

# ECOLOGICAL DISTRIBUTION OF BIRDS IN THE KOLOMAK RIVER-ASKINUK MOUNTAIN REGION, YUKON-KUSKOKWIM DELTA, ALASKA

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Knowledge of the distribution and habitat relations of birds in Alaskan tundra communities is far from complete. Several reports exist for widely scattered areas in northern and northwestern Alaska (e.g., Kessel and Cade 1958; Maher 1959; Childs 1968; Williamson et al. 1966). For western Alaska, particularly the extensive tundra of the Yukon-Kuskokwim Delta, the information is more scanty. Williamson (1957) provides the best analysis of bird communities as related to habitat in the Napaskiak area near the inner edge of the Delta where it meets the tiaga. Brandt (1943) reports bird observations made during a year of study in the vicinity of Hooper Bay along the coast of the Bering Sea. Kessel et al. (1964) observed birds for 3 weeks along the Kolomak River, 30 km NE of Hooper Bay, while Harris (1966) gives records of birds seen along the Kashunuk River, 40 to 50 km SE of Hooper Bay during two summers. Other scattered observations from the general area are given by Walkinshaw and Stophlet (1949) and Gabrielson and Lincoln (1959).

In this paper we present an analysis of the occurrence and ecological distribution of birds inhabiting a 75-km<sup>2</sup> study area on the Yukon-Kuskokwim Delta in western Alaska. At this site the flat, marshy Delta tundra abuts a low, isolated range of hills, providing a greater variety of habitats for birds than found in most other parts of the Delta.

## STUDY AREA AND METHODS

The study was conducted in the west-central portion of the Yukon-Kuskokwim Delta, along the Kolomak River (fig. 1), 30 km NE of Hooper Bay (61°31'N; 164°50'W) at a site located within the northern boundary of the Clarence Rhode National Wildlife Range, approximately 16 km inland from the Bering Sea. The Delta in this region consists of a complex mosaic of wet, grass-sedge marsh, slightly raised and better drained dwarf shrub-heath tundra, and numerous lakes, ponds, and waterways. The latter consists of rivers, sloughs, and streams that are connected to

one another and to larger channels that drain into the Bering Sea. Because of these connections with the sea, their water levels fluctuate with the tide even many kilometers inland. During the late fall, severe storms in combination with high tides cause the rivers and sloughs to spill over onto the marshlands, which become inundated with brackish water and littered with driftwood.

In the area north of Hooper Bay, the flat Delta is interrupted by a low range of hills, the Askinuk Mountains, which extend in a narrow (7-12 km) band eastward from the coast about 50 km onto the Delta. The western end of the range projects into the Bering Sea to form Cape Romanzof; the hilltops at this end of the range are the highest, rising about 700 m above sea level. Most of the range to the east has a maximum elevation of only 300 to 400 m. The mountain most accessible to us was Kikuktok Mountain, with a height of 278 m. It sloped off steeply on the south to Kokechik Bay and on the southeast and east to the flat marshlands of the Delta (fig. 1, inset; fig. 2).

Our investigations at the Kolomak were conducted during four summers, 1966 through 1969. In each of the first 3 years, we arrived on the tundra during the early phase of snow melt in mid-May and remained there through mid-July, by which time most bird breeding activity was completed. In 1969, the field season lasted for 2 weeks in mid-June. Records were kept of all birds observed, their relative abundances, habitat utilization, and foraging activities. In addition, we covered three census plots intensively, one each in wet marsh, lowland heath tundra, and hillside tundra on Kikuktok Mountain.

Plants were collected and preserved. They are deposited in the Jessup Herbarium, Dartmouth College, and the Tufts University Herbarium. Specimens of some bird species were also taken; these are located at Dartmouth College and in the U.S. Fish and Wildlife Service collection at Bethel, Alaska.

## ECOLOGIC FORMATIONS

A profile diagram of the main ecological formations important as nesting and feeding habits for birds is presented in figure 3. These formations are named according to important physical factors or the dominant vegetation types that distinguish them from one another. The habitat classification scheme is based on that of Hanson (1951), Britton (1957), Williamson (1957), and Williamson et al.

(1966), with some modifications for local features found exclusively at the Kolomak.

**Gravel beaches.** In contrast to the Cape Thompson area (Williamson et al. 1966), gravel bars or other types of stream-side alluvium are infrequent on the western part of the Delta, because mud is moved about by strong tidal action. Only one gravel beach area was found at the Kolomak, a section of shoreline, 0.5 km long  $\times$  10 m wide, along the north shore of Kokechik Bay (fig. 1). It consisted of fine gravel and sand, with some scattered grass and sedge along its highest part, and on the inland side, it graded into a series of shallow pools and then into wet marsh tundra.

**Fluviatile waters.** The flowing water habitats of the study area include the tidal rivers and sloughs. A few freshwater streams drain the hill slopes but are dry during most of the summer. The width of the Kolomak River within our study area varied from 75 to 100 m at high tide. The smaller tributaries and sloughs range in width from 10 m to less than 1 m. These are intricately related to other lowland habitats (see below). There is no riparian shrub community along any of the streams or rivers in the western part of the Delta, probably again due to tidal action.

**Mud banks (tidal).** At low tide, the banks of the Kolomak have a 10–15 m wide strip of mud on each side, while the smaller channels and sloughs empty completely. These muddy banks are important feeding habitats for some shore birds and waterfowl.

**Lacustrine waters.** Many thousands of lakes and ponds dot the Delta surface. Most are concentrated in the low-lying marshes but some occur on the islands of heath tundra and on the lower parts of the hills. On our Kolomak study area, these ranged in diameter from a few meters to 300–400 m; elsewhere on the Delta, larger lakes of several kilometers in length are relatively common. Most of the lakes and ponds are shallow, ranging in depth from 0.5 to several meters. Water levels in these remain relatively stable, dropping only slightly during temporary dry spells in summer.

For the purpose of this analysis, "lacustrine waters" refers only to standing water habitats; the shorelines of lakes and the shallow ponds choked with emergent vegetation are considered part of the wet marsh habitat (see below).

**Mud ponds (tidal).** Some former lake beds and other areas adjacent to the tidal sloughs are flooded regularly at high tides. As the

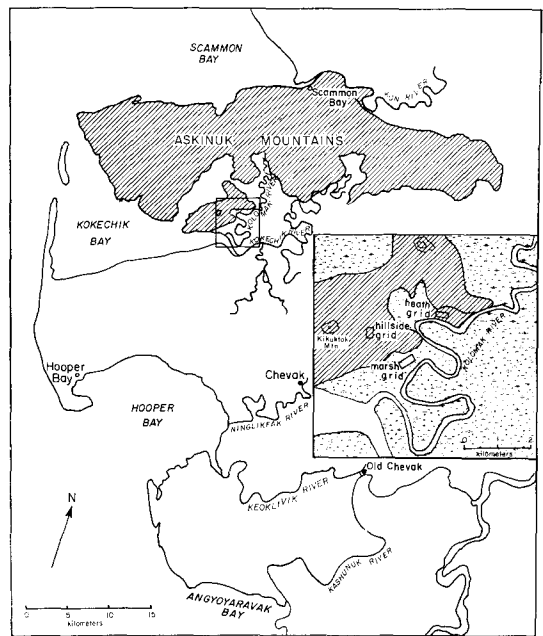


FIGURE 1. The Hooper Bay-Old Chevak-Askinuk Mountain region at the west-central edge of The Yukon-Kuskokwim Delta, Alaska. Inset shows the main study area along the Kolomak River and Kikuktok Mountain. The grids are the census study areas.

water drains from these, extensive areas of mud become exposed and available to feeding birds. These sites contain high densities of insect larvae (mostly Chironomidae, order Diptera), which are heavily utilized by shore birds. In some areas, these inland mudflats have a sparse covering of a sedge (*Carex rariflora*) which grows to a height of only 5–10 cm. This sedge is an important food source for several species of geese, especially during mid and late summer. Along the coast near the mouth of the Kashunuk River, this habitat-type is well represented and is referred to as salt flats (Harris 1966).

