Branch of Wildlife Refuges, Alaska Area

Project: Clarence Rhode No. 3
Part A-4

Progress Report

WATERFOWL POPULATIONS, PRODUCTION AND HABITAT ECOLOGY ON THE YUKON-KUSKOKWIM DELTA, ALASKA

Populations and Ecology of Emperor Geese

by

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Charles M. Kirkpatrick

Department of Interior
Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service
Bethel, Alaska

10 October 1971

FOREWORD

The attached report by David I. Eisenhauer, Carl Strang, and Dr. Charles M. Kirkpatrick of Purdue University, is submitted as a progress report for Refuge Management Study No. 3, Part A-4 - "Populations and Ecology of Emperor Geese." The report summarizes the results from the first year of a three year field study, as well as existing data in refuge files. The completed study will be used as a thesis by Eisenhauer in partial fulfillment of requirements for the degree of Doctor of Philosophy. The work is under the general supervision of Dr. C. M. Kirkpatrick, Professor of Wildlife Management.

Principal support for the project during the current year was provided by Purdue University, The Bureau Sport Fisheries and Wildlife, the American Petroleum Institute, and the National Wildlife Federation. Support by the Bureau consisted chiefly of assistance in selection of suitable study areas, providing results from census and surveys conducted prior to and during the study, logistical support and assistance, and furnishing of various camping equipment and supplies.

The study area on Magak Flats is within the area of highest nesting density for emperor geese thus far examined in the region of the Yukon-Kuskokwim Delta. In addition, on the Magak Flats nearly all major habitats of the refuge are telescoped in a relatively small area, thus facilitating evaluation of habitat requirements and/or selection by emperors that otherwise would require a much larger study area.

The emperor goose shares the distinction with brant as being among the most marine oriented of all geese. Its restriction to estuarine habitat during all phases of its life, as well as its restricted breeding and wintering range, makes it particularly vulnerable to pollution from marine sources, although its land base is largely protected by the Clarence Rhode Range, and the Cape Newenham, Izembek, and Aleutian Island Refuges. Thus, this study is particularly timely, as intensive exploration by the petroleum industry, with high prospect for discovery of oil, is occurring throughout most of the emperor's range. Discovery and development of oil resources in the Bering Sea would constitute a significant threat to the continued existence of this beautiful goose.

Calvin J. Lensink
Refuge Manager
Clarence Rhode National Wildlife Range

NESTING ECOLOGY OF THE EMPEROR GOOSE (Philacte canagica Sewastianov) IN THE KOKECHIK BAY REGION, ALASKA*

FIRST ANNUAL REPORT

1971

by

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10 October 1971

* Receiving principal support during the current year from the American petroleum Institute, the National Wildlife Federation, and the U. S. Bureau of Sport Fisheries and Wildlife.

NOT FOR PUBLICATION

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ABSTRACT

A preliminary study of the nesting ecology of Emperor Geese (Philacte canagica), in the Kokechik Bay region of Alaska, during the summer of 1971, is reported here. The weather, vegetation, and fauna of the area are described.

The following factors in the nesting ecology of Emperor Geese are discussed: productivity, nest initiation, incubation, mortality, nesting characteristics, interspecific relationships, and some behavioral aspects.

Emperor Geese use three different habitats for nesting: tidal grasslands, lowland pingo tundra, and Carex lyngbyei marsh. The highest density of nests was observed in the lowland pingo tundra, which offers the best protection to the incubating female. Little difference in clutch size and nest success was observed between various nest locations. Clutch size averages 4.16. Late nesters lay smaller clutches.

Nest success and egg fertility were high. Abandoned nests were rare. Predation accounted for the greatest percentage of unsuccessful nests. Glaucous Gulls (Larus hyberboreus) accounted for most of the egg and gosling mortality, and foxes for adult mortality.

Brood counts revealed heaviest losses immediately after hatching. Goslings gained weight rapidly and were almost adult size by end of the fledging period.

Lines of further investigation and plans for future field seasons are included.

INTRODUCTION

The Emperor Goose (Philacte canagica Sewast.) is one of North America's rarest and least understood waterfowl species. Its breeding and wintering range is restricted to western Alaska and eastern Russia with only a few stragglers reaching the lower United States. The ecological and behavioral peculiarities of the Emperor, a maritime species, are little known. Some observations on the biology of the Emperor in its Asiatic range were made by Tugarinov (1941) and Kistchinski (1970). Information obtained for the Emperor Goose in its North American range is found in Bailey (1925, 1943, 1948), Conover (1926), Fay and Cade (1959), Gabrielson and Lincoln (1959), Headley (1967), and Lensink (per. com.). However, no comprehensive or definitive study of the Emperor Goose has been made.

The Problem

Vulnerability of Habitat

Breeding Emperor Geese occupy the extreme coastal fringe of the Yukon Delta and nest within the tidal zone of estuaries or streams draining the coastal plain. Distribution of driftwood on the plain indicates that the entire nesting habitat would be subject to pollution carried inland by storm waters from the adjacent seas, or from contamination within the plain itself. Simmilarly vulnerable are the primary migration and wintering areas, e.g., the shallow bays of Nunivak Island, Cape Newenham, and the Alaska Peninsula.

Vulnerability of the Emperor Goose

The particular vulnerability of this goose is related to the restricted range it occupies at all seasons and to the relatively small population numbers (perhaps as low as 60,000, but probably higher). A single major release of oil from any source within the range could conceivably do significant damage to habitats essential to survival or to geese themselves.

The probability of pollution in the Bering Sea region is unknown but undoubtedly will correspond to oil industry activity. A future risk is suggested by reported acceleration of exploration and probability of oil discovery in the area of the Alaska Peninsula, the Yukon Delta, and offshore in the Bering and Chukchi Seas. Tanker traffic in these areas has not been ruled out.

Purpose

The purpose of this project is to establish comprehensive data for the normal behavioral responses of the Emperor Goose to its breeding habitats that remain unchanged by significant human disturbance. These data will form a basic reference to the Emperor Goose.

Objective

The objective is to study breeding ecology and behavior of the Emperor Goose and to determine its productivity in the Kokechik Bay region, an area of high nesting density.

The 1971 Season

The 1971 field season at Kokechik Bay was limited in scope by the short time we had to prepare for the summer's work in a virgin area of a semi-wilderness region. In addition, none of us were available before June 15 to start for Kokechik Bay, and transportation to the area from Bethal headquarters of the Clarence Rhode National Wildlife Range depended upon availability of floatplane and flying weather. All this resulted in 1971 being a "crash" program as respects gathering useful biological data. Actually, we benefited by the late spring that retarded waterfowl nesting on the Delta, hence the majority of Emperor Goose nests were unhatched when we arrived on the study area June 21. Fortuitiously, we made many observations on nesting ecology applicable to a "late" spring.

Otherwise, the season's work resulted in several preliminary but essential accomplishments that can be stated in a general way: 1) the researchers selected and intimately familiarized themselves with a study area used by many nesting pairs of Emperor Geese; 2) researchers learned the logistic problems of living and doing waterfowl research in the area; and 3) they identified general and specific lines of attack needed to advance the project toward completion.

ACKNOWLEDGEMENTS

This study is supported by grants from the Wildlife Management Institute and the American Petroleum Institute to Charles M. Kirkpatrick, Department of Forestry and Conservation, Purdue University, who initiated and supervised the project in cooperation with the Bureau of Sport Fisheries and Wildlife. We are especially indebted to Calvin J. Lensink, Refuge Manager, Clarence Rhode National Wildlife Range, for essential logistic support and technical assistance. We are grateful also to Jerry Hout, Assistant Refuge Manager, and to Peter G. Mickelson, Research Biologist, University of Michigan, for their advice and help.

This progress report covers the period June 15-October 10, 1971. The students were on the Kokechik Bay study area June 21-August 9 and Kirkpatrick from June 21 to 27. The students cooperated in collecting data but Strang was responsible for much of the habitat and floral description. Eisenhauer compiled and collated most of the faunal data and prepared preliminary drafts of the report.

THE STUDY AREA

Topography and Vegetation

The Yukon-Kuskokwim Delta of western Alaska encompasses an area of approximately 26,000 square miles. Within this vast area many different topographical features are recognized: tidal mud-flats, lowland tundra, upland tundra, and tidal grasslands. A considerable portion of the Delta is covered by lakes and

ponds ranging from a few hundred square feet in area to thousands of acres. Many of these water bodies are influenced either by tides or rainfall and can vary in size from year to year. Along with lakes and ponds, numerous tidal sloughs and rivers add great variety to the terrain. Topography as well as vegetation is influenced by flooding, climate, frost heaving, and tidal action. The coastal part of the Delta is further molded by wave action.

