3 | 7.4 | 0.5 | 70.7 |
| Small Sh. | 0.3 | 39.2 | 0.2 | 7.0 | 0.3 | 35.2 |
| Med. Sh. | 0.2 | 9.8 | Tr | 0.2 | 0.1 | 8.6 |
| Lg. Sh. | Tr | 0.1 | Tr | 0.2 | Tr | 0.1 |
| Mx. Sh. | 0.2 | 30.6 | 0.1 | | 0.1 | 26.8 |
| Jaegers | | Tr | Tr | 0.1 | Tr | Tr |
| Gulls | 1.5 | 10.1 | 7.1 | 0.8 | 4.3 | 8.9 |
| Terns | 0.6 | 0.7 | 0.6 | 5.4 | 0.6 | 1.2 |
| Alcids | | | Tr | | Tr | |
| Owls | | Tr | | | | Tr |
| Corvids | | | Tr | | Tr | |
| Other Passerines | 0.3 | Tr | Tr | | 0.2 | 0.9 |
| TOTAL | 14.6 | 126.1 | 33.4 | 73.2 | 23.8 | 119.5 |
| Distance/Area | 193.6Km | 87.6Km$^2$ | 185.1Km | 12.3Km$^2$ | 378.7Km | 99.9Km$^2$ |

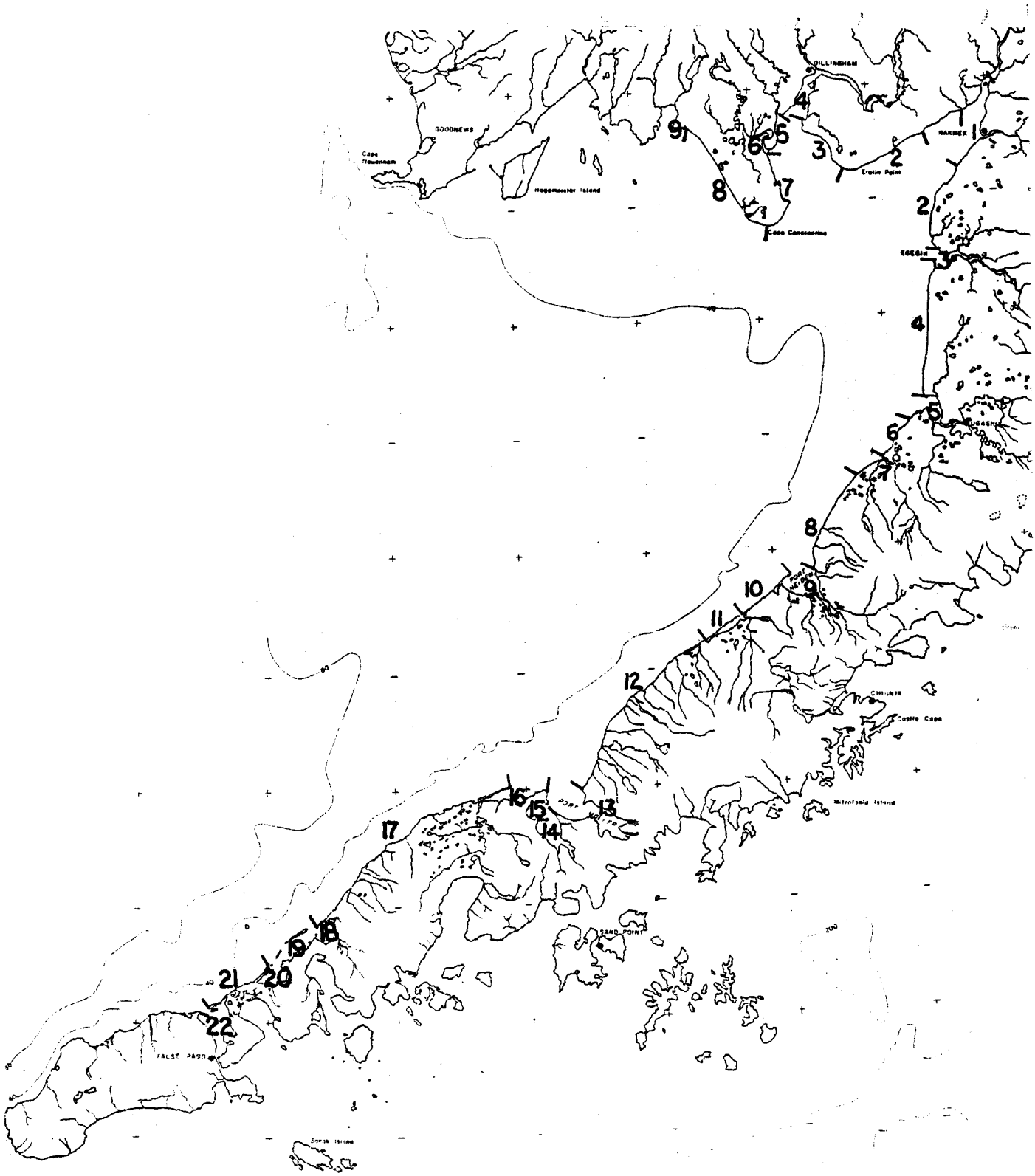


Figure 4. Subdivisions of North Alaska Peninsula and North Bristol Bay used in the analysis of bird data from aerial surveys, May 1977.

Table 6. Relative abundance of bird species groups in shoreline and pelagic surveys of Lower Cook Inlet, Winter 1977-78.

| Species Group | Percent of Total Birds | |
|---|---|---|
| | Shoreline | Pelagic |
| Cormorant | 5 | 1 |
| Eiders | 12 | 23 |
| Scoters | 43 | 24 |
| Other Seaducks | 9 | 17 |
| Gulls | 25 | 15 |
| Alcids | 4 | 18 |
| Other | 3 | 1 |

Table 7. Total number of birds by species or group in three areial surveys of shoreline stations and pelagic transects in Lower Cook Inlet, 1977-78.

| Species or Group | Shoreline Stations | | | Pelagic Transects | | |
|---|---|---|---|---|---|---|
| | 22 Nov. 1977 | 12 Jan. 1978 | 3 Mar. 1978 | 22 Nov. 1977 | 12 Jan. 1978 | 3 Mar. 1978 |
| Loon | 7 | | 14 | 1 | | 3 |
| LgLo | 7 | 8 | 11 | 4 | 4 | |
| SmLo | 1 | | 3 | | | |
| Greb | 8 | | 8 | | | |
| RnGr | 1 | | | | | |
| Fulm | | | | | 6 | |
| Shea | | | | 4 | | |
| Corm | 73 | 35 | 183 | 10 | 22 | 6 |
| SmCo | | 1 | 4 | | | 1 |
| EmGo | | 2 | | | | |
| Mall | | | | 1 | | |
| Scau | | 2 | 5 | | | |
| Buff | 2 | | 1 | | | |
| SeDu | 136 | 13 | 77 | 8 | 12 | 33 |
| Olds | 59 | 32 | 201 | 18 | 337 | 53 |
| Harl | 26 | | 31 | | 2 | 4 |
| Eide | 83 | 98 | 37 | 7 | 8 | 31 |
| StEi | 9 | | 25 | 65 | 9 | 136 |
| LgEi | | | | 120 | | |
| CoEi | 52 | 123 | 265 | 19 | 119 | 104 |
| KiEi | | 60 | | | 3 | 6 |
| Scot | 993 | 626 | 345 | 48 | 390 | 71 |
| WWSc | 7 | 38 | 89 | 8 | 85 | 19 |
| SuSc | 14 | 22 | 79 | 10 | 9 | 1 |
| BlSc | 157 | 217 | 141 | | 9 | 17 |
| Merg | 23 | | | | | |
| RBMe | 1 | | | | | |
| BaEa | 1 | 2 | 1 | | | |
| MeSh | 26 | | 1 | 15 | | |
| Gull | 98 | 227 | 227 | 39 | 8 | 30 |
| LgGu | 110 | 27 | 136 | 59 | 11 | 44 |
| GlGu | | | 1 | | | |
| GwGu | 35 | 54 | 106 | 22 | 48 | 83 |
| HeGu | | | 1 | 1 | 2 | |
| SmGu | 338 | 28 | 51 | 22 | | 4 |
| BlKi | 5 | | | 6 | | 2 |
| MeGu | 21 | | 96 | 11 | 6 | 14 |
| SeBi | | | | 1 | | 2 |
| Alci | 40 | | 8 | 2 | | 5 |
| SmAl | 12 | 2 | 1 | | 8 | 9 |
| SLAl | 1 | | | | | |
| Murr | 84 | 1 | 51 | 86 | 87 | 237 |
| Mule | 7 | | 9 | 1 | 9 | 7 |
| PiGu | 28 | | 10 | 16 | 4 | 7 |
| Pass | 38 | 1 | | | | |
| Rave | 3 | 1 | 3 | | | |
| NWCr | | 3 | | | | |
| SnBu | 1 | | | | | |
| Total | 2507 | 1623 | 2221 | 604 | 1198 | 929 |