**Wet marsh tundra.** On the flat expanses of the Delta, most of the area between the lakes, ponds, rivers, and sloughs is covered by poorly drained, wet marsh. The vegetation consists primarily of mosses (*Sphagnum* spp.), grasses (*Elymus arenarius*, *Poa arctica*) and sedges (mostly *Carex aquatilis* and *Eriophorum* spp.). At melt-off in spring, the marshes are covered by the flattened dried remains of the previous years' plant growth. As the season progresses, new green shoots begin to appear and by late June to early July, the marshes become green. By this time, the grasses and sedges are 20–40 cm tall.

The wet marsh contains many lacustrine

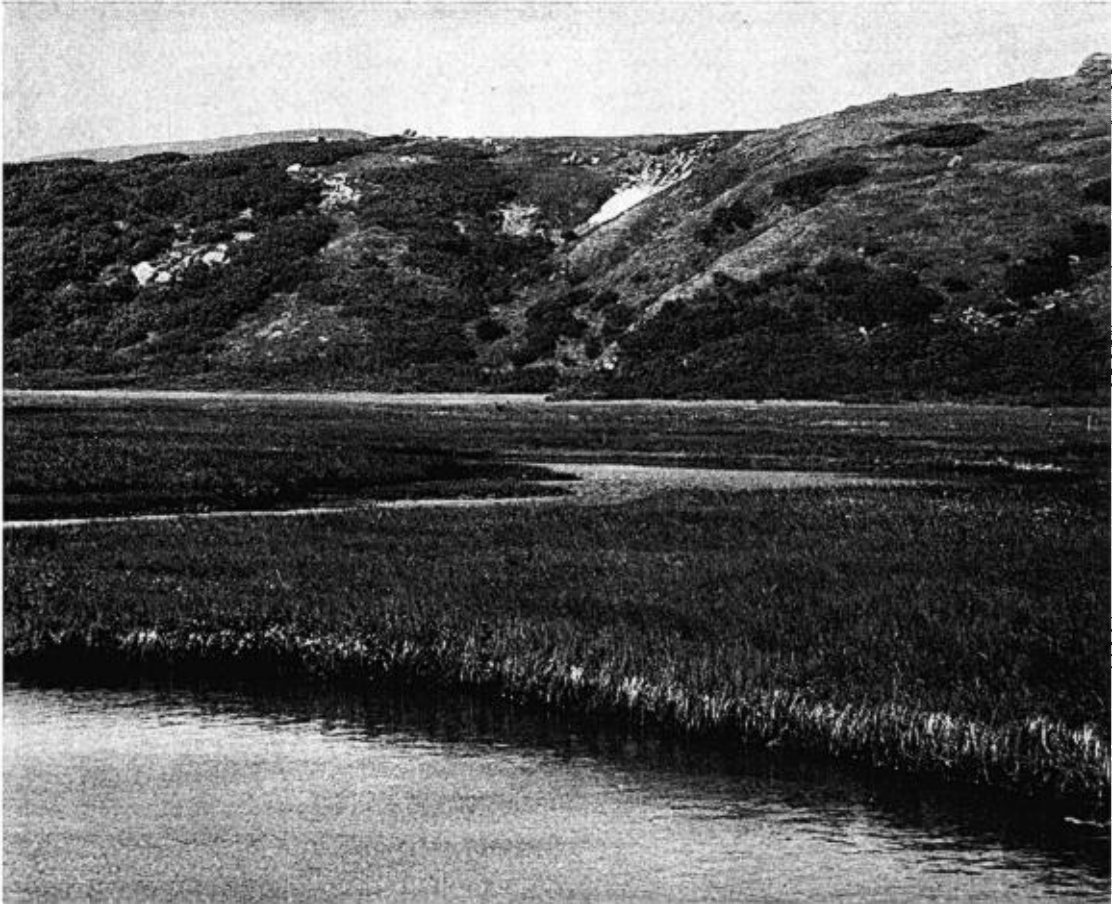


FIGURE 2. The junction of Delta marsh habitat (foreground) with the hillside of Kikuktok Mountain, showing the well-developed alder thickets. The hillside heath tundra of the upper slopes is out of the picture. Photograph taken July 1968.

waters. The pond edges and the centers of the shallower ponds have dense stands of emergent vegetation, mainly *Hippurus vulgaris* and *Carex aquatilis*.

*Heath tundra.* Scattered throughout the lowland marshes in a mosaic pattern are slightly elevated patches of better drained tundra ranging in size from small islands of a meter or two in diameter to some several hectares in extent. In other parts of the Delta, long ridges of such elevated ground occur, and as one goes eastward, the frequency of this type of habitat increases. These slightly elevated areas are vegetated with mosses, lichens, prostrate shrubby plants, and a variety of forbs. This formation has been termed heath tundra by Williamson (1957) and is similar to the dwarf shrub-heath tundra described by Britton (1957) for northern Alaska but lacks the tussock development.

The dominant plants here are prostrate willows (*Salix* sp.), dwarf birch (*Betula nana*), blue berry (*Vaccinium parviflorum*), mountain cranberry (*Vaccinium vitis-idaea*),

crowberry (*Empetrum nigrum*), Alaska tea (*Ledum groenlandicus*), various herbs such as *Pedicularis*, *Potentilla*, *Anemone*, and scattered grasses and sedges. At the edges of some of these islands of heath tundra, there are occasional low willow shrubs, ranging in height to 0.5 or 1 m.

*Shrub zone.* At the base of the Askinuks lies a zone of shrubs (see fig. 2), composed mostly of willows (*Salix* sp.) and alder (*Alnus crispa*). The willows occupy a narrow (1–5 m) zone next to the marsh. They are 0.5–1.5 m tall and are usually scattered one to several meters apart. Above the willows on the lower slopes, the alders form dense stands varying in width from 20 m–150 m. This band surrounds the base of the hills. The alders are 3–6 m tall, and provide a dense tangle of shrubbery. The understory is relatively sparse, but ferns (*Dryopteris*) and scattered herbs do occur.

*Hillside heath tundra.* Above the shrub zone, the hillsides of the Askinuks are clothed by a low, lichen-moss-heath formation similar

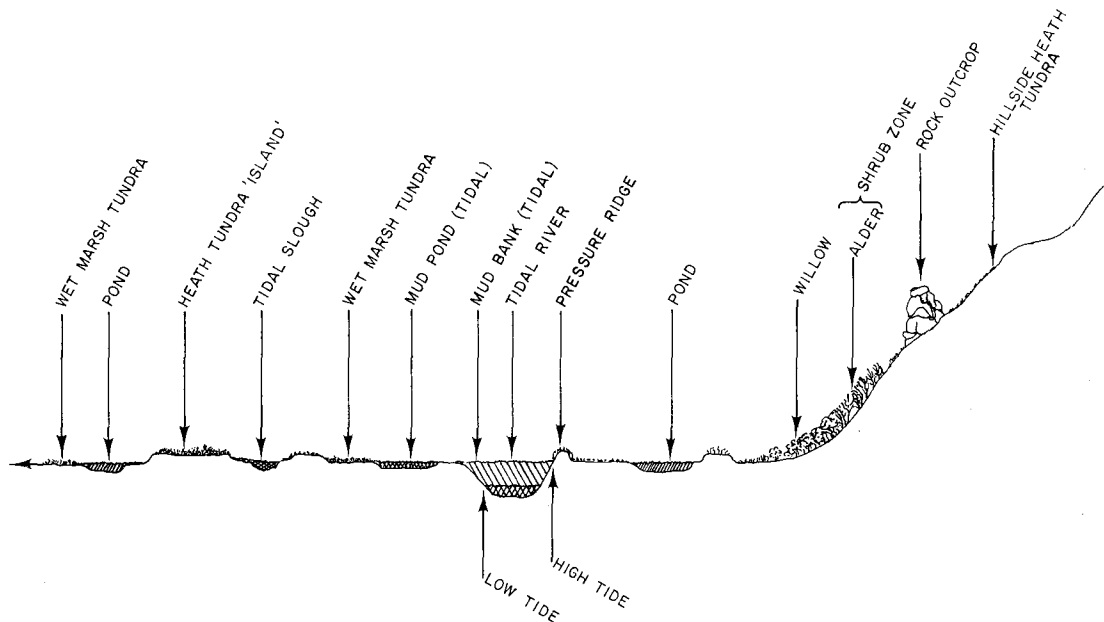


FIGURE 3. Profile of the major ecological formations and topographic changes at the Kolomak-Askinuk region, western Alaska, showing the complex interdigitation of habitat types.

to that on the slightly raised mounds of the flat Delta. On these hill slopes, however, the lichens are more numerous and in combination with mosses often form extensive spongy mats, with only occasional patches of prostrate ericaceous or other low shrubby plants, scattered sedges, and forbs. Above 250–300 m, the vascular plants become even more sparse, the lichens more dense, and patches of gravel-like soil become evident. This latter condition is found on the ridge tops in the central and eastern Askinuks. No evidence of a *Dryas* fell-field formation typical of other high mountain areas in northern and interior Alaska (Williamson et al. 1966) was found in the Askinuks.