Clarence Rhode National Wildlife Range, covering approximately 2,800,000 acres, occupies a key coastal strip of the Delta. The south part of the Range is divided into North and South Units by a strip of land near Baird Inlet. Much farther north, at the mouth of the Yukon River, is the Yukon Unit.

The Emperor Goose study area is located adjacent to the south shore of Kokechik Bay in the northwestern part of the North Unit of the Clarence Rhode N.W.R. (Fig. 1). The study area includes the eastern half of Sections 12, 13, 24, and 25 in Township 18 North, Range 92 West. This area is between 61°36' and 61°40' North latitude, and between 165° 50' and 166° West longitude (Fig. 2).

Kokechik Bay is separated from the Bering Sea by Panowat Spit on the south and Aniktun Island on the north. These two land forms are separated by a strip of open water only 1 mile wide. This small opening to the sea probably reduces the effect of wave action and storms tides in the Bay. Sand and mud, presumably deposited by annual flooding of the Kokechik River, extend up to a mile into the Bay from its south shore. Rising abruptly from the north shore of Kokechik Bay, the Askinuk Mountains, ranging up to 2,700 feet, probably add further to the relative calmness of the Bay.

Off the tip of Panowat Spit, Kokechik Bay reaches its greatest depth of 60 fathoms. This deep area is small, the majority of the Bay having an average depth of 6 fathoms. Numerous sand and mud bars are scattered throughout the Bay, making boat travel very uncertain.

Nearly all the topographical and vegetational features found on the Clarence Rhode National Wildlife Range can be observed on the 1.75-square-mile rectangular study area, which is 1/2 mile wide, 1 1/2 miles long, with its long axis oriented north and south. The north end, comprised of the southeast 1/4 of Section 12, is strongly influenced by daily tides. This flat area is laced with tidal sloughs, streams which are full at high tide and nearly empty at low tide. These sloughs vary in width from 5 to 30 feet and in depth from 3 to 7 feet. They connect to shallow tidal lakes and ponds, some of which fill with every tide and some with only the highest. Tidal ponds have an average depth of 1 foot at high tide and are bare mud flats when the tide is out.

The vegetation in Section 12 is relatively simple, and tidal inundation is presumably the major influence. The predominant plants are short sedges (Carex rariflora, etc.) which are found on all vegetated areas. A cinquefoil (Potentialla egedii egedii) is second in abundance and also covers the entire area. Third in importance is Elymus arenarius mollis, a 2-foot-high grass that dominates the taller vegetation bordering sloughs and tidal ponds. These borders, varying in width from 5 to 30 feet, form the densest cover in Section 12. Less abundant plants include Calamagrostis deschampsioides, which codominates with Carex and Elymus in scattered patches, Chrysanthemum arcticum, Saussurea nuda, Poa eminens, and Dupontia fischeri.

Fig. 1. Outline of Alaska showing general location of Emperor Goose study area on Kokechik Bay.

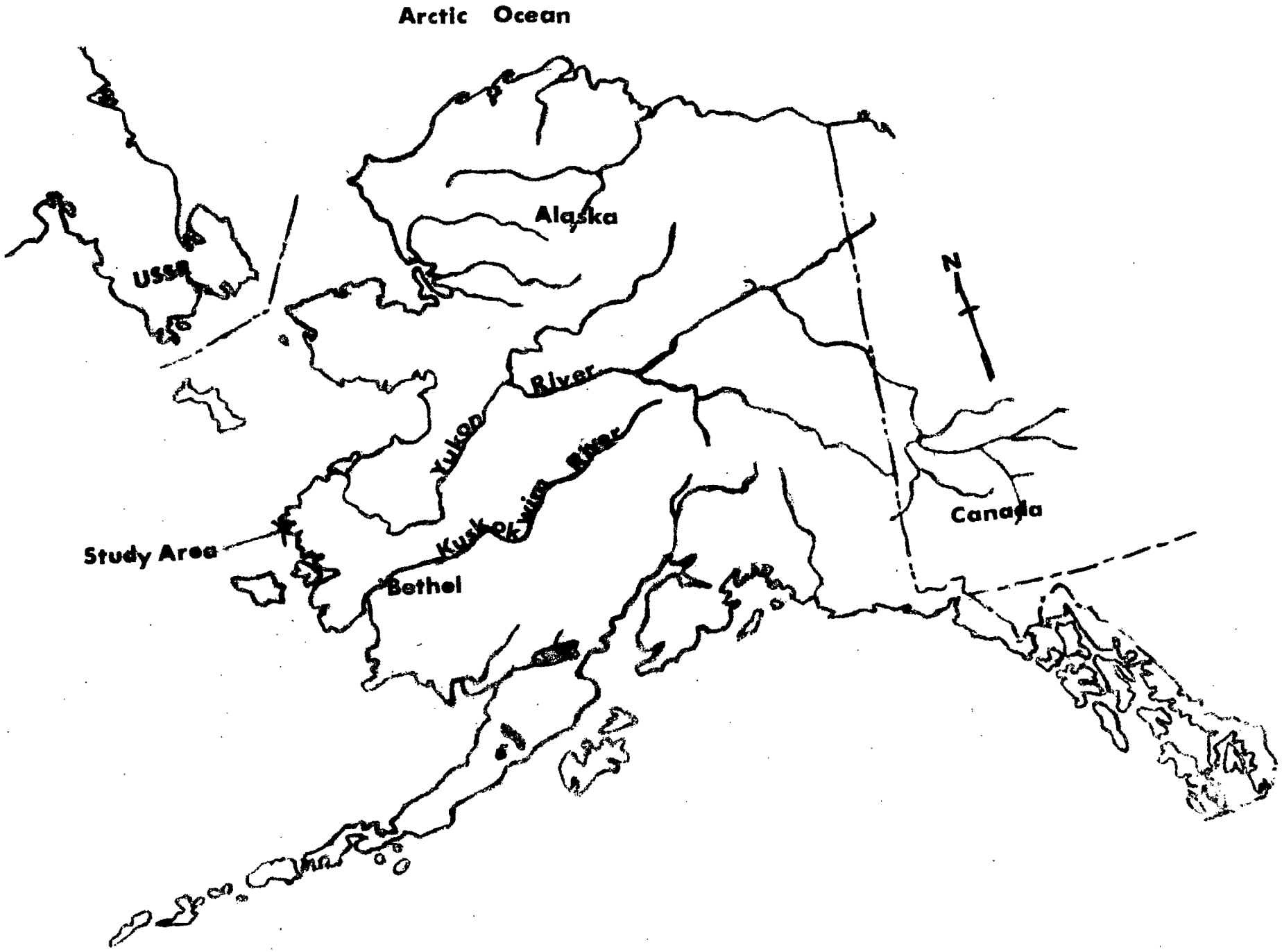
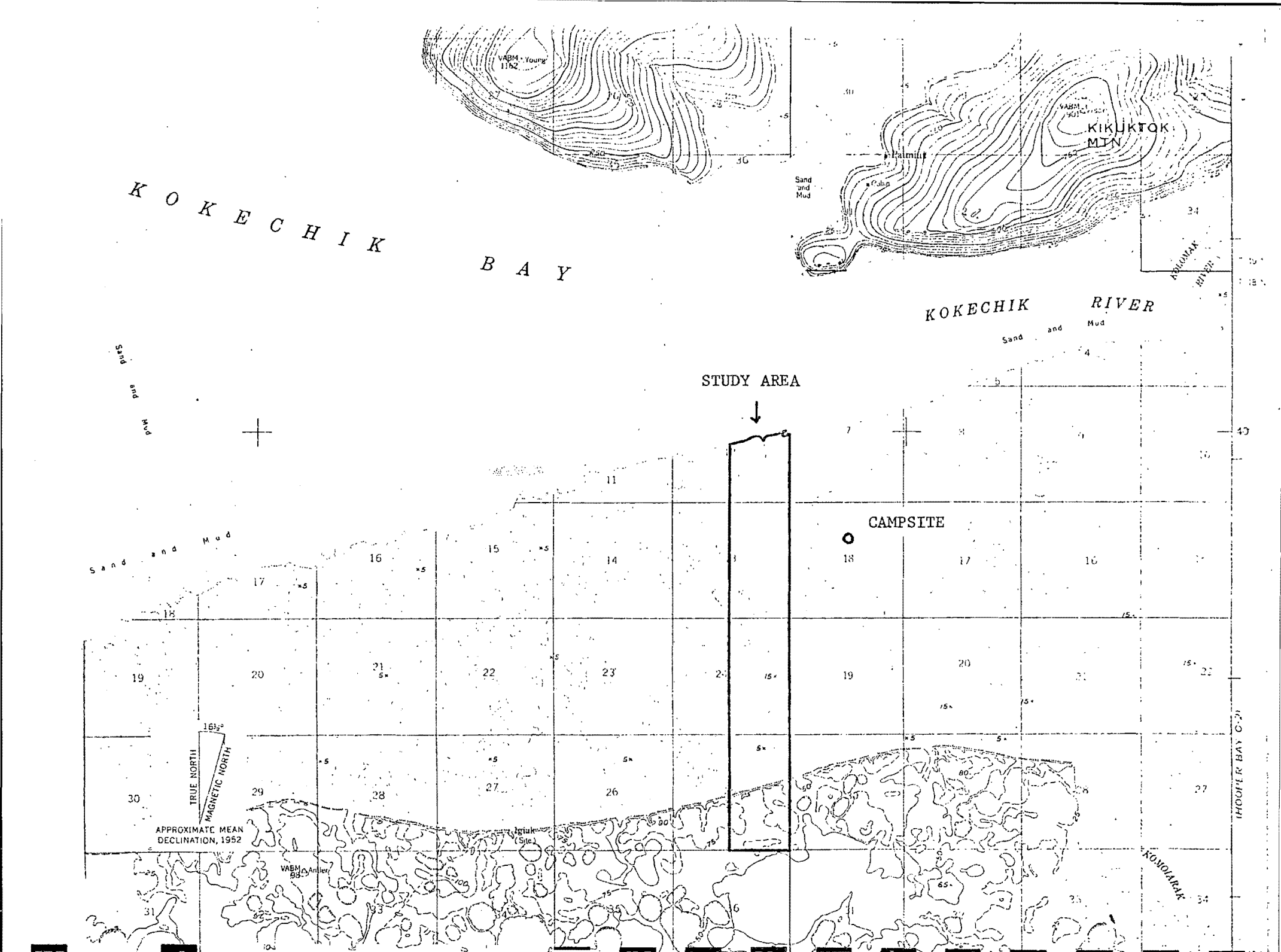