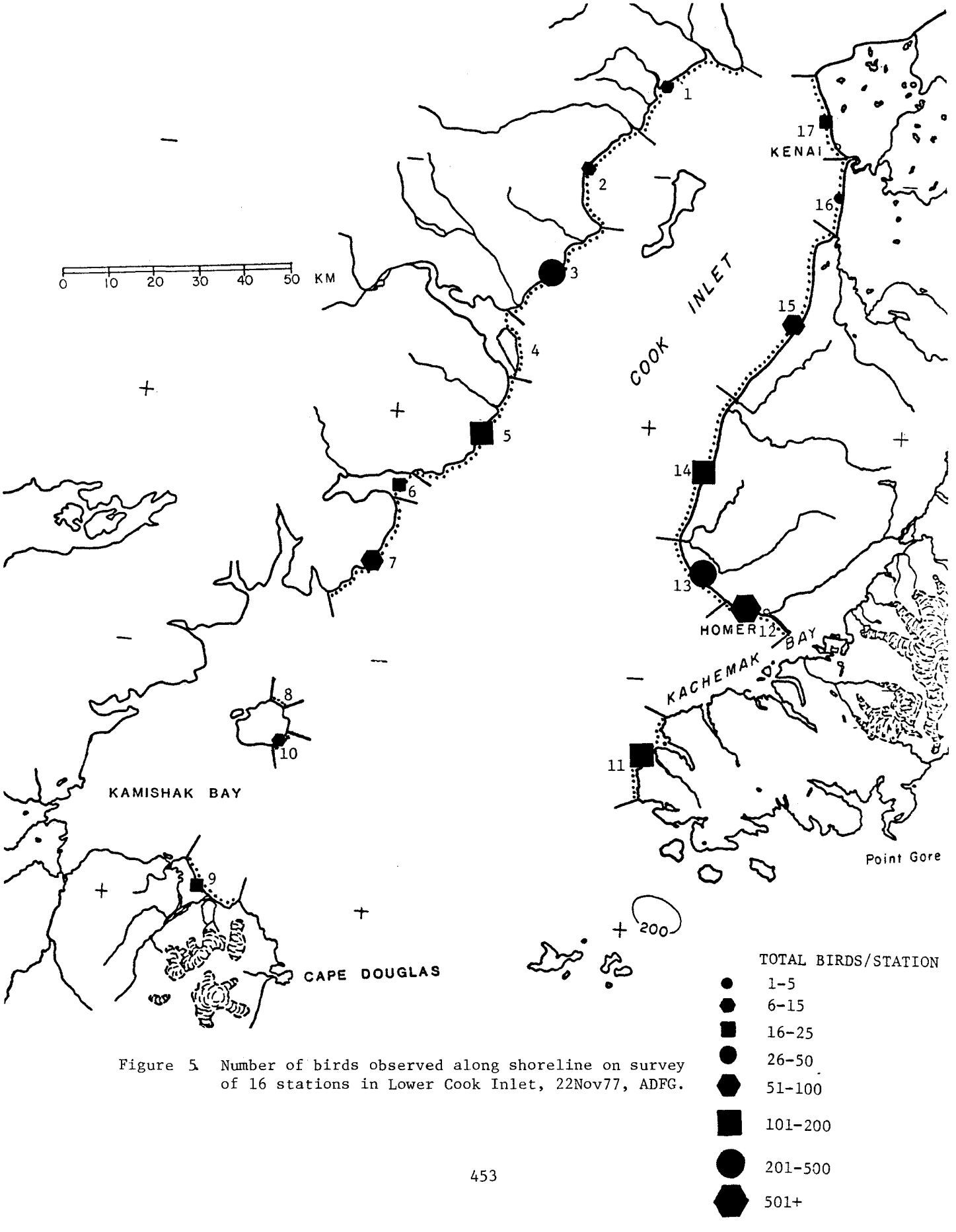


Figure 5. Number of birds observed along shoreline on survey of 16 stations in Lower Cook Inlet, 22Nov77, ADFG.

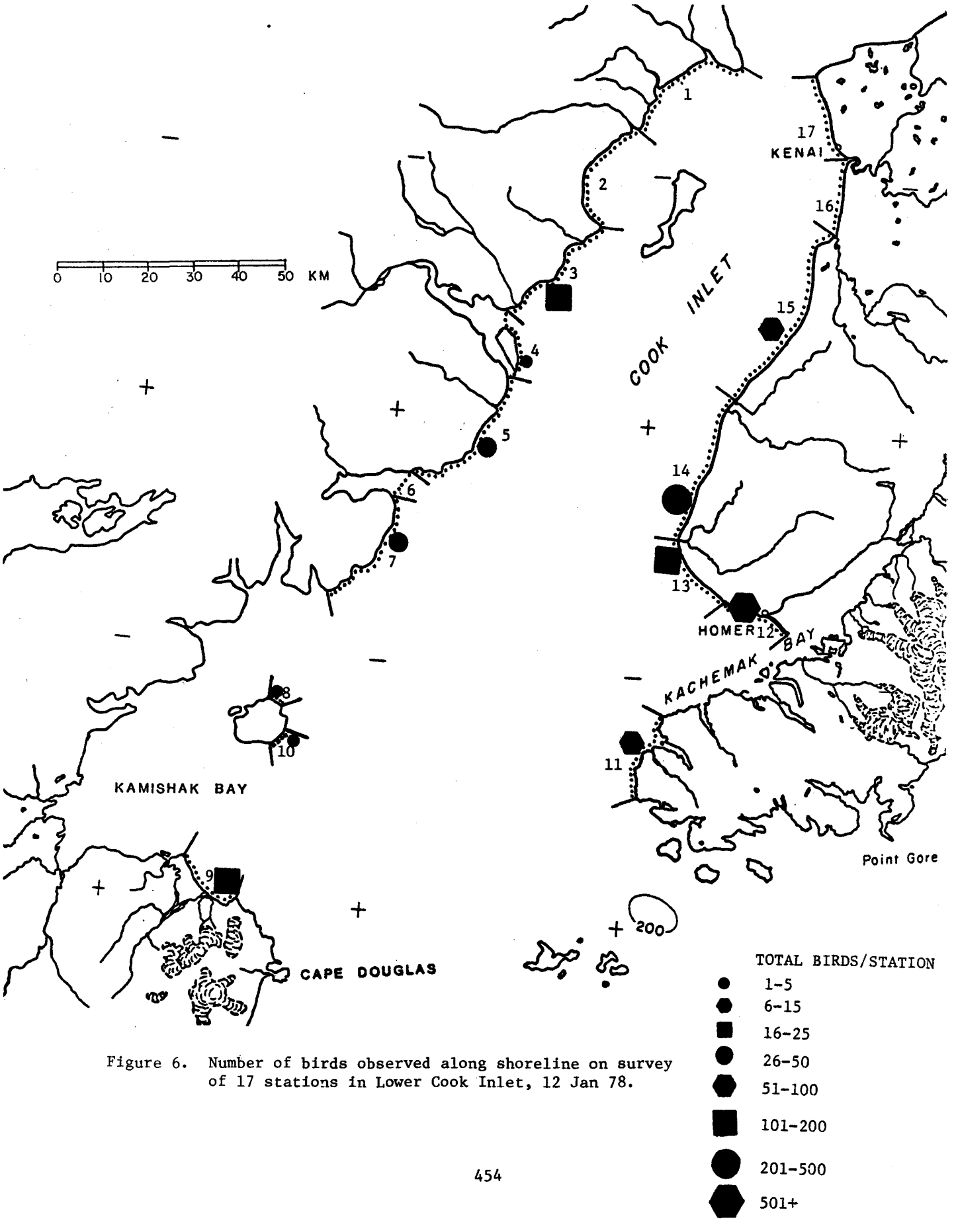


Figure 6. Number of birds observed along shoreline on survey of 17 stations in Lower Cook Inlet, 12 Jan 78.

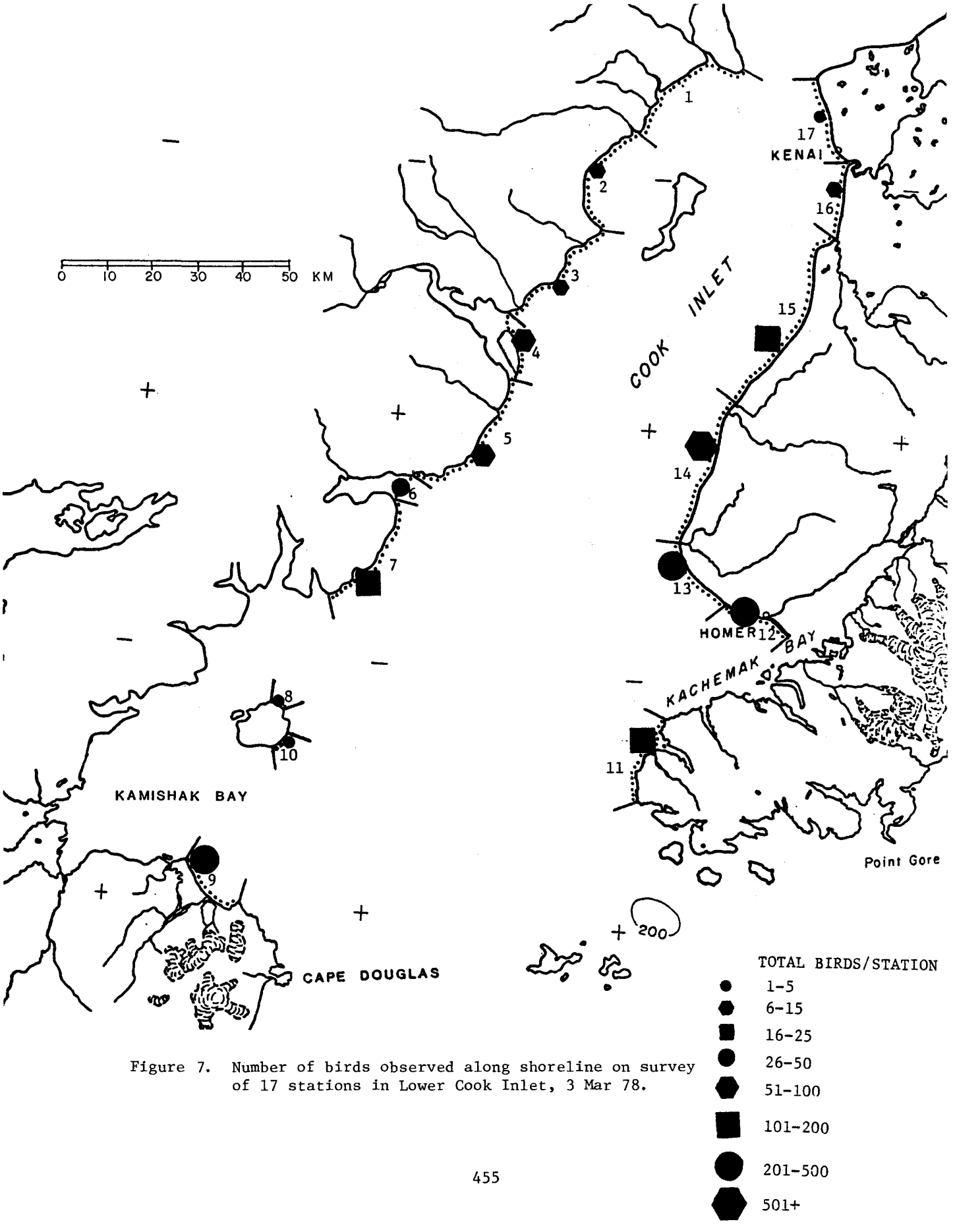


Figure 7. Number of birds observed along shoreline on survey of 17 stations in Lower Cook Inlet, 3 Mar 78.