**Rock outcrops.** Scattered along the base of the hills, occasionally on the hillsides and along the crest of the ridges, are widely scattered, large, granitic, dike-like masses of rock. These rise precipitously 10–40 m above the surrounding tundra.

#### ECOLOGICAL DISTRIBUTION AND OCCURRENCE OF BIRDS

In order to analyze how birds utilize ecological formations at the Kolomak, we have divided the species into four groups, based on taxonomic/ecologic considerations. In tables 1 and 2, the nesting habitat for each breeding species is given, and the major feeding sites of each, based on our observations of foraging activities, are classified according to their fre-

quency of use and probable importance. A brief survey of the general patterns of habitat utilization by birds in each of these four groups followed by an annotated list of all species in that group recorded in the Kolomak study area is given below.

Two other groups of investigators, Brandt (1943) and Kessel et al. (1964), have also visited the south slopes of the Askinuks near or at the Kolomak, and their observations on individual species are incorporated into the annotated list where they supplement our records. References to the occurrence or habitat utilization of bird species on nearby portions of the Delta, based on our own observations, those of Brandt (1943), or of Harris (1966), are also included when appropriate.

#### WATER BIRDS

Twenty-two species of water birds have been recorded within the Kolomak study area: 2 species of loons, 1 grebe, 1 swan, 5 geese, and 13 ducks. The loons, grebe, swan, four of the geese and eight of the ducks are considered regular breeders (table 1). Two of the other five duck species (Steller's Eider and Common Scoter) are known to breed in the Hooper Bay area and may nest at least occasionally near the Kolomak.

All of the breeding water birds nest on the tundra and feed mostly in lakes, ponds, and rivers, although some feed on the tundra (e.g., grazing activities by geese). Loons, grebes, and the swan build low platforms for

TABLE 1. Nesting (N) and feeding (F) habitats of water birds and shorebirds breeding at the Kolomak River, Yukon-Kuskokwim Delta, Alaska.

	Gravel beaches	Fluviatile waters	Mud banks (tidal)	Lacustrine waters	Mud ponds (tidal)	Wet marsh tundra	Heath tundra	Shrub zone	Hillside heath tundra	Rock outcrops
A. Water Birds										
<i>Gavia arctica</i>		F <sup>1</sup>		F <sup>1</sup>		N				
<i>Gavia stellata</i>		F <sup>1</sup>		F <sup>1</sup>		N				
<i>Podiceps grisegena</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Olor columbianus</i>					F <sup>2</sup>	NF <sup>1</sup>				
<i>Branta canadensis</i>					F <sup>2</sup>	NF <sup>1</sup>				
<i>Branta nigricans</i>					F <sup>1</sup>	NF <sup>1</sup>				
<i>Philacte canagica</i>						NF <sup>1</sup>				
<i>Anser albifrons</i>						NF	N			
<i>Anas platyrhynchos</i>				F		NF				
<i>Anas acuta</i>				F <sup>2</sup>	F <sup>3</sup>	N <sup>2</sup> F <sup>1</sup>	N <sup>1</sup>		N <sup>2</sup>	
<i>Anas carolinensis</i>				F <sup>2</sup>		NF <sup>1</sup>				
<i>Aythya marila</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Clangula hyemalis</i>		F <sup>2</sup>		F <sup>1</sup>			N			
<i>Somateria mollissima</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Lampronetta fischeri</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Mergus serrator</i>		F <sup>1</sup>		F <sup>2</sup>		N				
B. Shorebirds										
<i>Grus canadensis</i>						NF				
<i>Charadrius semipalmatus</i>	NF <sup>1</sup>				F <sup>2</sup>					
<i>Pluvialis dominica</i>					F <sup>2</sup>				NF <sup>1</sup>	
<i>Squatarola squatarola</i>					F <sup>3</sup>	F <sup>2</sup>	NF <sup>1</sup>			
<i>Arenaria melanocephala</i>			F <sup>3</sup>		F <sup>2</sup>	NF <sup>1</sup>				
<i>Capella gallinago</i>						NF				
<i>Calidris melanotos</i>						F	-N <sup>4</sup>	F		
<i>Calidris alpina</i>			F <sup>2</sup>		F <sup>2</sup>	NF <sup>1</sup>				
<i>Calidris mauri</i>			F <sup>2</sup>		F <sup>2</sup>		NF <sup>1</sup>		NF <sup>1</sup>	
<i>Limosa lapponica</i>					F <sup>1</sup>	F <sup>2</sup>	NF <sup>1</sup>			
<i>Phalaropus fulicarius</i>				F <sup>1</sup>		NF <sup>1</sup>	NF <sup>1</sup>			
<i>Lobipes lobatus</i>				F <sup>1</sup>	F <sup>2</sup>	NF <sup>1</sup>	NF <sup>1</sup>		NF <sup>1</sup>	

<sup>1,2,3</sup> Primary, secondary, or tertiary use of habitats, respectively.

<sup>4</sup> Nesting at interface between marsh and heath tundra.

their nests; all others hollow out a shallow depression in the tundra vegetation as a nest site. All but three species in this group (White-fronted Goose, Pintail, and Oldsquaw) usually nest on wet marsh tundra within 5–10 m of a pond or small lake. Although the Oldsquaw nests on heath tundra, it also locates its nest relatively close to a pond. The Pintail was found nesting in three habitats: wet marsh tundra; heath tundra; and hillside heath tundra, long distances from water. Brandt (1943) also reported Pintails nesting in a wide range of sites.

*Gavia arctica*. Arctic Loon. A common nester on the larger ponds and lakes in the marshlands and along the base of the hills. Nests were usually located among tall sedges on relatively well-drained pond margins. First eggs were laid in late May, with hatching occurring by late June. In one case, a nest still contained two eggs on 8 July.

*Gavia stellata*. Red-throated Loon. Common during all four summers. They nested in smaller and

shallower ponds than did the Arctic Loon. The nest sites were along marshy pond edges, where the adults formed a low mound of uprooted sedges, *Hippurus*, mosses, and mud with a hollow on top for the eggs. Nests were fairly conspicuous early in the season, but became hard to locate once the emergent vegetation began growing.

*Podiceps grisegena*. Red-necked Grebe. Uncommon in the study area. Several were seen each summer and in 1968 one nest was found among tall sedges along the margin of a small pond at the edge of the marsh.

*Olor columbianus*. Whistling Swan. Common throughout the Delta. Although numerous pairs were seen frequently on lakes and ponds near the Kolomak, only six nests were actually found (clutch sizes of 1, 4, 5, 5, 6, and 7). The one-egg clutch was incubated and successfully produced one young. Nests were placed in the marsh, usually near small ponds with marshy borders. By early July, groups of 2 to 10 swans began to gather on the larger lakes; apparently these were nonbreeders or birds which had lost their clutches.

*Branta canadensis*. Canada Goose. We made no attempt to distinguish subspecies of the Canada

TABLE 2. Nesting (N) and feeding (F) habitats of predatory, gallinaceous, and passerine birds breeding at the Kolomak River, Yukon-Kuskokwim Delta, Alaska.