Arctic Ocean
USSR
Alaska
N
Yukon River
Kuskokwim River
Canada
Study Area
Bethel

Fig. 2. Location of Emperor Goose study area on north side of Kokechik Bay. Scale 1 inch = 1 mile.


KOKECHIK BAY
KOKECHIK RIVER
KIKUKTOK MTN
STUDY AREA
CAMPSITE
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1952
Sand and Mud
THOOLER BAY
KOMOIARAK

During the nesting season the vegetation in Section 12 is extremely low, exceeding 3 inches only along slough edges, where Elymus reaches 5 inches (Figs. 3 and 8).

Fig. 3. Southeast 1/4 of Section 12, Kokechik Bay study area. Shallow ponds are fed and drained by fingers of tidal sloughs. View toward Bering Sea to the west shows the unbroken relief of the vegetated flats.

The transition from simple vegetation in Section 12 to the more complex situation farther south is first seen in the scattered dwarf willows (Salix ovalifolia) and chickweeds (Stellaria spp.), which begin to appear approximately 1/2 mile from the coast. As one passes into Section 13, he begins to encounter primroses (Primula borealis and P. sibirica), stonecrop (Sedum roseum), abundant lovage (Ligusticum scoticum), northern flower-of-parnassus (Parnassia palustris), and more willows. The ground begins to rise above water level and the ponds take on a cookie-cutter appearance with abrupt banks 6-12 inches high. As few of these ponds are tidal, most remain water-filled, some reaching a depth of 3 or 4 feet. Storm tides insure the brackishness of the water, but the salt concentration is low enough that algae and pondweeds (Potamogeton spp.) can grow. Marestail (Hippurus tetraphyllum) becomes an important emmergent (Figs. 4 and 9).

The terrain assumes relief in the form of low mounds, called pingos, which are 1 to 2 feet high and 3 to 10 feet in diameter. Pingos are believed to be caused by subterranean lenses of ice, which push the earth above into mounds, evident by a maze of ice cracks on the surface of many pingos. These low scattered pingos are dryer than surrounding areas permitting invasion by lichens, mosses, black crowberry

(Empetrum nigrum), sweet coltsfoot (Petasites frigidus), timothy (Alopecuris alpinus), starflower (Trientalis europea), Rubus chamaemoris, and bluejoint (Calamagrostis canadensis).

Vegetation of Section 13 growing between pingos and ponds has a characteristic appearance. Covering most of the area is primarily a mixture of the vegetation in Section 12 (decreasing in importance as one moves south), willows and Ligusticum, with fairly abundant primroses, daisies, a short sedge (Carex saxatilis), and tall grasses (Calamagrostis canadensis, Poa eminens and Dupontia fischeri). Lower areas along pond edges support chickweed and tall sedges (Carex aquatilis and C. lyngbyei).

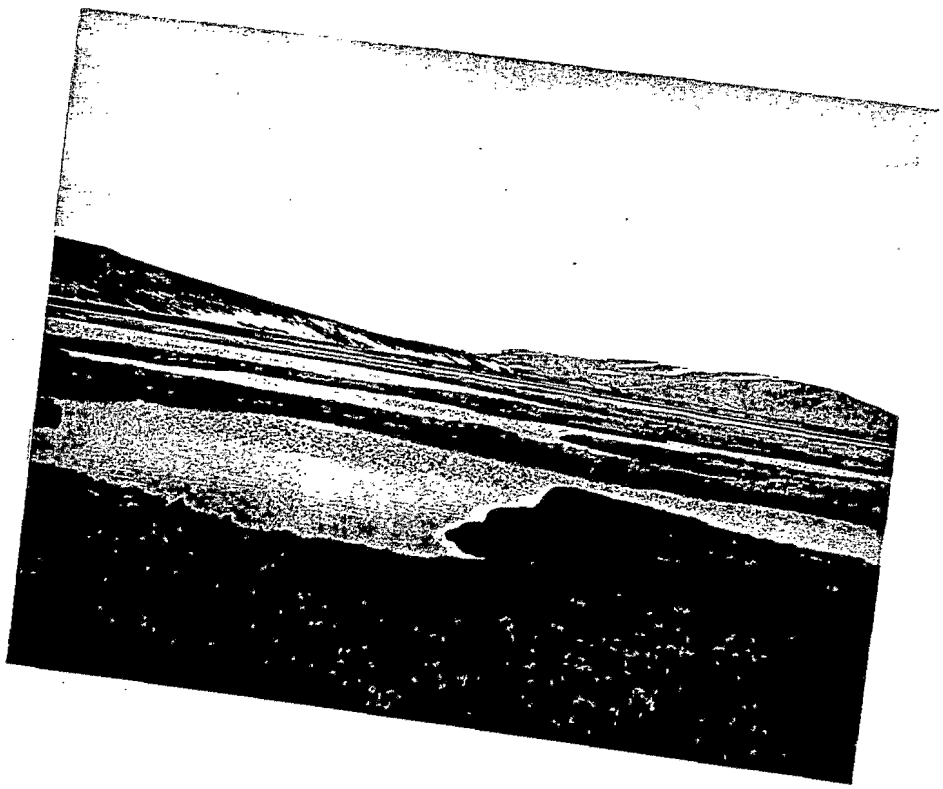


Fig. 4. Abrupt low banks outline lakelets of brackish water, often without interconnections or obvious tidal influence.

In the southeast part of Section 13, as well as the northeastern part of Section 24, large lakes and high pingos (up to 15 feet) cover most of the area. These pingos, as much as 75 yards across, are topped with upland tundra vegetation. Pingo sides are covered with tall grasses (Calamagrostis lapponica, C. canadensis and C. deschampsioides), Rubus chamaemoris and Petasites frigidus. Between the pingos are short Carex spp., chickweeds, and cinquefoils; wet areas are thickly covered with Carex aquatilis and/or C. lyngbyei. Potamogeton spp. and marestail remain the important aquatic species (Fig. 5 and 10).

Fig. 5. Emperor Goose nest on typical site in grass-sedge edge between pingos and intervening lowlands.