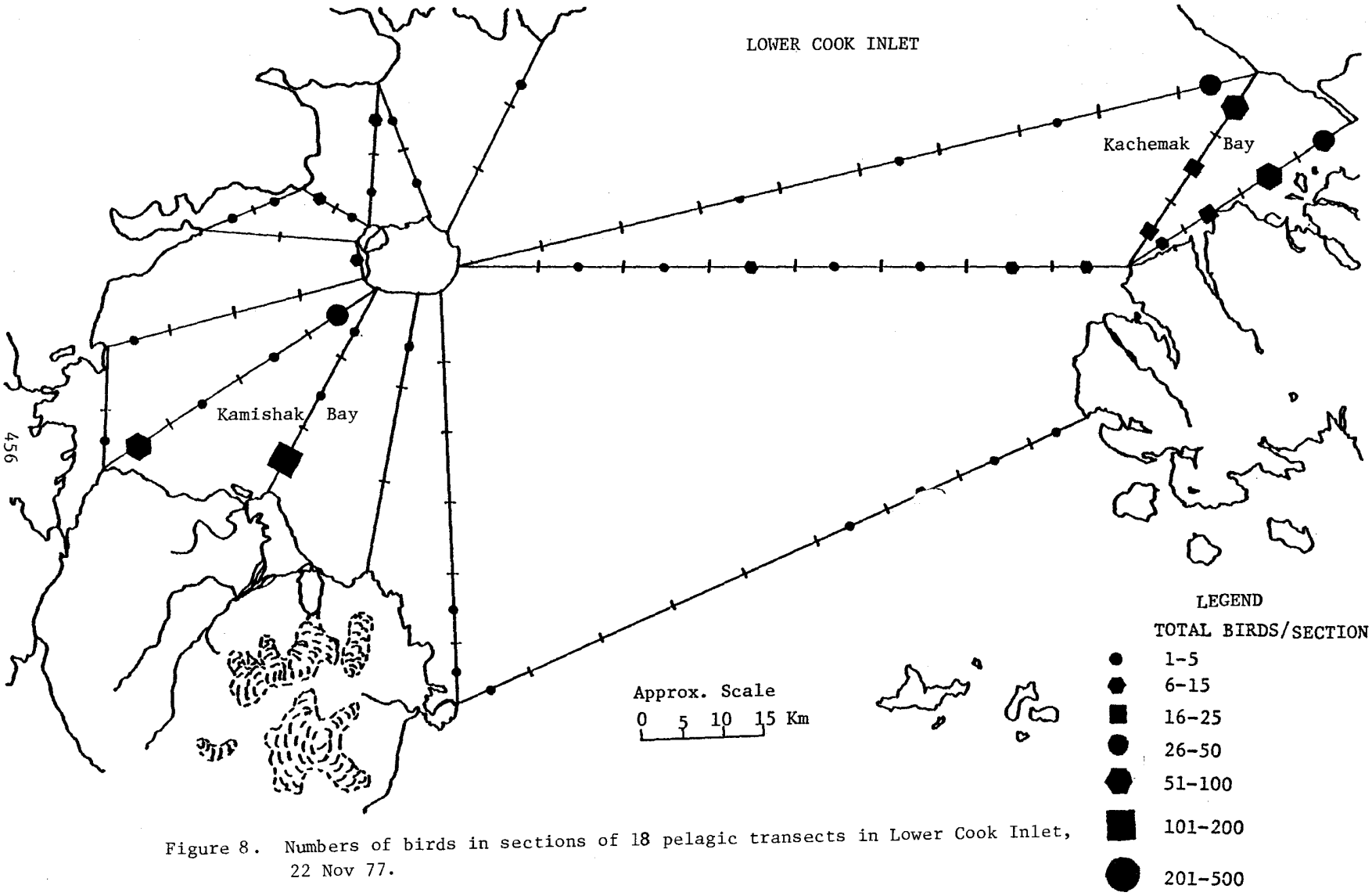


Figure 8. Numbers of birds in sections of 18 pelagic transects in Lower Cook Inlet, 22 Nov 77.

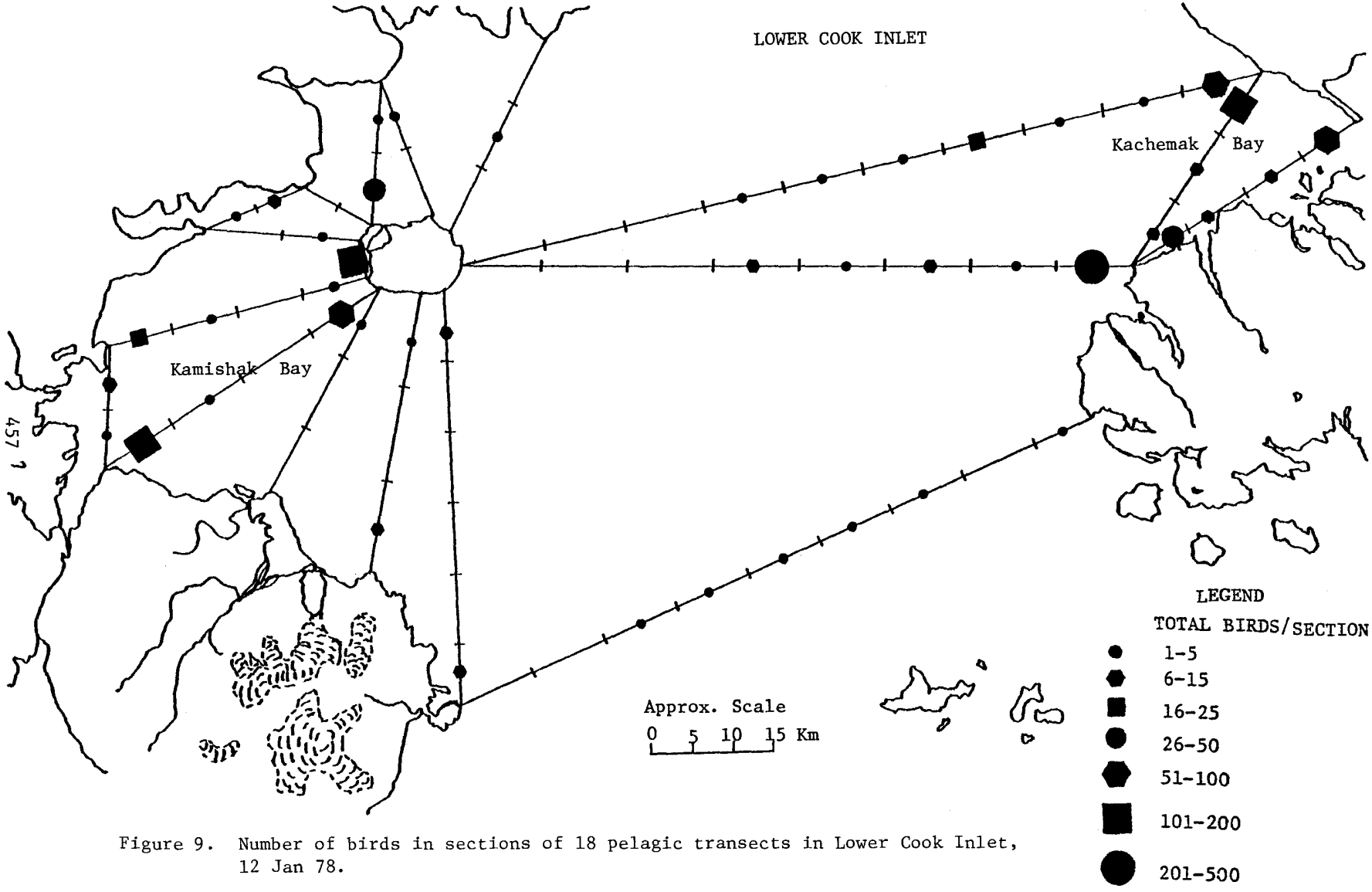


Figure 9. Number of birds in sections of 18 pelagic transects in Lower Cook Inlet, 12 Jan 78.

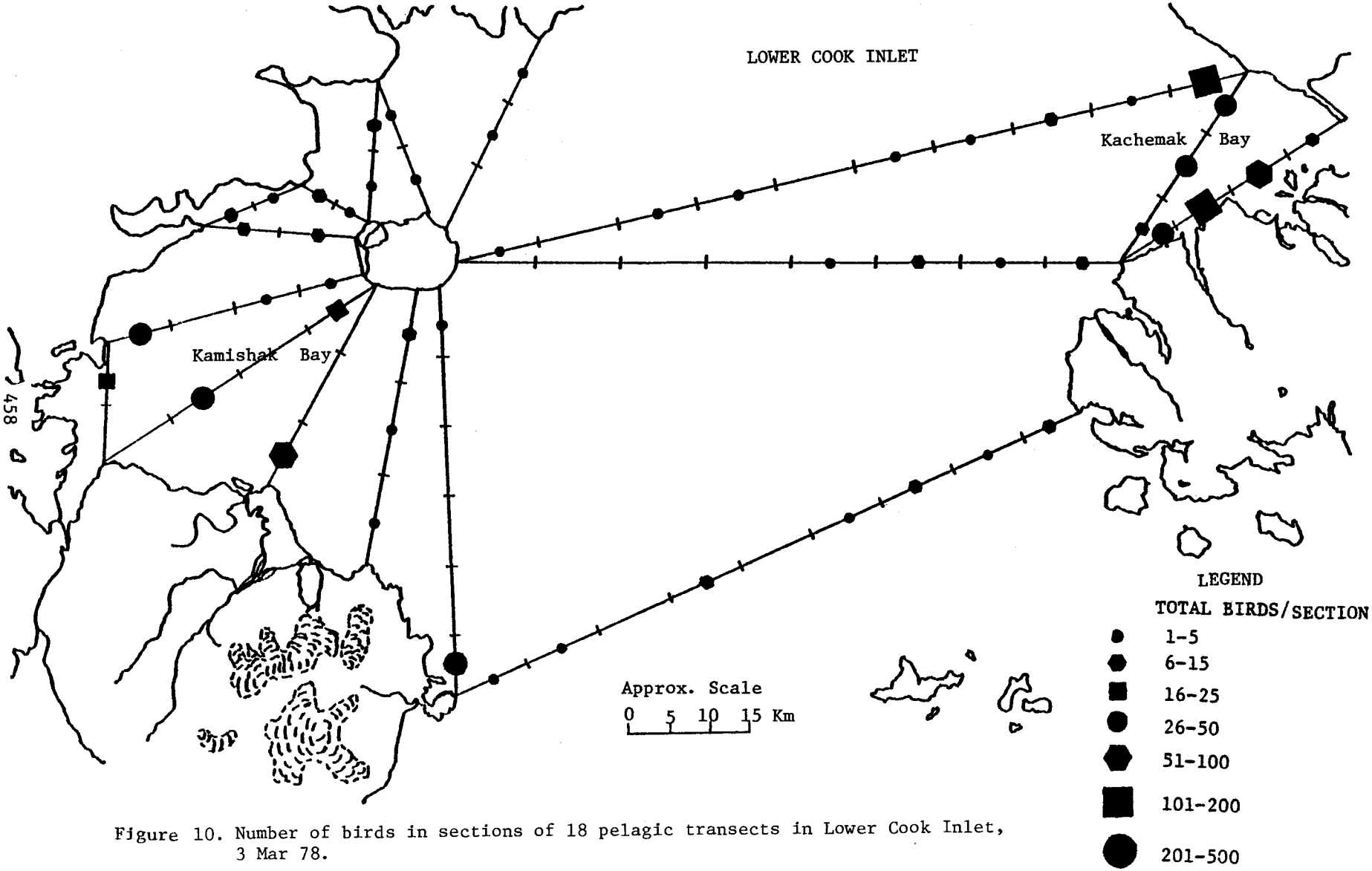


Figure 10. Number of birds in sections of 18 pelagic transects in Lower Cook Inlet, 3 Mar 78.