	Gravel beaches	Fluviatile waters	Mud banks (tidal)	Lacustrine waters	Mud ponds (tidal)	Wet marsh tundra	Heath tundra	Shrub zone	Hillside heath tundra	Rock outcrops
<b>A. Raptors, Galliforms, and Larids</b>										
<i>Buteo lagopus</i>						F <sup>1</sup>	F <sup>1</sup>		F <sup>1</sup>	N
<i>Aquila chrysaetos</i>						F <sup>1</sup>	F <sup>1</sup>		F <sup>1</sup>	N
<i>Falco rusticolus</i>						F	F		F	N
<i>Lagopus lagopus</i>							N <sup>1</sup> F		N <sup>2</sup> F	
<i>Lagopus mutus</i>									N <sup>1</sup> F	
<i>Stercorarius parasiticus</i>						F <sup>1</sup>	N <sup>1</sup> F <sup>1</sup>		F <sup>2</sup>	
<i>Stercorarius longicaudus</i>						F <sup>2</sup>	N <sup>1</sup> F <sup>1</sup>		F <sup>3</sup>	
<i>Larus hyperboreus</i>		F <sup>1</sup>		F <sup>1</sup>		N <sup>1</sup> F <sup>2</sup>				
<i>Larus canus</i>		F <sup>2</sup>		F <sup>2</sup>		N <sup>1</sup> F <sup>1</sup>				
<i>Xema sabina</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Sterna paradisaea</i>		F <sup>2</sup>		F <sup>1</sup>		N				
<i>Asio flammeus</i>						F <sup>2</sup>	N <sup>1</sup> F <sup>1</sup>		F <sup>2</sup>	
<b>B. Passerine Birds</b>										
<i>Petrochelidon pyrrhonota</i>				F <sup>1</sup>		F <sup>1</sup>	F <sup>1</sup>			N
<i>Corvus corax</i>						F <sup>1</sup>	F <sup>1</sup>		F <sup>1</sup>	N
<i>Turdus migratorius</i>								N <sup>1</sup> F		
<i>Icterus naevius</i>								N <sup>1</sup> F		
<i>Hyalocichla minima</i>								N <sup>1</sup> F		
<i>Motacilla flava</i>							N <sup>1</sup> F <sup>1</sup>		N <sup>2</sup> F <sup>2</sup>	
<i>Anthus spinoletta</i>									N <sup>1</sup> F	
<i>Lanius excubitor</i>								N <sup>1</sup> F		
<i>Vermivora celata</i>								N <sup>1</sup> F		
<i>Dendroica petechia</i>								N <sup>1</sup> F		
<i>Seiurus noveboracensis</i>								N <sup>1</sup> F		
<i>Wilsonia pusilla</i>								N <sup>1</sup> F		
<i>Acanthis</i> sp.							F <sup>2</sup>	N <sup>1</sup> F <sup>1</sup>		
<i>Passerculus sandwichensis</i>							N <sup>1</sup> F <sup>1</sup>	N <sup>1</sup> F <sup>2</sup>		
<i>Spizella arborea</i>							F <sup>1</sup>	N <sup>1</sup> F <sup>1</sup>		
<i>Zonotrichia atricapilla</i>								N <sup>1</sup> F		
<i>Passerella iliaca</i>								N <sup>1</sup> F		
<i>Calcarius lapponicus</i>						N <sup>1</sup> F	N <sup>1</sup> F		N <sup>1</sup> F	
<i>Plectrophenax nivalis</i>									N <sup>1</sup> F	N <sup>2</sup>

1,2,3 Primary, secondary, or tertiary use of habitats, respectively.

Goose, but Brandt (1943) and Kessel et al. (1964) reported the probable occurrence of two subspecies. This species nested in isolated pairs in the marsh on small pond islands or along pond edges. No semi-colonial groups (as reported by Kessel et al. 1964) were noted, but by late June, family groups of two or more adults with as many as 13-15 young were frequently encountered along the shores of the Kolomak River.

*Branta nigricans*. Black Brant. The primary nesting area for this species is south of our study site along the coastal salt flats of the Clarence Rhode National Wildlife Refuge (C. J. Lensink, pers. comm.). At the Kolomak, flocks of 5-35 individuals as well as occasional pairs were seen during the last week of May and early June, although we did not find a nest. Kessel et al. (1964) found one and possibly two nests near the southern part of our study area in 1963, and it is likely that small numbers nest there regularly.

*Philacte canagica*. Emperor Goose. A common

nester on marsh tundra. Emperor Geese arrived in mid- to late May, as soon as the ponds and lakes were ice-free. They were first seen in flocks of 6-30, with individuals in the flocks associating as pairs. Nesting occurred on the wet marsh tundra away from the base of the hills. In 1967, the first nest was found on 30 May and contained four eggs, so that egg-laying must have begun several days earlier. By early June, groups of young and attending adults were seen commonly along the riverbanks where they actively fed.

*Anser albifrons*. White-fronted Goose. A common breeder at the Kolomak. Flocks of 2 to 12 were first observed during the meltoff period each spring. By late May, pairs could be found dispersed over the flat marshes and especially along the heath tundra at the base of the hills. Eight nests were found, seven of which were in well-drained heath tundra. The eighth was located in the marsh, 1 km away from the hills. Clutch size ranged from two to seven eggs, with a mean of 4.3. In late June and July adult

White-fronts and their young were encountered frequently along the base of the hills; they did not tend to congregate on the rivers, as did family groups of other species of geese.

*Chen hyperborea*. Snow Goose. A frequent spring migrant. Kessel et al. (1964) did not record this species, but Harris (1966) saw two in late June at the Kashunuk River and Brandt (1943) observed a flock of 11 on 11 May at Hooper Bay. In late May each year, we saw several flocks of 10–40 Snow Geese, flying high over the tundra, apparently on migration to more northerly breeding areas.

*Anas platyrhynchos*. Mallard. This species was an uncommon nester on marsh tundra. Each year at the Kolomak, several males and occasionally a pair were seen on small ponds in the marsh. In 1968, one nest with seven eggs was located among marsh vegetation, about 300 m from the base of Kikuktok Mountain. Brandt (1943), Kessel et al. (1964), and Harris (1966) all reported Mallards as being uncommon in the Hooper Bay region, and Brandt and Harris each found only one nest.

*Anas acuta*. Pintail. Pintails were the most abundant duck in the study area. They arrived in small flocks of 2–10 in mid-May, and by early June were associated mostly in pairs. In 1968, a nest with nine eggs was found on 30 May, indicating a very early start. Most nests were situated on lowland heath tundra, about 1 km from the nearest marsh. Clutch size for nine nests varied from six to nine (average = 7.4). By late June and early July, small flocks of males were common about the tundra ponds and lakes.

*Anas carolinensis*. Green-winged Teal. A relatively common nesting species in the marshes and near ponds along the base of the mountains. Kessel et al. (1964) also considered this species to be common near the Kolomak, but Brandt (1943) and Harris (1966) reported them rare at Hooper Bay and along the Kashunuk River, respectively.

*Mareca americana*. American Widgeon. A probable but uncommon breeder in our study area. This species was seen at the Kolomak only on the following occasions, all in 1968: 4 June, a flock of 10 associating with a large group of male Pintails; 7 and 14 June, flocks of 14 and 9, respectively, flying north over the marsh; and 16 June, 4 males associated with several male Pintails on a shallow marsh pond. Kessel et al. (1964) and Brandt (1943) also reported this species as being scarce, although Brandt did locate a female with a brood near the upper Kokechik River.

*Spatula clypeata*. Shoveler. Uncommon on the Kolomak study area. We saw one male on 7 June 1966, while Kessel et al. (1964) saw a pair and made several sightings of single males, perhaps all of the same individual. Harris (1966) reported several scattered males along the Kashunuk River.

*Aythya marila*. Greater Scaup. A common breeding species in the marshes along the base of the hills, but less common on the more extensive marshlands away from the mountains. They appeared at the Kolomak in late May but did not begin nesting until 10–15 June. Three nests were found in the study area. These had clutches of 7, 8, and 10 eggs, and were all located among tall dense sedges near the edges of small ponds.

*Bucephala albeola*. Bufflehead. This species was not reported at the Kolomak by Kessel et al. (1964) or in the Kashunuk-Old Chevak area by Harris (1966). Brandt's (1943) party reported two birds

near Hooper Bay on 26 May. Our only observation was of two males on a small pond near the base of Kikuktok Mountain on 4 June 1968.

*Clangula hyemalis*. Oldsquaw. Next to the Pintail, the Oldsquaw is probably the most common duck at the Kolomak. Brandt (1943) considered them to be very common at Hooper Bay, as did Harris (1966) at Old Chevak. In our area, Oldsquaws were present by mid-May each year and were conspicuous throughout the nesting season.