The southeastern quarter of Section 24 as well as the northeastern quarter of Section 25 is a very low, wet plain. At least half of this area is covered by large lakes exceeding 4 feet in depth. The bulk of the vegetation is simple in composition, indicating that it is in an early successional stage. In all of the area not in open water the dominant plant is Carex lyngbyei. This tall sedge appears to grow on a mat of Sphagnum. Scattered chickweed, bedstraw (Galium spp.), buttercup (Ranunculus hyperboreus), and marestail complete the basic plant components. Otherwise, the plain is broken here and there by small pingos averaging about 2 feet in height and 10 feet in diameter (Figs. 6 and 11). A more complete description of the vegetation found on this area appears in Table 1.

Fig. 6. Lakes at south end of study area (Section 25) in Carex lyngbyei plain. View is south toward bluff.

The most complex vegetation on the entire study area is found on the bluffs in the southeastern part of Section 25. An abrupt, 50-foot, bluff rises above the Carex lyngbyei plain. The high ground south of this bluff gradually descends to Hooper Bay, a few miles south of the study area. The Carex lyngbyei begins to give way, about 100 yards from the base of the bluff, to a very wet mat of Sphagnum and Potentilla palustris, and various sedges and grasses. Grasses, along with a dwarf willow, line the base of the bluff face. A myriad of plant species cover the bluff face as well as other steep slopes south of the face. The primary cover of the bluff face itself is a mosaic of 2-foot shrub willows (probably Salix pulchra), ferns, and lichens (Figs. 7 and 11). Other species are listed in Table 1. Steep hills behind the bluff contain fewer willows and lichens than the bluff itself, but more abundant grasses and other herbaceous flowering plants. The most typical species found abundantly on all of the interior hills is Geranium erianthum.

Fig. 7. Willow clumps and snow banks along north-facing slope of bluff in southeast 1/4 of Section 25. Wet Sphagnum mat at left and Carex lyngbyei plain in distance across the lake. View to northeast.

Snow remained in one depression in the bluff face through July 16. Vegetation on this spot was noticeably retarded in development, plants there flowering a full month behind those in areas which had thawed earlier.

The area south of the bluff face is primarily a rolling upland tundra broken occasionally by steep indentations which surround shallow lakes. Most of these lakes are intermittent, filling with melt and rain-water, and drying when there is little rain. Carex aquatilis, mosses, and grasses fill the lake bottoms, with scattered Eriophorum spp., Rumex arcticus, Cardamine pratensis (a white-flowered bittercress) and Viola langsdorffii. A few of the lakes and ponds are more permanent and are characterized by marestail (Hippuris vulgaris), bur-reed (Sparganium minimum) and a buttercup (Ranunculus pallasii). Water covers only 10 percent of the surface on top of the bluff.

The upland tundra vegetation is similar to that of the pingo tops to the north. The basic cover is a mat of lichens and mosses. The lichens form mounds 1 foot high and 1 foot across, covering about 75 percent of the area, with the mosses in the low ground between these mounds. Abundant flowering plants, in order of frequency are Carex spp., a procumbent willow (probably Salix arctica), labrador tea (Ledum decumbens), black crowberry (Empetrum nigrum), Rubus chamaemoris, and Betula nana.

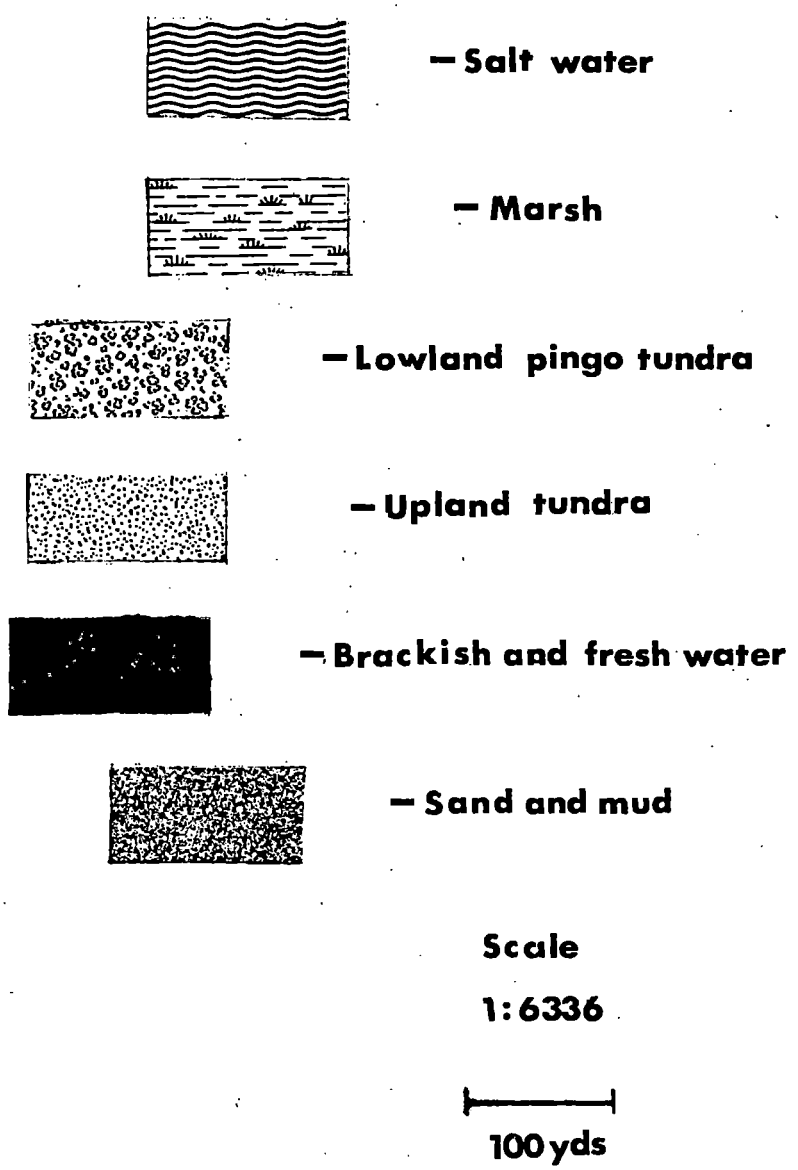


Fig. 8. Legend for vegetation maps of study area.

Fig. 9. East 1/2 of Section 12, Kokechik Bay study area.