Table 8. Relative abundance and percent composition of the most abundant bird species groups for three shoreline surveys in three regions of Lower Cook Inlet, Winter, 1977-78.

| Species Groups | 22 November 1977 | | | 12 January 1978 | | | 3 March 1978 | | |
|---|---|---|---|---|---|---|---|---|---|
| | NW side | Kamishak | East side | NW side | Kamishak | East side | NW side | Kamishak | East side |
| **Abundance - Birds/km of transect** | | | | | | | | | |
| Eiders | - | - | 0.8 | Tr | - | 1.6 | Tr | Tr | 1.9 |
| Scoters | 0.1 | 0.4 | 6.7 | 0.1 | 3.1 | 4.7 | 0.5 | 2.1 | 3.0 |
| Other Seaducks* | 0.2 | - | 1.1 | Tr | Tr | 0.2 | 0.2 | 0.3 | 1.6 |
| Larids | 2.5 | 0.4 | 0.9 | 1.4 | 2.0 | 0.2 | 1.3 | 6.2 | 1.3 |
| Alcids | - | - | 1.0 | - | Tr | Tr | 0.2 | Tr | 0.3 |
| Other Birds | 0.1 | 0.4 | 1.0 | Tr | - | 0.3 | 0.1 | - | 1.3 |
| **Composition - Percent of Total** | | | | | | | | | |
| Eiders | - | - | 7 | 2 | - | 23 | 1 | 1 | 20 |
| Scoters | 3 | 36 | 58 | 8 | 59 | 66 | 24 | 24 | 32 |
| Other Seaducks* | 6 | - | 10 | 2 | 1 | 3 | 7 | 3 | 17 |
| Larids | 87 | 33 | 8 | 87 | 39 | 3 | 57 | 72 | 14 |
| Alcids | - | - | 8 | - | 1 | 1 | 7 | 1 | 3 |
| Other Birds | 3 | 30 | 8 | 1 | - | 4 | 3 | - | 14 |

* Other Seaducks includes Oldsquaw, Harlequin Duck, and unidentified seaducks.

Table 9. Density and percent composition of the most abundant bird species groups for three pelagic surveys in three regions of Lower Cook Inlet, Winter, 1977-78.

| Species Groups | 22 November 1977 | | | 12 January 1978 | | | 3 March 1978 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Across Outer | | | Across Outer | | | Across Outer | | |
| | Kamishak | LCI | Kachemak | Kamishak | LCI | Kachemak | Kamishak | LCI | Kachemak |
| **Density - Birds/km$^2$** | | | | | | | | | |
| Eiders | 3.0 | 0.4 | - | 0.2 | 0.6 | 7.4 | 1.8 | 2.7 | 1.4 |
| Scoters | 0.4 | 0.4 | 1.6 | 2.5 | 4.7 | 6.6 | 0.6 | 0.5 | 3.8 |
| Other Seaducks* | 0.2 | Tr | 0.9 | 5.3 | 0.1 | 0.7 | 1.2 | Tr | 0.7 |
| Larids | 0.3 | 0.4 | 9.4 | 0.3 | 0.3 | 3.2 | 1.6 | 0.4 | 4.4 |
| Alcids | Tr | 0.4 | 6.8 | - | 0.6 | 6.1 | Tr | 0.9 | 17.5 |
| Other Birds | 0.4 | 0.1 | 0.4 | Tr | 0.4 | 1.0 | 0.1 | 0.1 | 0.2 |
| **Composition - Percent of Total** | | | | | | | | | |
| Eiders | 69 | 21 | - | 3 | 9 | 29 | 34 | 60 | 5 |
| Scoters | 10 | 21 | 8 | 30 | 71 | 26 | 10 | 10 | 14 |
| Other Seaducks* | 4 | 3 | 5 | 63 | 1 | 3 | 23 | 1 | 2 |
| Larids | 7 | 25 | 49 | 3 | 5 | 13 | 30 | 8 | 15 |
| Alcids | 1 | 22 | 35 | - | 9 | 24 | 1 | 19 | 62 |
| Other Birds | 8 | 7 | 2 | 1 | 5 | 4 | 1 | 1 | 1 |

* Other Seaducks includes Oldsquaw, Harlequin Duck, and unidentified seaducks.

Table 10. Density and percent composition of birds in three combined winter 1978 surveys in Lower Cook Inlet. Data are segregated into three regions and then combined for total Lower Cook Inlet.

| | Shoreline Stations | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Northwest side | | Kamishak | | East side | | Lower Cook Inlet Combined | |
| Species/Group | Density Birds/km | Composition % | Density Birds/km | Composition % | Density Birds/km | Composition % | Density Birds/km | Composition % |
| Cormorants | Tr | 1 | 0 | 0 | 0.6 | 6 | 0.3 | 5 |
| Eiders | Tr | 1 | Tr | Tr | 1.5 | 16 | 1.3 | 12 |
| Scoters | 0.2 | 11 | 1.9 | 37 | 4.8 | 51 | 2.4 | 43 |
| Other Seaducks* | 0.1 | 6 | 0.1 | 2 | 1.0 | 10 | 0.5 | 9 |
| Gulls | 1.7 | 77 | 2.9 | 58 | 0.8 | 9 | 1.4 | 25 |
| Alcids | 0.1 | 3 | Tr | 1 | 0.4 | 5 | 0.2 | 4 |
| Other | Tr | 2 | 0.1 | 3 | 0.3 | 3 | 0.2 | 3 |
| Total | 2.2 | 101 | 5.1 | 101 | 9.3 | 100 | 5.6 | 101 |

* Other seaducks includes Oldsquaw, Harlequin Duck and unidentified seaducks.

Table 11. Density and percent composition of birds in three combined winter 1978 surveys in Lower Cook Inlet. Data are segregated into three regions and then combined for total Lower Cook Inlet.

Pelagic Transects

| Species/Group | Kamishak Density Birds/km$^2$ | Kamishak Composition % | Across LCI Density Birds/km$^2$ | Across LCI Composition % | Outer Kachemak Density Birds/km$^2$ | Outer Kachemak Composition % | Lower Cook Inlet Combined Density Birds/km$^2$ | Lower Cook Inlet Combined Composition % |
|---|---|---|---|---|---|---|---|---|
| Cormorants | 0.1 | 1 | 0.1 | 2 | 0.3 | 1 | 0.1 | 1 |
| Eiders | 1.7 | 28 | 1.2 | 28 | 2.9 | 12 | 1.6 | 23 |
| Scoters | 1.2 | 19 | 1.8 | 43 | 4.0 | 17 | 1.7 | 24 |
| Other Seaducks* | 2.2 | 37 | 0.1 | 1 | 0.8 | 3 | 1.2 | 17 |
| Gulls | 0.7 | 12 | 0.4 | 9 | 5.7 | 24 | 1.1 | 15 |
| Alcids | Tr | Tr | 0.6 | 15 | 10.1 | 42 | 1.2 | 18 |
| Other | 0.1 | 2 | 0.1 | 2 | 0.2 | 1 | 0.1 | 1 |
| Total | 6.0 | 99 | 4.3 | 100 | 24.0 | 100 | 7.0 | 99 |

* Other seaducks includes Oldsquaw, Harlequin Duck and unidentified seaducks.

In the Kvichak Bay area, where several stations were intentionally duplicated in bird censuses spaced several days apart, a dramatic change occurred in species composition and abundance. The most noticeable change was with shorebirds and in particular Black-bellied Plovers (classified medium shorebirds in Table 2). Relatively large numbers of this species and other shorebirds fed on the mudflats on both sides of Kvichak Bay on 6 and 7 May, but on 10 and 13 May, when replicate counts were made, most of the shorebirds had departed. A similar situation was true for dabbling ducks and Canada Geese on the North Bristol Bay side of Kvichak Bay. Although they were abundant on the first survey, most had migrated before the second survey.

Total bird densities dropped from 589 to 145 birds/$km^2$ in upland portions of North Bristol Bay between the first and second survey and from 44 to 34 birds/km along the coast. On the North Alaska Peninsula side, densities dropped from 105 to 38 birds/km. Gulls were the only species group that maintained relatively high densities from one survey to the next. However, many gulls are residents in the area and would not be expected to migrate.

Cinder River/Hook Lagoon was also surveyed twice because of a tape recorder malfunction on the first survey, and a similar change in species composition and abundance was noticed. Although surveys were separated by only two days, a striking change was made noticeable by an increase of Bar-tailed Godwits and decrease in Gadwalls from the first to the second counts.

By comparing bird densities in exposed versus protected areas, several marked differences were noted. As expected, densities on the North Alaska Peninsula were greater in protected nearshore and supratidal areas. Exposed areas had approximately one-half the total bird densities as did coastline portions and there were one-third fewer on upland areas than in protected estuaries. This difference was largely a result of large numbers of geese and sea ducks that congregated in the estuaries. Those few geese that were found in exposed areas were normally Emperors roosting on sandy beaches of sandspits and barrier islands near estuaries or Brant migrating northeasterly along the coast.

Surprisingly low densities of shorebirds were observed in both protected and exposed areas. The highest densities were those of small shorebirds in the exposed coastal floodplain areas, but since such a small area was surveyed, this does not represent large numbers (just over 1,000) of shorebirds.

Along coastal areas, gulls were more abundant on exposed beaches than in protected waters. They were relatively evenly spaced along the entire beach. Small groups of 10-20 were observed roosting on the sand, feeding in intertidal areas or flying up and down the coast. Occasionally, concentrations of several hundred were found bathing at mouths of streams or roosting on the sand.