*Polysticta stelleri*. Steller's Eider. Our only observation of this species was of a pair on a small pond in the marsh near the base of Kikuktok Mountain on 30 May 1966. Kessel et al. (1964) reported a few scattered observations of this species at the Kolomak, but Brandt (1943) found them breeding fairly commonly in the tundra south of Kokechik Bay, northeast of Hooper Bay.

*Somateria mollissima*. Common Eider. Although Brandt (1943) found Common Eiders nesting near the Askinuks, we saw only a few scattered males and two pairs flying over the marsh during the last few days of May. Kessel et al. (1964) likewise recorded only occasional individuals, although they did find one nest near the Kolomak. Harris (1966) considered them an uncommon breeder on the salt flats near the mouth of the Kashunuk River.

*Lampronetta fischeri*. Spectacled Eider. This was a common nesting duck and the only eider regularly nesting in the study area. In late May and early June, numerous pairs could be seen on small ponds in the marshes. We found two nests, each containing five eggs.

*Oidemia nigra*. Common Scoter. Kessel et al. (1964) considered this species to be relatively common at the Kolomak. We saw it only on five occasions, all of single birds on dates between 7 June and 1 July. Harris (1966) found them common at Old Chevak, as did Brandt (1943) near Hooper Bay. They probably breed in small numbers in this part of the Delta.

*Mergus serrator*. Red-breasted Merganser. A relatively common species at the Kolomak. Two or three pairs were present in the study area each year, and although no nests were found, it undoubtedly breeds in the region. Brandt (1943) and Harris (1966) found it uncommon in the Hooper Bay-Kashunuk area.

#### SHORE BIRDS

Twenty-two species of shore birds were recorded at the Kolomak during the 4-year period. Of these, 12 were regular breeders (table 1), two more (Ruddy Turnstone, Long-billed Dowitcher) are known to breed at least occasionally in the region, and two others (Rock and Baird Sandpipers) are possible breeders on the higher parts of the Askinuks.

With the possible exception of the phalaropes, the species in this group occupy nesting territories that are strongly defended against conspecifics. Most hollow out a shallow depression on the tundra as a nest cup. With the exception of the crane, these species depend heavily on the camouflage patterns of their eggs and on the location of their nests for protection against predators. Their choice

of nest sites is therefore highly selective. For example, Black-bellied Plovers place their black and white mottled eggs in shallow depressions on beds of moss and lichen, devoid of graminoid vegetation, while Western Sandpipers nest exclusively on heath tundra, mostly under low shrubby vegetation.

Although some feeding occurs in the vicinity of the nests, individuals of many species (e.g., *C. alpina*, Holmes 1970 and *C. mauri*, Holmes 1971b) move off territory to communal feeding areas to obtain most of their food. The margins of small ponds, lakes, and rivers are important feeding sites for shore birds, but the mud ponds at low tide are perhaps used most frequently (table 1).

*Grus canadensis*. Sandhill Crane. Scattered pairs occurred throughout the Kolomak area, from the heath tundra at the base of the mountains out onto the flat marsh of the Delta. Three nests were found in the study area; each had two eggs. Two nests consisted of flattened, matted grass, with the eggs fully exposed. The third was a raised mound, made of matted grass and sedge, and located among willow shrubs, 0.5–1 m tall, at the junction of marsh and shrub zone. Hatching in all nests took place in late June.

*Charadrius semipalmatus*. Semipalmated Plover. The only site within the study area in which Semipalmated Plovers were found was the sandy beach on the north shore of Kokechik Bay, where Kessel et al. (1964) also found them. On 5 July 1967, we located three recently hatched young with their attending adults along this beach.

*Charadrius vociferus*. Killdeer. Kessel et al. (1964) observed one Killdeer at the Kolomak on 8 June 1963. None was recorded during our study and there are only two other records for the Delta (Gabrielson and Lincoln 1959), indicating that this species is an uncommon wanderer in the region.

*Pluvialis dominica*. American Golden Plover. In this part of the Delta, the Golden Plover breeds only on the higher reaches of the Askinuks (Brandt 1943; Kessel et al. 1964; present study). We found several pairs near the top of Kikuktok Mountain and on the other high ridgetops nearby. During June, several Golden Plovers were observed feeding in the marsh near the base of Kikuktok. These were most likely individuals from the highland breeding areas.

*Squatarola squatarola*. Black-bellied Plover. This plover was common on the lower slopes of the mountains and on the ridges and larger islands of heath tundra occurring on the Delta. Many pairs occurred along the base of the hills where we found several nests each year. Two pairs nested each season on a 10-ha census plot located between the Kolomak River and the hills. Egg-laying commenced in late May in 1966 and 1968 and about 20 May in 1967, a year with an earlier snow melt. The length of the incubation period was determined in two cases as 27 days from laying of the fourth egg to hatching of the fourth chick.

*Arenaria interpres*. Ruddy Turnstone. On 19 and 20 May 1968, four Ruddy Turnstones were seen in a small flock of Dunlin, Black Turnstones, and Western Sandpipers on marsh tundra. This species was not recorded at the Kolomak by Kessel et al. (1964).

Brandt (1943), however, reports that it does breed in small numbers along the coast near Hooper Bay, and Harris (1966) considered it as a possible breeder near Old Chevak.

*Arenaria melanocephala*. Black Turnstone. This turnstone was a common breeder on the flat, wet marshlands. It did not frequent heath tundra. Nests were placed in clumps of sedge or grass, usually within a few meters of small mud-bordered ponds. The turnstones fed in these muddy areas, among the grasses and sedges of the marsh, and occasionally along the river banks at low tide. This species is also very common on low-lying salt flats and marshy tundra near Hooper Bay (Brandt 1943) and the Kashunuk River (Harris 1966).

*Capella gallinago*. Common Snipe. Snipe were very conspicuous at the Kolomak from mid-May through late June each year. They nested most commonly among the tall sedges and scattered willow bushes at the lower edge of the alder zone where it meets the marsh. The species is uncommon on the Delta away from the mountains (Brandt 1943; Harris 1966).

*Numenius tahitiensis*. Bristle-thighed Curlew. On 30 May 1968, we saw a single Bristle-thighed Curlew flying low over the tundra. The bird was clearly seen and its distinctive call was heard repeatedly for about a minute. Several minutes later, a flock of 30 large curlews which may have been of this species was observed flying high above the tundra. Brandt (1943) reported that Bristle-thighed Curlews filtered through the Hooper Bay region in small numbers through the summer season.

*Actitis macularia*. Spotted Sandpiper. The only record of this species for the Kolomak region is a single bird reported by Kessel et al. (1964) on 8 June 1963 along the north shore of the Kokechik River. There are no other records from the western Delta, although Spotted Sandpipers are common breeders in interior Alaska (Gabrielson and Lincoln 1959).

*Heteroscelus incanum*. Wandering Tattler. An adult male tattler was collected on 10 June 1963 among the boulders on the north shore of Kokechik Bay (Kessel et al. 1964). On 25 May 1968, we observed one feeding along the edge of a small pond near the eastern base of Kikuktok Mountain. Harris (1966) saw three tattlers along the Kashunuk in early August. This species is probably best considered a rare migrant through this section of the Delta.

*Totanus melanoleucus*. Greater Yellowlegs. Our only record of this species at the Kolomak is one individual seen on 4 July 1968 on marsh tundra near the base of Kikuktok Mountain. On 23 August 1967, we collected an adult female, weighing 163.7 g at Old Chevak. The specimen is deposited at the headquarters of the Clarence Rhode National Wildlife Range at Bethel, Alaska. The only other records of this species near Hooper Bay are a sight record by Murie in a valley on the west side of Kikuktok Mountain on 18 June and two specimens collected in July at Hooper Bay (Brandt 1943).

*Totanus flavipes*. Lesser Yellowlegs. Between 26 and 28 May 1966, two Lesser Yellowlegs were present along the shallow ponds at the edge of the marsh just east of Kikuktok Mountain. One bird displayed actively, indicating some possibility of settling. However, both individuals disappeared after 28 May, and were not seen again. Several other records of migrant Lesser Yellowlegs have been obtained on the Delta.



(Gabrielson and Lincoln 1959), but none in the vicinity of the Askinuks.