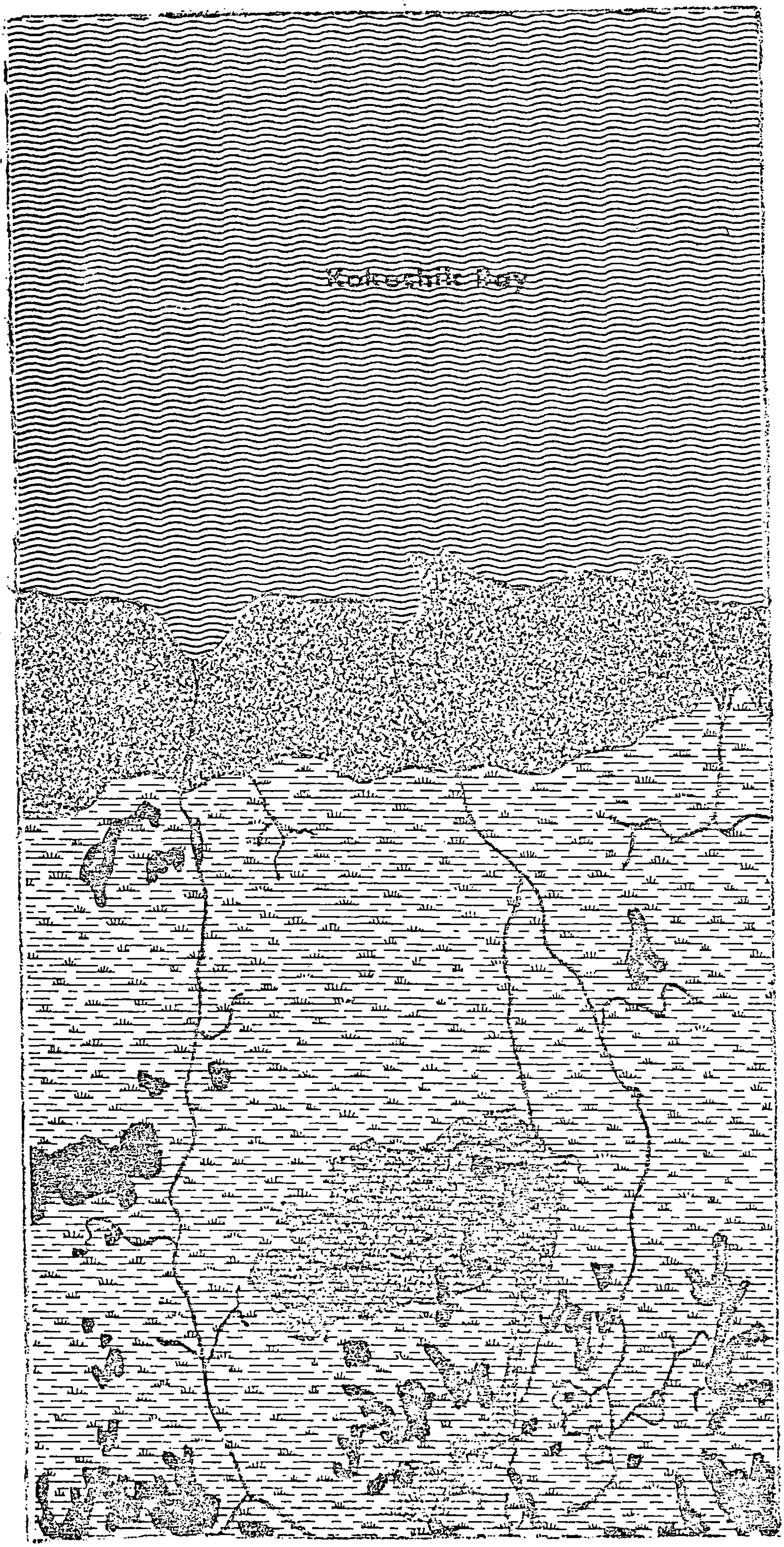

Kokechik Bay

Fig. 10. East 1/2 of Section 13, Kokechik Bay study area.

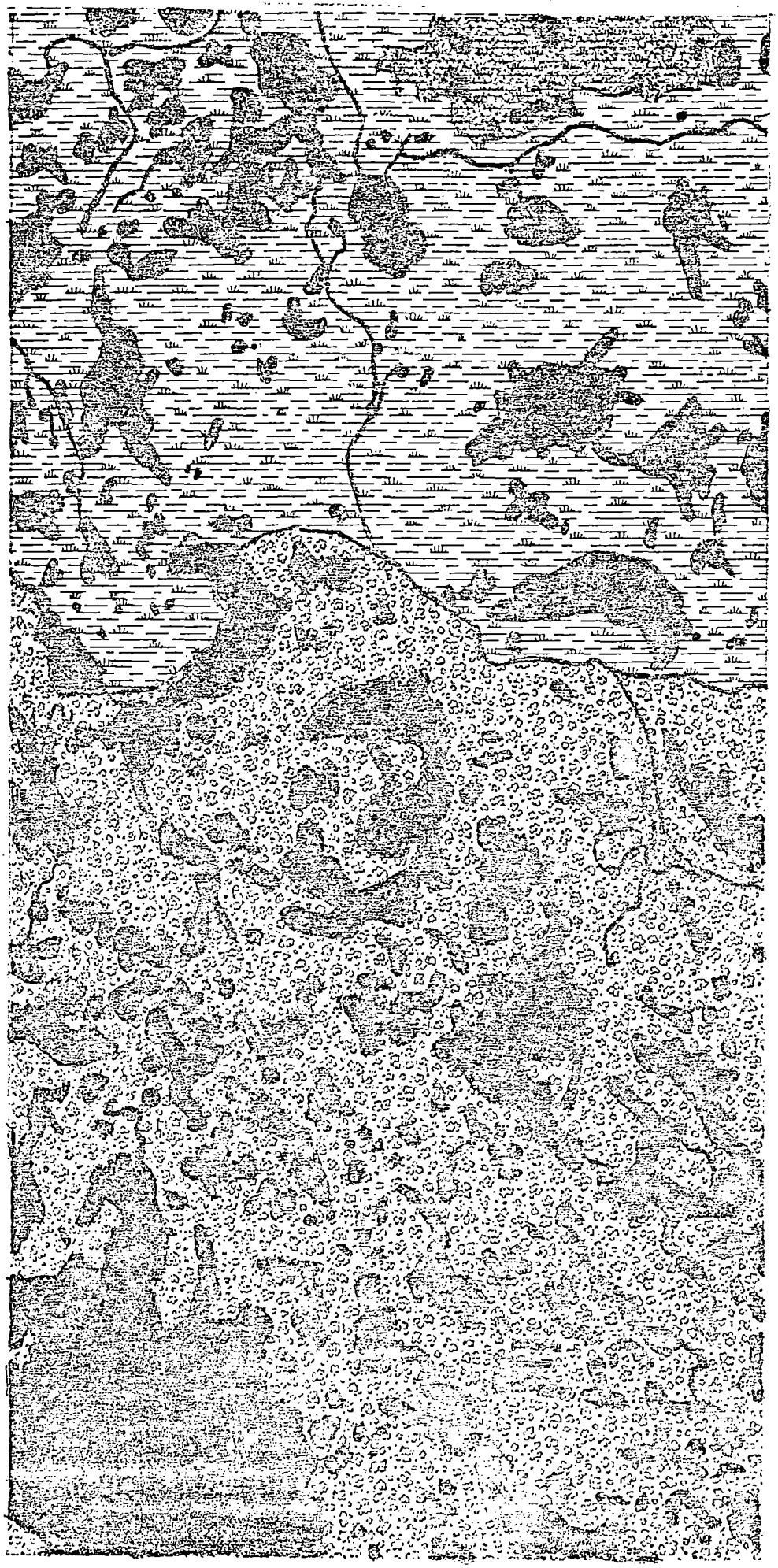


Fig. 11. East 1/2 of Section 24, Kokechick Bay study area.