Bird densities in North Bristol Bay differed markedly from those on North Alaska Peninsula. Along protected coastlines, total bird densities were almost one-sixth fewer on North Bristol Bay than on North Alaska

Peninsula. Values in other categories were more similar in density but species composition differed. Few geese were observed in North Bristol Bay by comparison, and those seen were predominately Canada Geese. On the 6 May and 13 May North Bristol Bay surveys, there were 73 percent Canada, 16 percent White-fronted, 12 percent Snow and 48 percent Canada, 31 percent Snow, 11 percent Emperor Geese, respectively. By comparison, there were 63 percent Brant and 36 percent Emperor Geese on the 10-12 May survey of North Alaska Peninsula.

Sea ducks were much less abundant in nearshore waters in North Bristol Bay than on North Alaska Peninsula but diving ducks were substantially more dense. On exposed and protected shorelines there were 16.0 and 7.2 diving ducks/km, respectively, versus 0.1 and 4.6 ducks/km in North Alaska Peninsula. Over 96 percent of the diving ducks in North Bristol Bay were Scaup, and 41 percent of the Scaup were found in station 3 or the Flounder Flats area of Nushagak Bay.

Although not evident from the data of coastal surveys, thousands of King Eiders were foraging far offshore throughout Nushagak Bay on May 7. Because of the mild winter in 1976-77, King Eiders were able to winter all along the north side of the Alaska Peninsula and gradually moved farther north as spring progressed. Thousands had been sighted outside of Egegik Bay a couple of months earlier (Bob Gill pers. comm.).

Dabbling ducks were an important component of the avifauna in floodplain portions of both North Bristol Bay and North Alaska Peninsula. Over 90 percent of the dabblers in both areas were Pintails. Use of this region by dabblers may be greater in fall migration, but analysis of data from fall surveys has not been completed for verification.

Densities of shorebirds were much greater in inter- and supratidal areas of Bristol Bay than in similar areas of North Alaska Peninsula. Almost 80 shorebirds/$km^2$ were recorded in protected upland portions of North Bristol Bay versus only 6.8/$km^2$ in similar habitat of North Alaska Peninsula. In both cases, it appeared that small-sized sandpipers outnumbered those classified medium-sized shorebirds. However, size determination from aircraft is difficult, and species identification is almost impossible except on larger, more distinct species.

Several interesting observations were derived from the comparison of bird densities in estuaries of North Alaska Peninsula (Table 4). In several estuaries, geese far outnumbered other species present, but goose species composition differed among areas. Most of the geese in Izembek Lagoon were Brant and the remainder were Emperor Geese. Brant were recorded in small numbers in Port Moller, Seal Islands, Port Heiden and Cinder River, but Emperor Geese predominated in these bays. Snow geese were the most numerous species at Ugashik Bay and Canada Geese prevailed in Kvichak Bay.

Dabbling ducks were relatively numerous in only three estuaries: Port Heiden, Ugashik Bay and Kvichak Bay. The two northernmost estuaries were the only areas with comparatively great densities of diving ducks. These densities approximated those found in North Bristol Bay. Sea ducks were widely distributed but densest at Port Moller (particularly

in Nelson Lagoon) and Izembek Lagoon. Of the sea ducks identified to species on the North Alaska Peninsula survey, 73 percent were Steller's Eiders and 19 percent Black Scoters. Common Eiders comprised only four percent and Oldsquaw three percent of the total. Mergansers were common only in Kvichak Bay and several hundred were observed in the fresh water of Naknek River.

The densest concentrations of shorebirds were found in Kvichak Bay on the 6 May survey and in Cinder River/Hook Lagoon. Medium-sized shorebirds were more abundant than small shorebirds in both these areas. Cinder River also had the greatest population of large shorebirds (predominately Bar-tailed Godwits).

Gulls were abundant in all estuaries but most dense in the Seal Islands and Nelson Lagoon (Port Moller) areas where numerous sandbars and barrier islands provided suitable nesting habitat. Gulls were the only abundant bird group in the St. Catherine Cove and Hook Bay portions of Bechevin Bay. The tern migration was just beginning at the time of the survey and only low numbers were seen in most areas.

The densest concentration of total birds (704 birds/$km^2$) in all estuaries was in the Port Moller supratidal areas. This value is inflated in that only a small area (15.8 $km^2$) of upland was surveyed, and this area was the loafing site for many Emperor Geese and gulls. Most estuaries supported reasonably large bird numbers. Smallest numbers of birds were found in Bechevin and Egegik Bays.

Lower Cook Inlet Shoreline Stations: Sea ducks comprised the largest percentage (64 percent) of birds found on shoreline portions of surveys in Lower Cook Inlet during winter 1977-78. Most common were scoters (all three species combined), followed by eiders and other sea ducks including Oldsquaws and Harlequin Ducks. Black Scoters were the most abundant of those scoters identified, but the composition of large numbers of unidentified scoters cannot be assumed to follow that of those identified. An unexplained decrease in scoter density and percentage occurred between the first and last shoreline surveys. Perhaps migration to summer areas had begun.

Common Eiders were the most numerous eiders, and few of the other eider species were seen along shoreline counts. A marked increase in numbers of Common Eiders occurred from the November to March surveys but total numbers were relatively small. Oldsquaws were most abundant in the March survey and at that time were distributed along the eastern shore from Homer Spit to north of Ninilchik.

Greatest densities of sea ducks were on shoreline Stations 12, 13 and 14 which had mean densities of 43, 14 and 11 birds/km, respectively. Most birds were within 150 meters of the shore. By March many birds (particularly Oldsquaws) moved north into Station 15, and Station 14 had more than Stations 13 and 12. Weather cannot be ruled out as a factor affecting this distribution because northeast winds made the coast from Anchor River to Homer the leeward portion. Conditions were much worse in Kamishak Bay, particularly in November and January. However, a more plausible explanation is that an abundance of food organisms attracted

birds to that shore. Winds were not strong in Lower Cook Inlet on the March survey, yet seaducks congregated in the same coastal areas as before.

Few sea ducks were found along the shoreline of the northwest side and in Kamishak Bay. Greatest densities were in Station 9 in January and March and in Station 7 in March. Most were scoters with occasional flocks of Oldsquaws.

Gulls represented the next most abundant bird group in shoreline counts. Glaucous-winged Gulls were the most widespread and were observed on 66 percent of shoreline stations. On the Northwest side, larids were by far the most abundant group. A flock of approximately 200 Mew and Glaucous-winged Gulls remained in the vicinity of Tuxedni Bay and Polly Creek throughout the winter. Relatively large numbers of gulls were recorded for Kamishak Bay during the March survey, but the length of shoreline stations in that area was so small that this may represent an inflated value and may not be typical of other parts of the bay. Of the three regions, gulls were least abundant on the east side of Lower Cook Inlet.

Other species groups were much less abundant on shoreline stations. Although cormorants comprised five percent of the total, the majority were observed on the March survey. That increase may have been the result of severe, prolonged stormy weather prior to the survey that may have "pushed" the cormorants into Lower Cook Inlet from the exposed southern coastline of the Kenai Peninsula. It may also represent seasonal movements by cormorants at that time of year.

Four percent of the total birds seen on shoreline counts were alcids, the majority of which were murres. As with cormorants, most murres were observed in the March survey. The effect of the aforementioned storm on murres was more dramatic and obvious than the effect on cormorants. Just prior to the survey murres were found well inland from Upper Cook Inlet, and substantial numbers of dead and dying murres were found in Resurrection Bay. During the survey, distribution of murres was highly unusual. Two were seen along the shore near Nikiski on the east side of Lower Cook and as high as Station 3 on the west side. For that time of year, this distribution would be entirely unexpected. While flying the March survey we observed about 24 dead, floating murre-like birds. More were reported in Kachemak Bay by fisherman in boats.

Lower Cook Inlet Pelagic Transects: As with shoreline stations, sea ducks comprised almost two-thirds of all birds recorded on pelagic transects. However, eiders were almost as abundant as scoters, and other sea duck species, particularly Oldsquaw, made up a larger percentage of the total. Sea ducks preferred nearshore waters to those offshore. They were one-third as abundant on pelagic transects as on shoreline stations.

The composition of sea ducks did not change between surveys and within regions in a regular pattern. In Kamishak Bay, eiders predominated in November, Oldsquaw in January and numbers were more equal in March. On transects across the inlet in January, scoters were the most abundant

sea duck, but in March eiders predominated.

The scoters in January were largely found in two locations on the trans-inlet transects. One location was west of Point Pogibshi and the other southwest of Bluff Point. Both areas have been recognized in the past as having scoter concentrations in winter. This is the third consecutive winter that scoters, particularly White-Winged scoters, have been observed in the area southwest of Bluff Point. This area was also used by Steller's and Common Eiders but in lesser numbers.

On the two outer Kachemak Bay transects, sea ducks were less abundant than other bird species (7.7 vs 16.3 birds/$km^2$). Scoters were only slightly more numerous than eiders (4.0 vs 2.9 birds/$km^2$), and few Oldsquaws and Harlequin Ducks were recorded.

Gulls were densest (9.4 birds/$km^2$) in the November survey of Outer Kachemak Bay. This represented the second highest density of birds in all three winter pelagic surveys. Gulls were eight times more dense in Outer Kachemak Bay than in Kamishak Bay. Twelve percent of the birds in Kamishak Bay were gulls while in Outer Kachemak gulls made up 24 percent. During a survey on 1 April 1976, this species composition was reversed. Only one percent of the birds in Kachemak Bay were gulls while 18 percent were gulls in Kamishak Bay (Arneson 1976b).

Alcid distribution was more consistent. Only a few were counted in all three surveys of Kamishak Bay, and there were similar findings in the 1976 survey. Moderate numbers were found on transects across the inlet, but highest densities were recorded in Outer Kachemak Bay. The highest density, 17.5 birds/$km^2$, was found on the March 1978 survey. Forty-two percent of the birds observed in Outer Kachemak in the three surveys were alcids. Common Murres far outnumbered the next two most abundant alcids-Pigeon Guillemots and murrelets.

Other species or groups made up an insignificant proportion of the total birds in pelagic transects in comparison to the previously discussed groups. Interestingly, shearwaters were still present in Lower Cook Inlet in November when four were observed in Transect Q. Northern Fulmars, surprisingly, were only observed on the January survey and then only in small numbers (six).