*Calidris ptilocnemis*. Rock Sandpiper. Our only record of the Rock Sandpiper at the Kolomak is one individual seen on 19 May 1968 in company with a flock of Dunlin, Western Sandpipers, and Black Turnstones. All were feeding in marsh tundra, east of Kikuktok Mountain. This species was not seen by Kessel's party but they report an observation by Alan Baldrige of a Rock Sandpiper nest containing four young on the north side of the Askinuks near Scammon Bay. This substantiated Brandt's (1943) statements that this species might breed in these mountains.

*Calidris melanotos*. Pectoral Sandpiper. Kessel et al. (1964) observed this species six times, including one bird that acted as if it had a nest and a female with a well-developed brood patch, which was collected. Brandt (1943) reported Pectoral Sandpipers as relatively uncommon on the rolling upland tundra near Hooper Bay. At the Kolomak, we found Pectoral Sandpipers to be regular but not common breeders. Each year, at least two males occupied territories on a census plot situated on heath tundra at the edge of the marsh. In 1966 and 1968, one nest was found on this study plot, while in 1967 two occurred there. The nests were placed in tall grass at the border of heath tundra and wet marsh. All nests had four eggs and were incubated only by the females.

*Calidris bairdii*. Baird's Sandpiper. We obtained the following four records of this species at the Kolomak, all presumably of migrating birds: one on 23 May 1966, and in 1968, one on 17 May, two on 21 May, and one on 23 May. The first three records were of birds feeding in the marsh. The fourth was of a bird feeding on heath tundra on the lower slopes of Kikuktok Mountain. After a few minutes it was chased by a Western Sandpiper and flew off up the slope. Brandt (1943) reports evidence that this species may breed rarely among the sand dunes near the Bering Sea and more commonly in the Askinuks. In spite of our familiarity with breeding *bairdii* in other parts of Alaska, we never saw or heard any display activity of this species on Kikuktok or surrounding hills.

*Calidris alpina*. Dunlin. An abundant breeder in the low-lying grass and sedge marshes of the Delta. Detailed information on its habitat preferences, density, and breeding biology at the Kolomak are given elsewhere (Holmes 1970, 1971a).

*Calidris mauri*. Western Sandpiper. In contrast to the Dunlin, Western Sandpipers nest exclusively on the heath tundra wherever it occurs from the islands and ridges of slightly elevated ground on the flat Delta to the hillslopes of the Askinuks. Detailed descriptions of their habitat used and population biology at the Kolomak are given in other publications (Holmes 1971b, 1972, 1973).

*Limnodromus scolopaceus*. Long-billed Dowitcher. This species was seen infrequently during the last 10 days of May in each season. Most of these records were of pairs or single individuals, some of which actively displayed, on marsh habitat, east of Kikuktok Mountain. We did not find any nests, but it is likely that a few pairs nested in the vicinity. Kessel et al. (1964) reported seeing only one bird, while Brandt (1943) found dowitchers uncommon at Hooper Bay, as did Harris (1966) along the Kashunuk River.

*Limosa lapponica*. Bar-tailed Godwit. A common breeder at the Kolomak along the base of the hills, but not on the mountain slopes. Brandt (1943) found

them to be common on mossy upland tundra near Hooper Bay and Harris (1966) reported several pairs on the upland tundra near Old Chevak.

*Phalaropus fulicarius*. Red Phalarope. An uncommon breeder on marsh tundra near the Kolomak. Brandt (1943) found Red Phalaropes to be common throughout the marshes around Hooper Bay, but Harris (1966), Kessel et al. (1964), and our records indicate that they occur in small numbers, occasional pairs scattered on ponds and lakes in the marshes.

*Lobipes lobatus*. Northern Phalarope. Next to the Western Sandpiper, this phalarope is perhaps the most common shorebird in the Kolomak study area. They were abundant in marsh tundra, along the base of the hills, and we even found them nesting in the heath tundra over half-way up the side of Kikuktok Mountain, 1–2 km from the nearest marsh.

#### RAPTORS, GALLIFORMS, AND LARIDS

Twelve of the 16 species in this category are known to breed at least in some years at the Kolomak (table 2). In addition, the Snowy Owl may breed in years of high populations of rodents, a condition that did not coincide with the visit of Kessel et al. (1964) or with our four summers at the Kolomak.

All except the raptors and the Rock Ptarmigan nest primarily in the marshes or along the base of the Askinuks. The Rock Ptarmigan occurs exclusively at the high elevations, while the hawks and eagles nest mainly on the large rocky outcrops occurring on or near the hills and hunt over all tundra habitats.

*Buteo lagopus*. Rough-legged Hawk. A sporadic nester in the Askinuks. We did not observe this species in 1966, 1967, or 1969, but in 1968, a pair nested about 3 km north of our main study area in the upper Kolomak Valley. The nest was located on a ledge, 10 m above the tundra, of a large dike-like mass of rock. When we discovered it on 4 July, it contained two partly grown young, with both adults in attendance. Kessel et al. (1964) did not observe Rough-legs at the Kolomak, although Brandt (1943) considered them fairly common in the Askinuks in 1924, a year of high rodent populations.

*Aquila chrysaetos*. Golden Eagle. The nesting site for Golden Eagles reported by Kessel et al. (1964) on an isolated granite escarpment on the southeast-facing slope of Kikuktok Mountain was still in use during our years of study. In 1966, the nest contained two eggs on 24 May and by 3 June two downy young were present. Two nearly fully grown young were still in the nest when it was last checked on 14 July. On 25 May 1967, the nest contained two eggs, and on 7 June, two one-week-old downy young. In 1968, although two eggs were laid, only one hatched, this being on 31 May/1 June. We examined the second, unhatched egg in late June and found a partially developed but dead embryo. During the fledgling stage in all 3 years, there were always numerous ptarmigan carcasses scattered about the nest, which appeared to be the most important food item brought to the young. In addition, the following waterfowl remains were recorded in the nest: one adult scaup, two adult female eiders, and one downy Emperor Goose.

*Pandion haliaetus*. Osprey. A rare straggler in the western part of the Delta. One was observed by Kessel et al. (1964) at the Kolomak on 17 June 1963.

*Falco rusticolus*. Gyrfalcon. Our only record of a Gyrfalcon was one light-phase individual seen in the study area on 27 May 1966. Kessel et al. (1964) reported a nest on a dike-like mass of granite near the Kolomak in 1963. We examined this site in each of our 4 years and never found it occupied.

*Lagopus lagopus*. Willow Ptarmigan. A common nesting species on relatively well-drained tundra. At the Kolomak, Willow Ptarmigan were most common along the base of the hills, from the heath-covered tundra bordering the marsh to a point about half-way up the hillsides of Kikuktok Mountain. Nesting commenced in late May, with clutches being completed during the first week of June. Clutch size in the three nests found was 9, 10, and 11.

*Lagopus mutus*. Rock Ptarmigan. An uncommon nesting species on the upper third of Kikuktok Mountain and other parts of the Askinuks. We observed several individuals and pairs near the base of Kikuktok Mountain in mid-May of each year, but after this date, they were recorded only at the higher elevations. Brandt (1943) and Kessel et al. (1964) considered this species to be common above about 900 ft elevation in the Askinuks.

*Stercorarius pomarinus*. Pomarine Jaeger. A common migrant in early spring. We made the following observations of this species at the Kolomak: flock of 13 flying north on 24 May 1966; flock of 36 on 1 June 1967; group of 11 on 3 June 1967; flock of 17 on 18 May 1968. On 9 June 1966, one Pomarine was seen flying high over Kolomak and on 10 June 1968, two were chased by a Parasitic Jaeger as they cruised over the marsh. Kessel et al. (1964) did not observe this species at the Kolomak, but Brandt (1943) reported several flocks in late May at Hooper Bay and found several nests of this species in 1924, a year when rodent densities were high.

*Stercorarius parasiticus*. Parasitic Jaeger. A common breeding species on the marsh tundra and along the lower slopes of the hills. In each year of our study, at least one or two pairs nested in the study area, one usually near the base of the hill, the other about 1 km out on the marsh. They hunted intensively over marsh tundra and fed mainly on the eggs and young of waterfowl.

*Stercorarius longicaudus*. Long-tailed Jaeger. This jaeger was about equally as common as the Parasitic, although we never located a nest. A pair of Long-tails hunted consistently over our study plot on heath tundra at the base of the hills, and was responsible for the loss of a number of sandpiper eggs and in one documented case, of a clutch of Bar-tailed Godwit eggs. They were frequently seen chasing small birds such as sandpipers and some passerines.