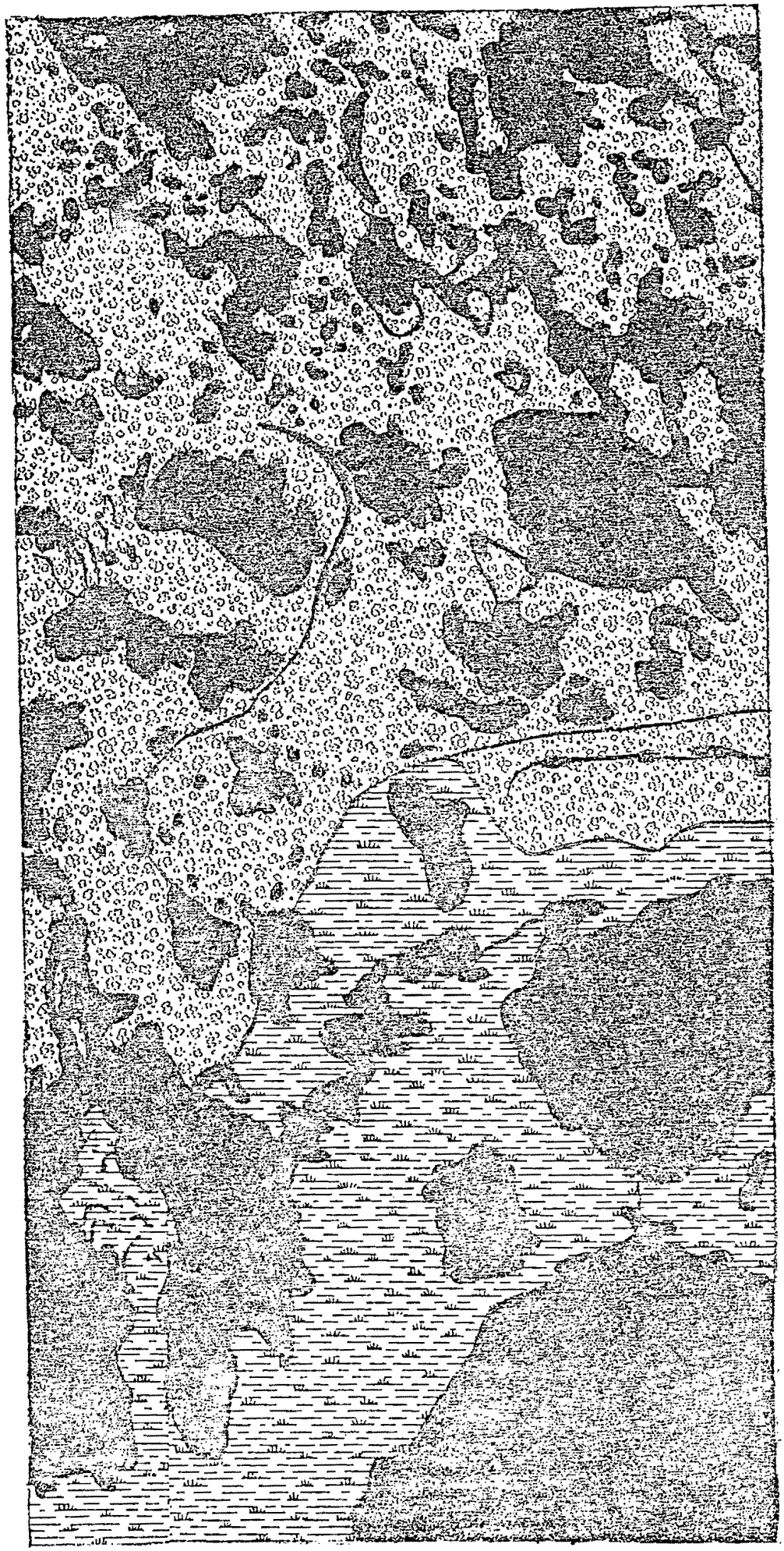
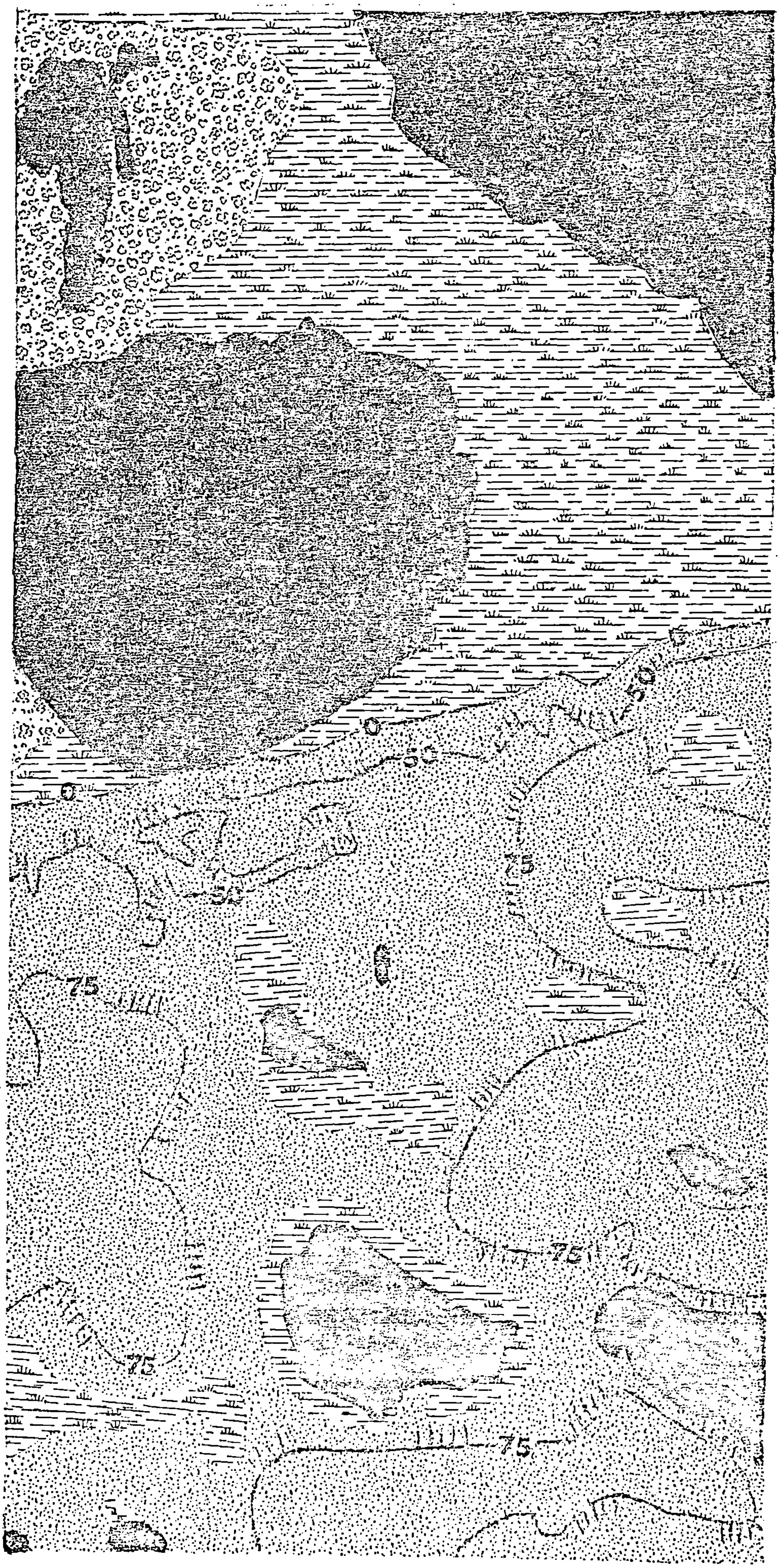


Fig. 12. East 1/2 of Section 25, Kokechik Bay study area.



50
0
50
0
75
75
75
75
75

Table 1. Estimated occurence of vegetation identified on Kokechik Bay study area in 1971.[1]

Family	and Species[2]	Tidal zone (Sec. 13)	Ponds (Sec. 13)	Low areas (Sec. 13)	Low pingos (Sec. 13)	High pingo tops (24)	Upland tundra (25)	Scattered low pingos in C. lyngbyei (24, 25)	Carex lyngbyei plain (Sec. 24 and 25)	Permanent tundra lakes (Sec. 25)	Intermittent tundra lakes (Sec. 25)	Base of bluffs (25)	Steep hillsides of bluff region (Sec. 25)
Lycopodiaceae	Lycopodium spp.					S	S						C
Equisetaceae	Equisetum arvense					S	S					C	D
Sparganiaceae	Sparganium minimum									V			
Potamogeton-aceae	Potamogeton spp.		V										
Juncaceae	Juncus filiformis									C			
	Luzula multiflora					S	S						S
Gramineae	Alopecuris alpinus			S	C								
	Calamagrostis canadensis	F		V	V			V					
	C. deschampsioides	S		C	S			S					
	D. lapponicus			S	C			C					V
	Dupontia fischeri	F		S									
	Elymus arenarius	M		C	S								
	Poa eminens	F		S									
Cyperaceae	Carex aquatilis		V						S	V	V		
	C. lyngbyei		S					C	M			S	
	C. rariflora	M	C	V	S								
	C. saxatilis			V	S								
	Eriophorum angustifolium			S	S						S	C	
	E. scheuchzeri			S	S					C	C	C	
Liliaceae	Veratrum album												F
Iridaceae	Iris setosa setosa												S
Salicaceae	Salix alaxensis					S	S						V
	S. arctica (?)					V	V						
	S. ovalifolia (?)	S		M	M						S		
	S. pulchra (?)					S	S						C
Betulacea	Betula nana					V	V						S
Polygonaceae	Polygonum viviparum												F
	Rumex arcticus			S	S			C			C	S	S
Halorrhagida-ceae	Hippuris tetraphyllum		V						C				
	H. vulgaris									V			
Rosaceae	Potentilla egedii	M		C									
	P. palustris											M	
	Rubus arcticus					S	S					S	C
	R. chamaemoris			S	V	V	V	S				S	C
	Spirea beauverdiana					F	F					C	V
Caryophylla-ceae	Stellaria spp.	S		S				C	S		S		

Table 1. Continued.

Family and Species	Tidal zone (Sec. 12)	Ponds (Sec. 13)	Low areas (Sec. 13)	Low pingos (Sec. 13)	High pingo tops (24)	Upland tundra (25)	Scattered low pingos in C. lyngbyei (24, 25)	Carex lyngbyei plain (Sec. 24 and 25)	Permanent tundra lakes (Sec. 25)	Intermittent tundra lakes (Sec. 25)	Base of bluffs (25)	Steep hillsides of bluff region (Sec. 25)
Portulacaceae Claytonia sarmentosa												S
Ranunculaceae Aconitum delphinifolium												F
Anemone narcissiflora												S
A. richardsonii											S	C
Caltha palustris												
Ranunculus hyperboreus				S								
R. lapponicus					S	S						F
R. pallasii									V			
R. reptans									S			
Cruciferae Barbarea orthoceras				S			V					S
Cardamine pratensis										C		S
Cochlearia officinalis							S					
Leguminosae Astragalus polaris				F								
A. unbellatus					F	F						F
Crassulaceae Sedum rosea			S	C			S				S	C
Saxifragaceae Chrysosplenium tetrandrum							C					
Parnassia palustris	S		V	S			S					
Geraniaceae Geranium erianthum												V
Violaceae Viola epipsila												S
V. langsdorffii										C		S
Cornaceae Cornus suecica												C
Umbelliferae Angelica lucida				C	F	F	C					S
Ligusticum scoticum			V	V	F	F	V					S
Empetraceae Empetrum nigrum			C	M	V	V	S				S	C
Ericaceae Arctostaphylos alpina				F	S	S						F
Ledum decumbens					V	V						F
Loiseleuria procumbens					F	F						
Phyllodoce coerulea					F	F						F
Vaccinium vitis-idaea				F	C	C						F
Primulaceae Primula borealis	S		C	S			S					
P. cuneifolia												S
P. sibirica			C	S			S					
Trientalis europea			S	C			V					S
Gentianaceae Gentiana glauca												S
Polemoniaceae Polemonium acutiflorum			F	C			V					S
Scrophulariaceae Pedicularis kanei			S	C								
P. labradorica					S	S						S
P. langsdorffii					S	S						S