## VII. Conclusions

Bristol Bay: The importance of the Bristol Bay region to migrating birds was further substantiated by surveys conducted in May 1977. Over 200,000 birds were enumerated along coastal areas of North Alaska Peninsula and North Bristol Bay. Densities as high as 704 birds/$km^2$ in supratidal sedge/grass habitat and 236 birds/km along coastal beaches were recorded.

Protected waters of estuaries and river deltas supported the greatest densities of most species. Much variability in bird densities and species composition existed among estuaries in the region, and it was obvious that each bay, lagoon and delta had its own intrinsic value to particular species or groups. The most important habitat types within protected waters are intertidal mud/sand flats and sedge/grass meadows

that are occasionally flooded by storm tides. Nearshore subtidal areas also likely supply large proportions of diving and sea duck food organisms.

Brant were the single most abundant bird species along the coast in May 1977. Almost all were found in Izembek Lagoon. Emperor Geese and Steller's Eiders were next in abundance and most of these birds were found in estuaries from Port Heiden south. Canada, White-fronted and Snow Geese were more abundant in North Bristol Bay and as far south as Ugashik Bay on North Alaska Peninsula.

In spring, shorebirds are more dense on the northern portions of the region, particularly in Kvichak Bay. Small sandpipers are slightly more abundant than medium-sized shorebird species. Black-bellied Plovers and Rock Sandpipers were the most abundant medium-sized shorebirds that we identified.

The dynamic nature of spring migration was evident when stations in Kvichak Bay and Cinder River were reflown two to six days after the initial survey. Large numbers of Canada Geese, Pintails and Black-bellied Plovers that were present on intertidal and supratidal areas on the 6-7 May surveys were almost gone by 10 and 13 May. There also appeared to be differential migration corridors used by birds. Shorebirds, Canada, White-fronted and Snow Geese, and Pintails likely migrated overland to use the north portion of Bristol Bay whereas others like Emperor Geese, sea ducks and loons followed much of the coastline throughout the area, and others like Brant usedonly a few areas on North Alaska Peninsula and then traveled over Bristol Bay to nesting or other staging areas.

Gulls were the only species group that were as abundant or more abundant along exposed coastline as in protected waters. This species group was normally second or third in abundance for all survey types and locations, and therefore was an important part of the avifauna of the region.

Further analysis will determine differences in species composition and densities between spring and fall migration. Some species use the region more in the fall than spring and vice versa. Nonetheless, this coastline is extremely valuable to staging birds to provide sufficient energy stores for migration.

Lower Cook Inlet: As a result of aerial bird surveys in Lower Cook Inlet during the 1977-78 winter Outer Kachemak Bay was determined to be by far the most important region for wintering birds. The greatest species diversity and highest densities were found on both pelagic transects and shoreline counts in that region during the 1977-78 winter. These high coastal densities extended northward to Anchor River and beyond. The most abundant species found in this area (scoters, alcids, eiders and larids) will be susceptible to oil if spills occur in the region. For the third consecutive year a concentration of scoters was observed south of Bluff Point, and the area appears to be very important to several thousand birds.

Kamishak Bay had much lower densities, and concentrations were found in varying locations on the three identical surveys. Sea ducks were the

predominate species group although the composition consisted of more eiders than scoters as opposed to more scoters than eiders in Kachemak Bay. Few alcids or other species vulnerable to oil spills were found in the region.

Low densities of wintering birds were found in open water between Kamishak and Kachemak Bays and along the shoreline of Northwest Lower Cook Inlet. The only concentration was a flock of gulls that remained near Tuxedni Bay all winter, but ice conditions in a "normal" winter may preclude their presence in the area. Large flocks of eiders and possibly other birds were apparently missed on our 3 March survey. The previous day during a survey of marine mammals, Don Calkins reported seeing hundreds of eiders in Kamishak Bay and another large flock of unidentified birds between Anchor Point and Chinitna Bay in open water. Although our transect pattern thoroughly covered Kamishak Bay, we did not see such concentrations. Diel movements must have put the birds out of our line-of-sight but still within Lower Cook Inlet. Because of this discrepancy, it is possible that our survey techniques and results did not reflect an accurate picture of what was present.

For the second consecutive winter, relatively mild temperatures prevailed in the Gulf of Alaska, and what effects that may have had on bird distribution and abundance are unknown at present. Severe winds persisting for several days before the last survey also may have affected bird distribution and definitely caused natural mortality in Common Murres.

IX. Summary of 2nd Quarter Operations

A. Aircraft activities

1. Field trip schedule: A combination shoreline/open water survey was conducted in a chartered Grumman Widgeon on 12 January 78. An identical survey was flown on 3 March 78.

2. Scientific party: For both surveys, bird observers were Paul Arneson and Marilyn Allen, Alaska Department of Fish and Game, Anchorage, Alaska.

3. Methods: The same methods described earlier in this report were used in surveys during this quarter.

4. Localities: The same shoreline stations and pelagic transects were surveyed as those shown in Figure 2.

5. Data collected: In both surveys 17 shoreline stations totaling 375 km and 18 pelagic transects totaling 650 km or 130 $km^2$ were flown. A minimum of 24 species and 2,821 individuals were observed on the January bird survey and 27 species with 3,150 individuals were observed in the March survey.

An experimental analysis was submitted to NODC/EDS to test the feasibility of using that type of analysis in the final report. This included mapping distribution and

abundance of bird species. A computer program was written for summarizing bird distribution and abundance in Bristol Bay.

6. Milestone chart: See Table 12 for an updated version of planned and completed research and data management for Fiscal Year 1978.

   Two slippages in last year's Milestone Chart occurred. One was a planned (or hoped for) bird survey of the Aleutian Shelf region in summer 1977. Due to increased aircraft costs, money for bird surveys was expended before this flight could be conducted. It is expensive to fly this area since a twin-engine, amphibious aircraft is necessary, and insufficient funds were available to do a suitable job.

   Secondly, I had hoped to be able to find time enough to summarize the past two years' work into final report form before beginning the Lower Cook Inlet work. The workload of a continuing field season, frequent meetings and an unforeseen problem with habitat coding errors precluded the completion of a report.

B. Problems encountered/recommended changes

During this quarter weather posed the greatest problem. Although weather predictions were favorable for the first two bird surveys, when we got to Kamishak Bay sea states were higher than is desirable for bird surveys. Consequently, birds may have been missed making our counts lower. Identification of birds was also more difficult, but it was not felt that a substantial underestimation of numbers resulted from the poor survey conditions.

The winter, in general, was milder than normal and may influence the outcome of our surveys. It is unknown whether our counts would be decreased (or increased) in a more severe winter.

Prior to the March survey, a severe storm (high winds) in the Gulf of Alaska had lasted for almost two weeks. This obviously changed the distribution pattern of some birds (as reflected by unusual Common Murre sightings), but the overall effect on our survey results is unknown.

The unavoidable problems with logistics and data management occurred this quarter as in the past, but are not major enough to elaborate.

MILESTONE CHART

Table 12.

Project Research Unit #3 Principal Investigator Paul D. Arneson Date FY 1978

| Major Milestones | Quarters 1 Oct. | Nov. | Dec. | 2 Jan. | Feb. | Mar. | 3 Apr. | May | Jun. | 4 Jul. | Aug. | Sep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lower Cook Inlet Winter Bird Surveys | | ▲ | | ▲ | | ▲ | | | | | | |
| Kamishak Bay Spring Waterfowl Surveys | | | | | | | △ | | | | | |
| Kamishak Bay Spring Shorebird Surveys | | | | | | | | △ | | | | |
| Kamishak Bay Bird Colony Field Work | | | | | | | | | ○ | ○ | ○ | |
| Summarization of Summer Field Work | | | | | | | | | | | | ⬡ |
| Quaterly Reports | | | ■ | | | ■ | | □ | | | | □ |
| Annual Reports | | | | | | ■ | | | | | | |

Milestones: ▲ Completed

△ Proposed

## LITERATURE CITED


Arneson P. D. 1976a. Identification, documentation and delineation of coastal migratory bird habitat in Alaska. Pages 1-44 in Environmental assessment of the Alaska continental shelf Vol. 2. Marine Birds. Principal investigator's reports for the year ending March 1976. (Environmental Research Lab. Boulder, Colo.).

_____ 1976b. Identification, documentation and delineation of coastal migratory bird habitat in Alaska. Pages 177-196 in Environmental assessment of the Alaska continental shelf Vol. 1. Principal investigator's reports April-June 1976. (Environmental Research Lab. Boulder, Colo. Sept. 1976).

_____ 1977a. Identification, documentation and delineation of coastal migratory bird habitat in Alaska. Pages 1-80 in Environmental assessment of the Alaska continental shelf. Annual reports of principal investigator's for the year ending March 1977. Vol. II. Receptors-Birds. (Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.).

_____. 1977b Identification, documentation and delineation of coastal migratory bird habitat in Alaska. Pages 83-99 in Environmental assessment of the Alaska continental shelf. Principal investigator's reports July-Sept. 1977. Vol. I (Environmental Research Lab. Boulder, Colo. Dec. 1977).

Erikson D. E. 1977. Distribution, abundance, migration and breeding locations of marine birds, Lower Cook Inlet, 1976. Unpub. AK. Dept. Fish and Game. Pub. 82 pp+ Appendices.

Gill, R. E., P. D. Jorgensen, A. R. DeGange, and P. Kust, Sr. 1977. Avifaunal assessment of Nelson Lagoon, Port Moller and Herendeen Bay, Alaska. Part 12 of J. C. Bartonek, C. J. Lensink, P. J. Gould, R. E. Gill and G. A. Sanger. Population dynamics and trophic relationships of marine birds in the Gulf of Alaska and southern Bering Sea. Pages 594-632 in Environmental assessment of the Alaskan continental shelf. Annual reports of principal investigators for the year ending March 1977. Vol. IV. Receptors-Birds (Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.).

King, J. G. and D. E. McKnight. 1969. A waterbird survey in Bristol Bay and proposals for future studies. Unpublished manuscript Juneau, Alaska Oct. 1969. Looseleaf pub. 11 pp.

Petersen M. R. and M. J. Sigman. 1977. Field studies at Cape Peirce, Alaska 1976. Pages 633-693 in Environmental assessment of the Alaskan continental shelf. Principal investigator's Reports for the year ending March, 1977. Vol. IV. Receptors-Birds (Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.).

## APPENDIX I

Because results of the June-July 1977 field work in the Walrus Islands, Bristol Bay were thoroughly summarized in the Quarterly Report dated 30 September 1977, they will not be reiterated here except for the following two tables. These give basic information of seabird abundance on colonies and use of nearshore waters by marine birds. A publication is planned that will give more specific information on birds in the Walrus Islands.