*Larus hyperboreus*. Glaucous Gull. Common on the open marsh, away from the hills. A small, loosely organized colony of several pairs nested in a loop of the Kolomak, near the Kokechik River, in the southeastern sector of the study area, and a few other single pairs were scattered on the larger lakes in the marsh. In late June and July, they preyed heavily on young goslings and ducklings present along the river systems.

*Larus canus*. Mew Gull. An uncommon nester on the marshes. They occurred as isolated pairs along the shores of lakes and ponds. These gulls were seen most frequently flying along the rivers and sloughs. Harris (1966) found this species to be a common

nester on the salt flats of the Kashunuk and the edges of tundra pools near Old Chevak.

*Rissa tridactyla*. Black-legged Kittiwake. On 9 June 1968, a flock of eight Kittiwakes flew over the marsh near the Kolomak River. This species nests on many of the rocky headlands and cliffs along the Bering Sea (Gabrielson and Lincoln 1959) and may nest at Cape Romanzof (Brandt 1943), 22 km west of the Kolomak study area.

*Xema sabini*. Sabine's Gull. A common breeder near the small pools and lakes on marsh tundra throughout the western part of the Delta (Brandt 1943; Kessel et al. 1964; Harris 1966; present study). Brown et al. (1967) give detailed information on the breeding biology and behavior of this species near Hooper Bay.

*Sterna paradisaea*. Arctic Tern. This tern is a common breeding species along the shallow ponds in the Delta marshes. At the Kolomak, they nested throughout the study area and fed commonly in the deeper lakes and along the rivers and sloughs.

*Nyctea scandiaca*. Snowy Owl. The only Snowy Owl reported from the Kolomak is one individual seen by Kessel et al. (1964) on 8 June 1963. Brandt (1943) found this owl to be a common breeder on the tundra near Hooper Bay in 1924, again correlated with the abundance of rodents in that year.

*Asio flammeus*. Short-eared Owl. An irregularly occurring species at the Kolomak. Our only records of this owl are from 1968 when one or possibly two were present on the heath tundra near the base of the hills. They were seen frequently between 17 and 26 May, flying over the tundra, apparently hunting small mice which were relatively more common in this season than in the preceding 2 years.

#### PASSERINE BIRDS

Nineteen of the 28 species of passerines recorded in the Kolomak study area were residents during the breeding season (table 2). The large number of passerines at this locality is due principally to the presence of the shrub zone and, for some species (e.g., pipits, buntings, and swallows), the hillsides and rocky outcrops associated with the Askinuk Mountains. Only three of the species (Yellow Wagtail, Savannah Sparrow, and Lapland Longspur) typically inhabit the marsh tundra or lowland heath tundra.

*Tachycineta thalassina*. Violet-green Swallow. Kessel et al. (1964) saw this species three times at the Kolomak and collected a male and a female on 10 June 1963. There are no other records of it from the western Delta (Gabrielson and Lincoln 1959).

*Iridoprocne bicolor*. Tree Swallow. Brandt (1943) did not find this species at Hooper Bay, but Kessel et al. (1964) recorded it at the Kolomak on five separate occasions. In 1967, we observed it three times, single birds on 25 May, 2 June, and 11 June. In 1968, four different observations of tree swallows were made in mid-June. Two of these were of birds associating with Cliff Swallows near large, rocky outcrops where the latter species was nesting. Although we have no definite proof, it is possible that this species breeds in small numbers in this region.

*Petrochelidon pyrrhonota*. Cliff Swallow. This swallow nested on a large granitic outcrop near the

base of Kikuktok Mountain, and about 0.5 km from the Kolomak River. In 1966, there were 11 active nests; in 1967, there were 10 nests, plus 3 that were only partially built before being abandoned. In 1968, 14 occupied nests were on the outcrop, 9 on the north face, 2 on the west end, and 3 on the south side. The swallows foraged over the heath and marsh tundra, and on several occasions were seen 5 km away from the nesting rocks. In 1968, another colony was located on the large outcrop in the upper Kolomak Valley which also contained the Rough-legged Hawk nest.

*Corvus corax*. Common Raven. An uncommon species along the Askinuks. Kessel et al. (1964) did not find this species at the Kolomak in 1963. We had four observations of it, one harassing an eagle on 11 June 1967, two flying over the low hills near Kikuktok Mountain on 30 June 1968, and three chasing each other among the rocky outcrops near Kikuktok on 2 July and again on 6 July 1968. Small numbers probably nest in the Askinuks.

*Turdus migratorius*. Robin. An uncommon species in the alder zone along the base of the Askinuks. Kessel et al. (1964) reported one vocal bird near their camp. We subjectively estimate that two males of this species occurred per kilometer of alder zone.

*Ixoreus naevius*. Varied Thrush. Another uncommon thrush, this species was heard only infrequently, calling from the alder zone. They were most common in the more extensive and denser thickets of alder that occurred on the southeast slopes of Kikuktok Mountain near the Kokechik River. Brandt's (1943) party did not report them from the Hooper Bay region, but Kessel et al. (1964) saw several at the Kolomak.

*Hylocichla minima*. Gray-cheeked Thrush. This is one of the most common passerines inhabiting the alder thickets in the Kolomak study area.

*Oenanthe oenanthe*. Wheatear. A migrant at the Kolomak in mid- and late May. Five observations, each of a single bird, were made between 16 and 24 May. Four of these were on heath tundra near the base of Kikuktok Mountain, while the fifth was in the marsh, 0.5 km from the hills. Neither Kessel et al. (1964) nor Brandt (1943) report this species from the Delta, but Höhn (1965) mentions seeing one near Scammon Bay.

*Motacilla alba*. White Wagtail. The only previous record of the White Wagtail on the Yukon Delta is an observation made by Bishop (Gabrielson and Lincoln 1959) of a flock of six birds at the mouth of the Yukon River in late August. Records for the northwestern part of Alaska are more frequent, however, and there are at least two well-documented cases of breeding there (Peyton 1963).

In 1968, a male White Wagtail was found residing in the same large, granitic outcrop being used for nesting sites by the Cliff Swallows. The bird first appeared on 12 June and remained through 22 June, during which time it actively sang from the top of the rock and foraged in its crevices and on the surrounding tundra. Since no mate was seen and the bird remained for only 10 days, it was probably a wandering male. Nevertheless, the possibility exists that this species may breed in the rocky cliff or outcrop areas of the Askinuks.

*Motacilla flava*. Yellow Wagtail. This is a common species on heath tundra along the lower slopes of the hills.

*Anthus spinoletta*. Water Pipit. An uncommon breeding species confined to the sparsely vegetated tundra on the upper slopes and along the ridges of

the Askinuks. Kessel et al. (1964) reported it only above an elevation of 465 m, but we found several pairs on a ridge of about 100 m elevation at the north end of our study area.

*Lanius excubitor*. Northern Shrike. An uncommon predator in and among the alders. It was seen several times each season, but was not conspicuous. The species was not reported by Brandt (1943), but Kessel et al. (1964) saw it twice at the Kolomak.

*Vermivora celata*. Orange-crowned Warbler. An uncommon warbler occurring exclusively in the alder zone. Kessel et al. (1964) saw only three, but we found them scattered regularly along the length of the alder thickets.

*Dendroica petechia*. Yellow Warbler. This is a common species in the alder and willow thickets along the base of the hills. They were present from late May through at least late June, at which time singing activity ceased.

*Dendroica striata*. Blackpoll Warbler. The only record of this species for the Kolomak or the western part of the Delta is one bird observed by Kessel et al. (1964) on 18 June 1963.

*Seiurus noveboracensis*. Northern Waterthrush. A relatively common inhabitant of the alder zone. Kessel et al. (1964) considered it about twice as abundant as the Yellow Warbler, an estimate with which we agree.

*Wilsonia pusilla*. Wilson's Warbler. This is the most abundant warbler in the alder zone (Kessel et al. 1964), and could be heard singing throughout late May and June.

*Euphagus carolinus*. Rusty Blackbird. An uncommon or rare species in the study area. The only record from the Kolomak is a pair seen by Kessel et al. (1964) near the shrub zone. It was not recorded by Brandt (1943), nor did we see it.