Weather recording facilities on the study area were quite limited: a compass for determining wind direction and a Fahrenheit thermometer in a metal case, which hung in an exposed spot at the campsite. Since temperatures could only be recorded in the early morning and late evening (when we were at camp), our records did not indicate the true maximum and minimum temperatures. The values in Table 2 are those recorded at Old Chevak, where accurate maximum and minimum temperatures were recorded. Wind speed was estimated by walking with the wind at approximately 4 m.p.h. and comparing this with the windspeed.

The Bering Sea is overwhelmingly the major determinant of climate in the region. Moist air from the Bering Sea produced rain or fog on 27 of the 47 days we were present on the study area. Eight of the remaining 20 days had cloud cover of 80 percent or more. The sea's influence is evident in the low variation in daily temperature.

Most heavy fog occurred early in the season, when the ground was frozen to within 1 1/2 feet of the surface. Relatively warm, moist air coming off the sea would strike the colder coastal region resulting in condensation of the moisture into thick fog. As the frost line dropped to the permafrost level (2-3 feet below ground at the campsite), the difference in temperature between the ground and the air diminished. The same general sequence continued, however, with the prevailing northwest or southwest winds resulting in rain or heavy cloud cover. Clouds usually formed just west of the study area but rarely moved inland. This resulted in frequent but rather light rain.

Sound interpretations of the weather, as well as its effects on the Emperor Goose, cannot be made until data are collected for several seasons and compared. Some observations were made, however, which will be investigated more closely in the seasons to come. The two most critical periods seem to be early spring and the time of hatching.

How early or late the thaw occurs is undoubtably the major factor controlling nesting of the Emperor Goose. Ryder (1967) found Ross' Geese using exposed sub-optimal nest sites when optimal sites were snow-covered. Lack (1933) postulated that a major difference in breeding time could only be correlated clearly with the suitability of the ground for nesting. Data from abnormal and normal nesting seasons for Emperor Geese may bear out these observations.

In 1971, hatching reached a peak on July 4 when relatively mild weather prevailed. Less favorable weather during this period could have increased the mortality of newly hatched goslings. Female Emperors are very attentive during late incubation, which probably helps to keep gosling mortality to a minimum.

Fog did not seem to impede the major activities of Emperor Geese. A flock of 100 Emperors was observed feeding on Carex rariflora during the foggiest night of the summer (June 26-27). They were at the coast, a mile away from the heaviest concentration of nests. Flight calls of Emperors were not heard nearly as often in fog as on clear days; however, the number of flights may have dropped when visibility was poor.

Wind on the study area had at least one beneficial effect. When it blew, insects were forced to the ground or water. At such times most of the avian residents, including Emperor goslings, feasted on this easily obtainable food supply.

Table 2. Kokechik Bay weather data for 1971.[1]

Date	Temperature (°F) Max.	Min.	Diff.	Wind Direction and Speed (m.p.h.)	Sky Conditions
June					
15	43	41	2	----	------
16	45	41	4	----	------
17	46	38	8	----	overcast, light drizzle
18	46	33	13	----	cloudy, intermittent rain
19	46	38	8	S-7	clear, sunny
20	48	36	12	----	------
21	64	42	22	NE-10	cloudy, light rain
22	64	48	17	NE-2	light clouds, sunny
23	54	47	7	calm	sunny
24	65	46	19	calm	partly cloudy
25	46	44	2	NW-17	low overcast, fog
26	52	41	11	NW-10	low overcast, fog
27	42	40	2	NW-15	very foggy
28	43	42	1	W-10	low overcast, fog
29	--	29	--	W-13	low overcast
30	54	40	14	W-12	overcast
Monthly mean = 45.5					
July					
1	50	47	3	W-7	cloudy, fog
2	64	47	17	W-8	clear
3[2]	65	47	18	E-4	clear
4	63	45	18	NW-3	sunny, light clouds
5[2]	60	56	4	W-6	clear
6[2]	55	47	8	S-8	overcast, rain
7	--	--	--	S-5	overcast, rain
8	54	46	8	E-7	heavy cloud cover
9	56	--	--	ESE-7	heavy cloud cover
10	49	45	4	S-10	overcast
11[2]	48	46	2	SW-25	rain and fog
12	42	42	0	SE-17	overcast, rain
13	42	42	0	W-10	overcast, rain
14	48	39	9	S-7	heavy cloud cover
15	47	41	6	calm	overcast, light rain
16[2]	50	41	9	calm	overcast, rain
17	51	38	13	----	----
18	58	50	8	----	----
19	65	49	16	----	----
20	45	44	1	----	----
21	41	39	2	----	----
22	51	45	6	E-17	overcast, rain
23	46	44	2	E-8	sunny with occ. showers
24	54	44	10	E-7	overcast, showers
25	56	46	10	SSW-5	light cloud cover
26	52	42	10	W-8	light cloud cover
27[2]	45	45	0	W-5	overcast, light rain

Table 2. Continued.

Date	Temperature (°F) Max.	Min.	Diff.	Wind Direction and Speed (m.p.h.)	Sky Conditions
July					
28	54	40	14	S-5	heavy overcast
29	56	40	16	E-5	light cloud cover
30	55	49	6	NW-6	overcast
31	55	50	5	N-3	heavy cloud cover
Monthly mean = 48.5					
August					
1	56	43	13	NW-7	light cloud cover
2[2]	44	43	1	W-3	overcast
3	49	42	7	W-7	overcast
4	52	44	8	E-4	overcast, light drizzle
5	56	51	5	E-2	overcast, light drizzle
6	57	50	7	SE-2	overcast
7[2]	54	50	4	NE-5	heavy cloud cover
8	53	50	3	----	----
9	50	48	2	----	----
Monthly mean = 49.5[3]					

1. Temperature data taken from records maintained at Old Chevak field station about 20 miles southeast of Kokechik Bay study area. Other data recorded on study area.

2 Indicates date on which the maximum temperature on the study area varied more than 5 degrees from those recorded at Old Chevak.

3 It is probable that the monthly mean for August would be higher than indicated if more dates where available for inclusion in the mean.

Fauna

In 1971, 41 avian and 2 mammalian species were observed on the study area. We were not present early enough in the season to make accurate phenological observations for many species. The commonest avian species was the Dunlin (Erolea alpina) while the rarest was a Redhead (Aythya americana) seen on July 4. Only one Arctic fox (Alopex lagopus) was observed. The low number of foxes is attributed to a scarcity of small mammals, principally lemmings and voles. The most commonly seen mammal in the region was the Muskrat (Ondatra zibethica). Signs indicated the presence of some lemmings, but the genera represented are unknown by the authors.

Status of all species observed on the study area are presented in Table 3.

Table 3. Status of fauna observed on Kokechik Bay study area, 1971

Common Name	Tidal Zone	Lowland Tundra	Upland Tundra
Arctic Loon	3*	2	4
Red-throated Loon	3	2	4
Whistling Swan	4	3	4
Cackling Goose	2	1	5
Black Brant	1	3	5
Emperor Goose	2	1	5
White-fronted Goose	3	3	4
Mallard	3	3	5
Pintail	1	1	3
Shoveler	4	4	5
Green-winged Teal	5	2	5
Greater Scaup	3	2	5
Common Goldeneye	5	4	5
Common Eider	3	4	4
Spectacled Eider	3	2	5
Oldsquaw	2	1	4
Red-breasted Merganser	3	4	4
Willow Ptarmigan	5	2	3
Black-bellied Plover	5	3	3
Bar-tailed Godwit	3	2	4
Long-billed Dowitcher	4	5	5
Ruddy Turnstone	2	3	5
Black Turnstone	1	2	4

Table 3. Continued.