## APPENDIX II

Marine mammal observers W. L. Cunningham and M. S. Stanford arrived at Cape St. Elias, Kayak Island, Northeast Gulf of Alaska on 7 March 1977 to begin sea lion observations under RU #243. In addition to their duties concerning sea lions, they collected marine bird information. This included both local use of the area by birds and spring migration information. Stanford remained on the island until 27 April and Cunningham left 14 June. Some of the data they collected are shown in Table 1 and Figure 1.

Although information from this region was not a part of the objective of RU #3, it was felt important enough to include here because it gives us a much better understanding of what is happening in NEGOA. These data complement those being gathered on the Copper River Delta by other ornithologists.

Table 1. Bird abundance in pelagic transects conducted between islands of the Walrus Island group, Bristol Bay, Alaska.

| Species | Total No. of Birds | Frequency of Occurrence % of Total Transects | Mean No. of Birds/Transect | Density Birds/$KM^2$ |
|---|---|---|---|---|
| RT Lo | 1 | 6 | Tr | Tr |
| Corm | 521 | 100 | 29 | 15.1 |
| Olds | 6 | 17 | Tr | 0.2 |
| Harl | 30 | 6 | 2 | 0.9 |
| Eide | 2 | 11 | Tr | Tr |
| WWSc | 232 | 83 | 13 | 6.7 |
| Su Sc | 2 | 11 | Tr | Tr |
| Bl Sc | 3 | 11 | Tr | 0.1 |
| Scot (unid) | 97 | 44 | 5 | 2.8 |
| Subtotal | 372 | 83 | 21 | 10.8 |
| Me Sh | 6 | 6 | Tr | 0.2 |
| GW or Lg Gu | 42 | 67 | 2 | 1.2 |
| BL Ki | 166 | 100 | 9 | 4.8 |
| Tern | 1 | 6 | Tr | Tr |
| Subtotal | 209 | 100 | 12 | 6.1 |
| Murr | 3484 | 100 | 194 | 101.0 |
| Pi Gu | 68 | 72 | 4 | 2.0 |
| Pa Au | 7 | 11 | Tr | 0.2 |
| Ho Pu | 36 | 72 | 2 | 1.1 |
| Tu Pu | 39 | 78 | 2 | 1.1 |
| Subtotal | 3634 | 100 | 202 | 105.3 |
| TOTAL | 4743 | 100 | 264 | 137.5 |

Table 2. Estimated population sizes of seabirds inhabiting the Walrus Islands during June-July, 1977.

| Species | ISLAND | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Round | Summit | Black Rock | Crooked | North Twin | South Twin | High | Hagemeister | TOTAL |
| DC Co | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| Pe Co | 2,000 | 530 | 30 | 2,700 | 830 | 30 | 5,740 | 2,350 | 14,210 |
| RF Co | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 20 |
| GW Gu | 150 | 150 | 75 | 125 | 175 | 30 | 125 | 350 | 1,180 |
| BL Ki | 43,000 | 0 | 1,450 | 0 | 9,000 | 1,600 | 22,000 | 11,300 | 88,350 |
| Co Mu | 93,000 | 0 | 55,500 | 0 | 228,000 | 53,300 | 40,500 | 16,500 | 486,800 |
| Pi Gu | 400 | 330 | 10 | 270 | 60 | 0 | 270 | 120 | 1,460 |
| Pa Au | 1,500 | 0 | 5 | 30 | 15 | 0 | 540 | 320 | 2,410 |
| Cr Au | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| Ho Pu | 1,750 | 55 | 8 | 250 | 10 | 4 | 520 | 220 | 2,817 |
| Tu Pu | 400 | 20 | 10 | 75 | 1,500 | 4 | 260 | 40 | 2,309 |
| TOTAL | 142,300 | 1,100 | 57,088 | 3,450 | 239,590 | 54,968 | 69,955 | 31,220 | 599,671 |

Table 1. Appendix II. Total number of birds observed during 211 sea watches from 14 March to 14 June 1977, Cape St. Elias, Kayak Island, Alaska.

| Species | Total No. | Species | Total No. |
|---|---|---|---|
| Common Loon | 9 | Surf Scoter | 2,070 |
| Arctic Loon | 196 | Black Scoter | 414 |
| Red-throated Loon | 9 | Red-breasted Merganser | 47 |
| Loon (Unid.) | 14,051 | Black Oystercatcher | 43 |
| Horned Grebe | 4 | Whimbrel | 72 |
| Shearwater (Unid.) | 3,072 | Western Sandpiper | 16 |
| Fork-tailed Storm-Petrel | 1 | Parasitic Jaeger | 1 |
| Leach's Storm-Petrel | 40 | Long-tailed Jaeger | 1 |
| Double-crested Cormorant | 65 | Jaeger (Unid.) | 3 |
| White-flanked Cormorant | 431 | Glaucous-winged Gull | 1,533 |
| Cormorant (Unid.) | 79 | Herring Gull | 6 |
| Goose (Unid.) | 39 | Black-legged Kittiwake | |
| Canada Goose | 220 | Northerly | 25,255 |
| Brant | 292 | Southerly | 12,057 |
| Mallard | 68 | Common Murre | 1,242 |
| Pintail | 1,608 | Pigeon Guillemot | 2 |
| Green-winged Teal | 80 | Marbled Murrelet | 96 |
| Northern Shoveler | 34 | Kittlitz's Murrelet | 1 |
| Scaup (Unid.) | 854 | Tufted Puffin | 713 |
| Goldeneye (Unid.) | 6 | Alcid (Unid.) | 8 |
| Oldsquaw | 3 | Tree Swallow | 2 |
| Harlequin Duck | 60 | Common Raven | 3 |
| White-winged Scoter | 268 | Savannah Sparrow | 1 |

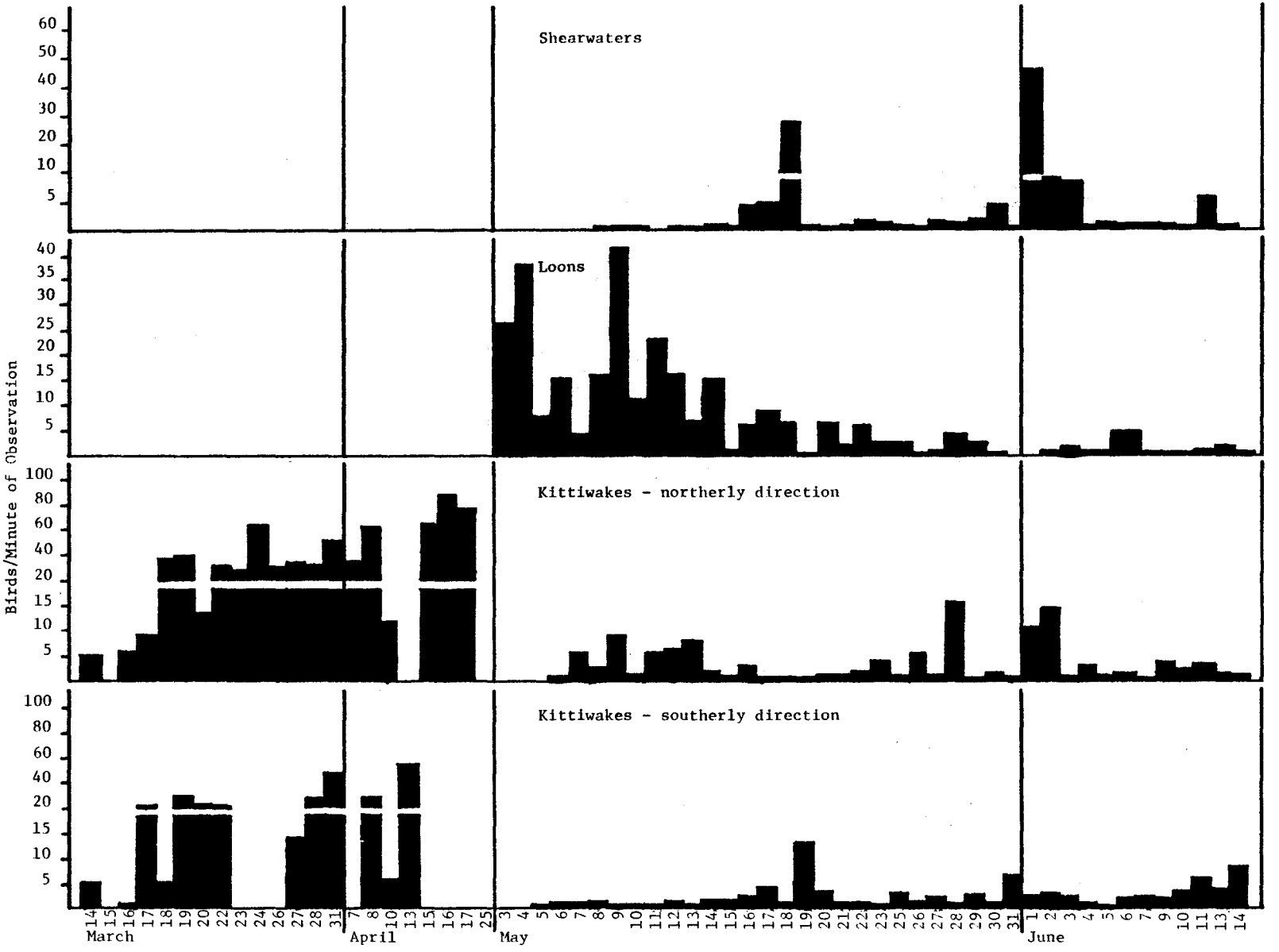


Figure 1. Appendix II. Migratory patterns of bird species/groups from sea watches at Cape St. Elias, Kayak Island, Alaska, Spring, 1977.