*Leucosticte tephrocotis*. Gray-crowned Rosy Finch. No previous records on this species exist from the Askinuks or the Hooper Bay region. Our only sighting of the species was of one individual seen feeding on heath tundra near the base of Kikuktok Mountain on 17 May 1968. It is known to nest on Nunivak Island (Gabrielson and Lincoln 1959), about 150 km southwest of the Kolomak.

*Acanthis* spp. Redpoll. Redpolls were common on the tundra wherever alder or willow thickets occurred. As reported by Kessel et al. (1964), Redpolls at the Kolomak showed great variation in plumage, ranging from the pure *A. flammea* type to the pure *A. hornemanni* form.

*Passerculus sandwichensis*. Savannah Sparrow. This is one of the most common passerines in the study area, occurring on the flat tundra and the lower heath-covered slopes of the hills. They were most abundant on grassy areas among willow shrubs along the lower edge of the shrub zone.

*Spizella arborea*. Tree Sparrow. A common species found along the shrub zone, especially the scattered willows at the edge of heath tundra.

*Zonotrichia leucophrys*. White-crowned Sparrow. Kessel et al. (1964) reported the occurrence of three widely separated individuals of this species at the Kolomak. It was not observed during our stay, nor during Brandt's (1943) work in the area.

*Zonotrichia atricapilla*. Golden-crowned Sparrow. This sparrow was found most commonly in the extensive alder zone on the south and southeastern slopes of Kikuktok Mountain. It was not heard or seen frequently in other parts of the alder thickets.

*Passerella iliaca*. Fox Sparrow. This species was

TABLE 3. Number of species of birds in several localities on the Yukon-Kuskokwim Delta, Alaska.

Site	Location	General habitat	No. of species	Numbers of breeding species				Source
				Water birds	Shore birds	Passerines	Other	
Napaskiak	Inner Delta, 13 km SW of Bethel	Inland tundra/tiaga	62	10	8	21	11	Williamson, 1957
Johnson River	Inner Delta, 48 km W	Inland tundra	49	5	7	10	6	Walkinshaw & Stophlet 1949
Hooper Bay-Kashunuk River	Delta on Bering Sea coast	Coastal tundra	81	19	13	4	10	Brandt 1943 Harris 1966
Kolomak River-Askinuk Mountains	30 km NE, Hooper Bay	Coastal tundra and hills	88	16	12	19	25	Kessel et al. 1964 This study

one of the most abundant passerines in the shrub zone, second only to the Gray-cheeked Thrush (Kessel et al. 1964).

*Calcarius lapponicus*. Lapland Longspur. The most abundant passerine in tundra habitats from the flat marshes to the higher slopes of the Askinuks. In contrast to the findings of Kessel et al. (1964), we found it more common than the Savannah Sparrow in all 4 years.

*Plectrophenax nivalis*. Snow Bunting. This is an uncommon breeder at higher elevations in the Askinuks. We observed several birds, both singles and pairs, in late May near the base of the hills, and on 27 June 1968, a nest was located on a rocky outcrop near the top on a low hill (elevation about 100 m) on a northerly extension of Kikuktok Mountain. The two adults were carrying food to the young on this date.

*Plectrophenax hyperboreus*. McKay's Bunting. We observed one male McKay's Bunting on 29 May 1968 while it fed on small adult insects on the river ice. Brandt (1943) reported this species to be common at Hooper Bay between 30 April and 20 May, but not after that. Other early spring records for this species have been obtained along the Alaska mainland (Gabrielson and Lincoln 1959).

## DISCUSSION

The Yukon-Kuskokwim Delta is well known for its great concentrations of bird life. At the Kolomak River site, the Delta marsh and heath habitats in combination with ecological formations provided by the topographical relief, rock outcrops, and shrub zone of the mountains support an even greater diversity of bird species. Within our relatively limited study area at the Kolomak, 88 bird species were recorded. Of these, 56 are known to breed regularly, 16 more are occasional or rare breeders, while the remaining 16 are transients that either move north to higher latitude nesting sites (e.g., Snow Geese, Bristle-thighed Curlews) or east into interior Alaska (e.g., Wandering Tattlers, Spotted Sandpipers, Wheatears).

Avifaunal surveys have been conducted at three other sites on or near the Delta. When the numbers and varieties of breeding bird species at these sites are contrasted with those at the Kolomak (table 3), the relative importance of the different habitat types becomes apparent. For water birds, the marsh at the Kolomak seems comparable with that on the more open Delta near Hooper Bay. There are differences, however, in the relative abundances of certain species. For example, the most abundant geese at the Kolomak are the White-front and the Emperor, while in coastal areas along the Kashunuk the Black Brant is most common (Harris 1966). The number of breeding shorebird species at the two coastal localities is essentially identical, and both the shorebird and water-bird components of the avifauna are significantly richer in the coastal areas than along the interior part of the Delta (table 3). Likewise, the total number of species recorded is greater along the coast because it is a more important migratory flyway.

The main difference in faunal composition between the Kolomak and the Delta habitat near Hooper Bay is in the numbers of breeding passerines and raptors. Both groups are better represented at the Kolomak, the passerines being restricted to the alder thickets at the base of the mountains, while the hawks and eagles utilize the rock outcrops and cliffs along the hills as nesting sites.

Along the eastern edge of the Delta near Bethel, the Delta tundra interdigitates with the boreal forest. At Napaskiak, about 13 km southwest of Bethel, Williamson (1957) found 51 bird species breeding in a range of habitats, including a well-developed riparian shrub community. This shrub community supported many passerines, most of which were also

found in the nonriparian shrub zone on the remote Askinuks. At the Johnson River, about 45 km west of Napaskiak, there is no well-developed shrub community, and the number of passerines is greatly reduced (table 3). Those present (e.g., Lapland Longspurs, Yellow Wagtails, and Savannah Sparrows) are the ones able to exploit open tundra habitats successfully.

At the Kolomak, the remarkable feature is that the long, narrow belt of shrubby alders can and does support a passerine fauna comparable to that in the more extensive shrub habitats along the inner edge of the Delta. A study comparing the relative abundance and breeding success of passerines in the two areas would be extremely interesting.

Besides the high diversity of bird species in the coastal sections of the Yukon-Kuskokwim Delta, another important feature is that certain species are extremely abundant. In the marsh habitats of the western Delta, the most conspicuous elements are the waterfowl, especially the four species of breeding geese, two species of ducks (Pintail and Oldsquaw), and one wader, the Dunlin. On heath tundra, Western Sandpipers are exceedingly abundant (see below), while on all tundra habitats from the marsh to the hillsides of the Askinuks, both the Lapland Longspur and the Northern Phalarope are very common. To illustrate this point further, we give two examples, using two species for which we have quantitative estimates of breeding densities at the Kolomak. The Dunlin nests at a density of about 75 pairs/km<sup>2</sup> throughout the wet marsh tundra, this being about five times more dense than populations of the same species in northern Alaska (Holmes 1970). The Western Sandpiper occurs at a density of about 330–490 pairs/km<sup>2</sup> on heath tundra at the base of the Askinuks and 500–750 pairs/km<sup>2</sup> on the hummocks and islands of heath tundra scattered throughout the marsh tundra on the flat Delta (Holmes 1971b). These extremely high densities of Western Sandpipers cannot be extrapolated throughout the Delta because its nesting habitat is not evenly distributed over the region. Nevertheless, its extremely high population densities within localized areas are very impressive, and the species obviously has an important role in the dynamics of these tundra communities.

## SUMMARY

The ecological distribution of birds was studied in four summers along the Kolomak River, 30 km northeast of Hooper Bay, Alaska.

At this location, the extensive wet-marsh and heath-tundra habitats of the Yukon-Kuskokwim Delta about a low, isolated range of hills, the Askinuk Mountains.

The occurrence and distribution of 88 species of birds and the nesting habitats and major feeding areas of 56 species regularly breeding at the Kolomak are presented and analyzed. The extensive marsh tundra, with scattered islands of slightly raised heath tundra, supports a diverse array of waterfowl and shore birds. The mountains provide additional ecological formations and contribute significantly to the avifaunal diversity. In particular, the better-drained tundra of the hill slopes is utilized by several shorebirds and some passerines. Rock outcrops provide nest sites for raptors, while a long, narrow zone of alder thickets along the base of the hills supports a variety of passerines not found elsewhere on the western part of the Delta. The avifauna in this region is also characterized by the extremely high densities of a few species.

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