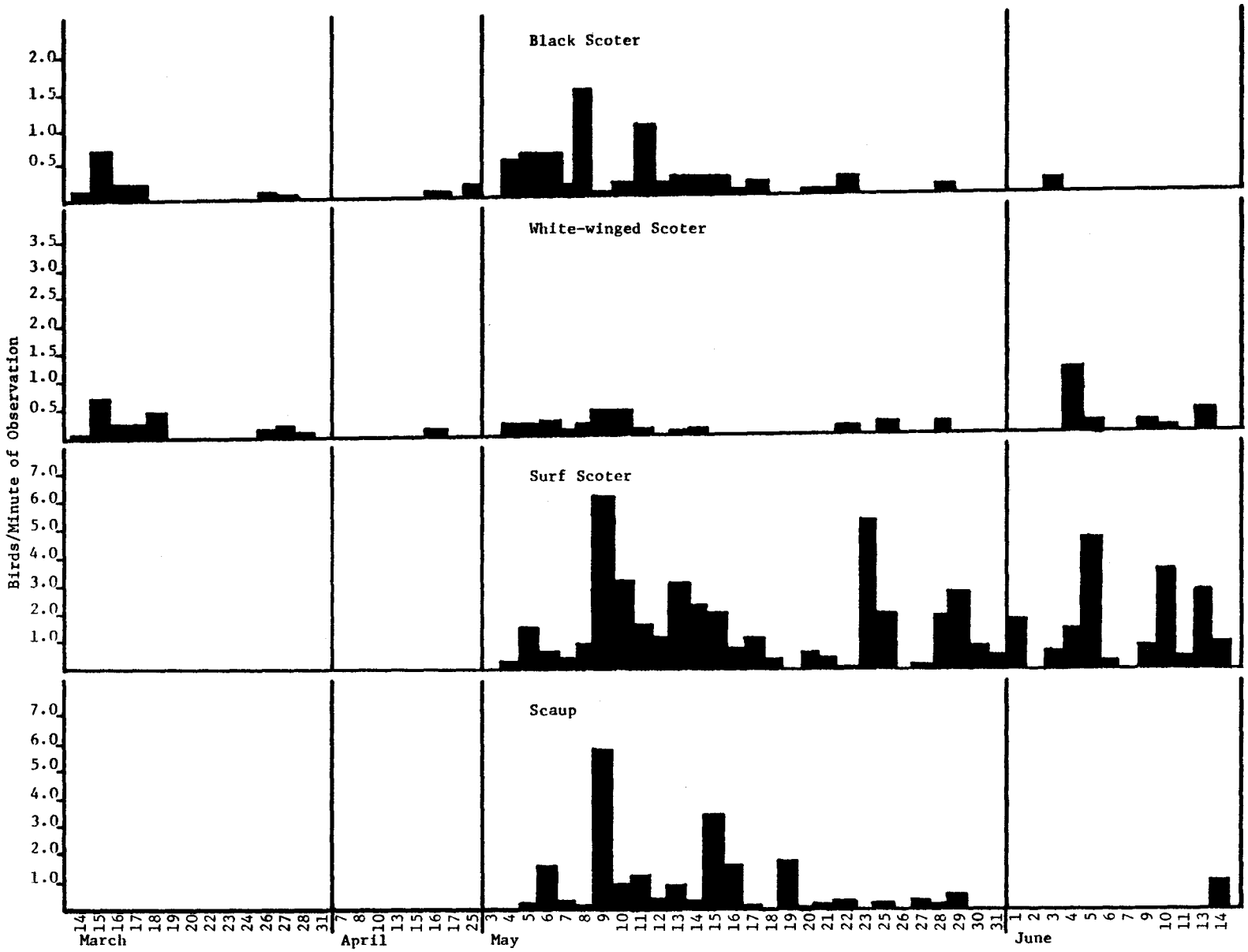


Figure 1. Appendix II (continued).

The same researchers departed mid-March 1978 to again gather marine mammal/bird data at Cape St. Elias until mid July.

During their stay in 1977, they conducted 211 Type II sea watches totaling 37.2 hours. A minimum of 41 species were recorded during sea watches. Observations made at other times, including during hikes into the interior of the island, resulted in recording an additional 38 species, for 79 species total.

The table and figure are only a cursory summarization of the data. Complete analysis and summarization will be done when the second field season is completed. A week of observation was missed between 25 April and 3 May, and there is therefore a substantial gap in the data which will hopefully be filled this year. That period is when many species are migrating. Included in the graphs are only species exhibiting a migratory pattern. Several species--including Cormorants, Glaucous-winged Gulls, Common Murres and Tufted Puffins--nest in the area and therefore would move back and forth across the sea watch observation post. Their movements were not graphed. The label--birds/minute of observation--was used to standardize the data. Because observation times frequently varied from day to day, the information had to be put on a standard base.

Early in the season, Black-legged Kittiwakes exhibited diel movement patterns moving north of the island (toward the gyre?) in the morning and returning to somewhere south of the island in the evening. This was a substantial migration involving thousands of birds, and it is unknown at this time what was represented by the movement. It could be hypothesized that they headed north to feed all day and returned to bathe, preen and roost at a fresh water source in the evening. A movement of this type at Crooked Island was suggested by Arneson (1977b).

## APPENDIX III

Although not a part of the objectives of this research unit, information on birds utilizing Tugidak Island at the south end of Kodiak Island was summarized using existing data from the area. A table of that information follows. It is an area that may be affected by oil and gas development, and therefore I considered it beneficial to include the table. More specific information by ornithological studies on Tugidak Island would be helpful.

Partial List of Birds of Tugidak Island

| Species | Use | Habitat | Season | Source |
|---|---|---|---|---|
| Common Loon | N | U, O | S, Su | 1, 3 |
| Red-throated Loon | F | U, O | Su | 3, 5 |
| Cormorant Red-faced and/or Pelagic | N, F | O, Z | S, Su, F | 3 |
| Whistling Swan | N | U, B | S, Su | 3, 4, 5 |
| Emperor Goose | W | S, L | W | 2 |
| Mallard | M, SN? | U, B | S | 4 |
| Gadwall | M | U, B | S | 4 |
| Pintail | N | U, B | S, Su | 4 |
| Green-winged Teal | M | U, B | S | 4 |
| American Wigeon | M | U, B | S | 4 |
| Scaup spp. | M | U, B, L | S | 4 |
| Old Squaw | M, W | L, O | W | 2 |
| Harlequin Duck | F | O | S | 4 |
| Steller's Eider | W, M | L, O, U? | W | 2, 4, 5 |
| King Eider | W | L, O | W | 2 |
| Surf Scoter | W | O | W | 2 |
| Black Scoter | W | L, O | W | 2 |
| Red-breasted Merganser | N | U, B | Su | 4, 5 |
| Rough-legged Hawk | N | T | S, Su | 4, 5 |
| Bald Eagle | N, W | T, S | W, S, Su, F | 1, 2, 3, 4, 5 |
| Marsh Hawk | M | T, C | F | 3 |
| Osprey | N | T | Su | 1 |
| Peregrine Falcon | N | T | S, Su | 1, 5 |
| Willow Ptarmigan | N, W | T, C | W, S, Su, F | 1, 3, 5 |
| Semipalmated Plover | N | S, L | Su | 3, 4, 5 |
| Wandering Tattler | M | Z | Su | 5 |
| Northern Phalarope | SN, M | U | S, Su | 3, 4, 5 |
| Common Snipe | SN, M | U | S, Su, F | 3 |
| Short-billed Dowitcher | SN, M | U, C | S, Su | 3, 4, 5 |
| Western Sandpiper | M | Z | Su | 5 |
| Least Sandpiper | N | T, Z | Su | 1, 4, 5 |
| Rock Sandpiper | M, W? | L, Z | Su, W? | 5 |
| (Small Shorebird) | W | S | W | 2 |
| Parasitic Jaeger | N | T, S, C | S, Su | 1, 3, 4, 5 |
| Long-tailed Jaeger | N | T, S, C | S, Su | 1, 3, 4, 5 |
| Glaucous-winged Gull | N, W | S, C, Z, L | W, S, Su, F | 2, 3, 4, 5 |
| Mew Gull | N, W | S, C, Z, L | S, S, Su, F | 2, 3, 4, 5 |
| Black-legged Kittiwake | F | O | S | 4 |
| Arctic Tern | N | S, C, Z, L, B | Su | 3, 4, 5 |
| Common Murre | F | O | Su | 5 |
| Pigeon Guillemot | F | O | Su | 4 |
| Horned Puffin | FD, F? | O | Su | 5 |
| Tufted Puffin | FD, F? | O | Su | 3, 5 |
| Short-eared Owl | N | T, C | Su | 1, 3, 4, 5 |

Partial List of Birds of Tugidak Island (cont'd.)

| Species | Use | Habitat | Season | Source |
|---|---|---|---|---|
| Violet-green Swallow | M | B, U | S | 1 |
| Bank Swallow | N | Z, B, U | S, Su | 3, 5 |
| Common Raven | SN?, F | T, S, C, Z | Su | 3, 5 |
| Northwestern Crow | F | S, C, Z | Su | 1, 3 |
| Rusty Blackbird | M | T, U | F | 3 |
| Grey-crowned Rosy Finch | M | T, Z | Su | 1 |
| Savannah Sparrow | SN | T, C | S, Su | 3, 4, 5 |
| Dark-eyed Junco | M | T | S | 1 |
| Golden-crowned Sparrow | M | T | S | 3 |
| Fox Sparrow | M | T | Su | 5 |
| Song Sparrow | N | T, Z, C | S, Su | 1, 4 |
| Lapland Longspur | SN | T, C | S, Su | 1, 3, 4, 5 |

Use:

| | |
|---|---|
| N | nesting |
| SN | suspected nesting |
| M | migration |
| W | wintering |
| F | feeding nearshore |
| FD | found dead |

Habitat:

| | |
|---|---|
| S | sand dune/spit |
| T | tundra |
| B | brackish pond |
| U | upland pond |
| L | lagoon |
| C | coastal meadow |
| O | ocean |
| Z | beaches, bluff |

Season:

| | |
|---|---|
| S | Spring(Apr.,May) |
| Su | Summer(Jun.-Aug.) |
| F | Fall(Sep.-Nov.) |
| W | Winter(Dec.-Mar.) |

Source:

| | | |
|---|---|---|
| 1 | Bishop-Lortie | 25 April-31 July, 1964 |
| 2 | Arneson-Berns | 28 February, 1976 |
| 3 | Johnson-Johnson | Summer, 1976 |
| 4 | Harrison-Wohl | 28-29 May, 1977 |
| 5 | Kelly-Lynn | Summer, 1977 |

Assumed Red Phalarope and Long-billed Dowitcher of Johnson-Johnson were actually Northern Phalarope and Short-billed Dowitcher.

# Environmental Assessment of the Alaskan Continental Shelf

## Annual Reports of Principal Investigators for the year ending March 1978

### Volume I. Receptors — Mammals
### — Birds

Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado

October 1978

**U.S. DEPARTMENT OF COMMERCE**
National Oceanic and Atmospheric Administration

**U.S. DEPARTMENT OF INTERIOR**
Bureau of Land Management