Common Name	Tidal Zone	Lowland Tundra	Upland Tundra
Dunlin	1	2	4
Western Sandpiper	1	2	4
Red Phalarope	2	2	5
Northern Phalarope	1	1	4
Common Snipe	4	3	4
Parasitic Jaeger	3	2	3
Long-tailed Jaeger	3	3	3
Glaucous Gull	1	1	5
Mew Gull	3	3	4
Sabine's Gull	1	1	4
Arttic Tern	1	1	4
Arctic Warbler	4	4	3
Yellow Wagtail	4	4	3
Savannah Sparrow	1	1	2
Lapland Longspur	2	1	2
Redhead	6	6	6
Spotted Sandpiper	6	6	6
Bristle-thigned Curlew	6	5	6
Arctic Fox	3	3	3
Muskrat	3	2	5

* Number symbols of observed status.

1. Abundant
2. Common
3. Uncommon
4. Rare
5. Very rare
6. Accidental

PROCEDURES

Nesting Study

After a 2-day reconnaissance of the breeding grounds, a study area was selected that had a large number of Emperor Goose nests, contained all habitat types previously recognized, and was close to the campsite. The eastern boundary of the area (Fig. 2) was marked with small numbered flags set approximately 100 yards apart. From each boundary flag, by using a compass, we extended a line of flags westward, again at 100-yard intervals. This divided the area into 100-yard x 1/2-mile strips. We searched for nests by walking in a zig-zag pattern between adjacent rows of markers. In this way no area large enough to conceal a nest was missed and we located nearly 100 percent of the active nests on the study area.

Early nests were easily found, but as vegetation increased in height the search had to be made carefully. Nests were usually located when incubating females were seen or flushed at the nest site, or we found the eggs or nest structure, often poorly concealed by sparse cover. As each nest was discovered, its location was noted in relation to the nearest flag marker and complete data were recorded in field notebooks for later transfer to a nest record form. A numbered, hospital tongue depressor was placed near the nest for positive identification of the nest at later inspections. Records were kept of all nests found of all other species.

An estimation of initiation and hatching date for each clutch was made by the method developed for pheasants by Westerskov (1950). This consists of placing the eggs in water deep enough to cover them and noting their relative displacement and position assumed in the water. We relied on the relationship between displacement and number of days incubated as determined for Emperor Geese by Headley (1967). No egg laying rate could be found for Emperor Geese, so we used the average of 1.5 eggs/day found for Ross' Geese (Ryder, 1967), large Canada Geese (Kossack, 1950), Black Brant, and White-fronted Geese (Lack, 1968). All eggs that were not pipping or soft-shelled were measured with Vernier calipers and numbered with a soft pensil or Rapidograph pen. After examination, all nests were covered with vegetation and down to reduce the chance of predation. When possible, each nest was revisited at least once during the nesting season to determine whether the clutch was successful or unsuccessful in hatching. In case of destroyed nests, it was sometimes impossible to determine if they had been deserted before destruction.

Successful nests were identified on the basis of nest appearance and particularly membrane and shell appearance. Membranes discolored and separated from shell fragments indicate successful nests. An egg broken before hatching shows membrane adhering tightly to the shell.

By the latter part of July, it became apparent that the marker flags would not last over winter. For more permanent markers, numbered, split shingles were forced into the ground about 10 yards west of each nest site.

Habitat Analysis

Maps of the study area were made by tracing from aerial photographs. If features had changed significantly since the time of the photographs, the changes as seen from the ground were drawn in freehand. A floral analysis started in 1971 will be continued in 1972. Specimens of all plant species encountered will be

preserved for identification if that is not possible in the field. In 1971, 86 species in 36 families were identified (Table 1).

Water samples were taken at irregular intervals throughout the study area. The analysis of these for major elements and salinity will follow as a supplement to this report. Likewise, samples of goose nest materials were gathered, and these will be identified and reported later.

Brood Counts

Two brood counts were conducted on the Kokechik and Kolomak Rivers from the surface, and two aerial surveys of the same area were made with the Cessna 180 of the U. S. Bureau of Sport Fisheries and Wildlife. Age class determination for goslings followed the method, developed by Gollop and Marshall (1954), based on plumage characteristics of known-age Canada Goose goslings.

RESULTS

Nesting

Chronology

According to Headley (1967), Emperor Geese begin incubation well before the end of May during seasons of early break-up. He determined that approximately 10 percent of the Emperor Goose nests were initiated furing late May in 1966. In 1971, 25 percent of the nests had started during the same period (Table 4) indicating a somewhat earlier season. Of the Emperor Goose nests discovered during 1971, 85 percent were started before June 10. By the same date, 86 percent of the Cackling Goose (Branta canadensis minima) nests and 98 percent of the Black [illegible] (Branta nigricans) nests had started (Appendix 2). The average date of first eggs for all Emperor Goose nests was one day earlier in 1971 (June 4) than in 1966 (Headley, 1967).

Start of the nesting season for the population as a whole was arbitrarily designated as that estimated time at which the first egg was laid. The date of laying of the first egg can be estimated, if clutch size, the rate of laying, incubation period, and stage of incubation are known.

Length of Season

Klopman (1958) stated that the two most important factors determining the length of the nesting season were destruction of early nests and late renesting. The nesting season for Emperor Geese in 1971 lasted approximately 54 days. No renesting was observed and it is generally agreed that this phenomenon is extremely rare in Arctic nesting geese. We could not determine the influence, on length of season, of nest destruction that occurred on the study area before our arrival.

Habitat

In 1971, 63 percent of the Emperor Goose nests at Kokechik Bay occurred in lowland pingo tundra. Nearly 100 percent of the Cackling Geese nested in this same habitat, while less than 1 percent of the nests discovered were Black Brant.

Black Brant prefer tidal grasslands for nesting sites. The habitat used most frequently by Emperor Geese for nesting consists primarily of a mixture of grasses and low tundra vegetation. The dominant grass surrounding the nests was Calamagrostis spp. The second most important plant was Empetrum nigrum.

Table 4. Calculated dates for start of egg laying by Emperor Geese in 1971.

Date[1]	Number of Nests
May 22-24	1
25-27	3
28-30	9
31-June 2	11
June 3-5	19
6-8	13
9-11	5
12-14	5
15-17	2
Total	682

1 Start of egg laying = number of eggs (X) egg laying rate (1.5 days/egg) (+) number of days incubated (after Westerskov, 1950). The total number of days calculated from above formula is then counted back from date nest was found.

2 No nests were found in the pre-incubation stage in 1971. The incubation period (24 days) used to calculate start of egg laying in this table was determined by Headley, 1967.

Density

For Ross' Goose, two factors that determine the density of nests in a given region are sufficient protection from the elements and ample space for grazing. Moss and grass must be present (Ryder, 1967). These requirements seem applicable to Emperor Geese nesting at Kokechik Bay. Highest density of nests is found in the lowland pingo tundra (Table 5), which offers the best protection from the elements and an abundance of moss and grass. Although the tidal grassland has a good supply of grass, it offers little protection from the elements, and the density there of Emperor Goose nests is low.

Only a small part of the Yukon-Kuskokwim Delta is used by nesting geese and brant (Headley, 1967). Spencer (1949) observed that Emperor Geese comprised an average of 5.3 percent of the breeding waterfowl on the Delta. Emperor Geese comprise 45 percent of the breeding waterfowl on the study area in 1971 and are probably the most abundant nester in the Kokechik Bay region (Appendix 1).

Williams and Hochbaum (in Klopman, 1958) suggest that each breeding unit evolves a pair distance that is specific to the nesting colony. Klopman (1958) objected because he felt this precluded any variation in year-to-year density within the colony. Klopman suggested that these differences, omitting differences in breeding-population size, could be a function of habitat, i.e., "each habitat offers a different number and distribution of nesting niches". He determined that the pattern of nesting among Branta canadensis interior did not expand outward from an initial focal point, i.e., the "nearest-neighbor" distance decreased as the number of nests increased. This pattern of nesting may be true for Emperor Geese at Kokechik Bay (Table 5) and may indicate that some type of social interaction is taking place.

Table 5. Comparison between the mean nearest-neighbor distances and nesting densities of Emperor Geese in the major habitat types common to the Kokechik Bay region.

Number of Nests	Habitat Type	Mean Nearest-neighbor Distance (in feet)	Nest Density (per acre)
22	Carex lyngbyei march	403 (50-663)[1]	.075
37	Tidal grassland	315 (95-925)	.125
93	Lowland pingo tundra	195 (25-650)	.299
0	Upland tundra	---	---
152	Total	Aug. 304	Aug. .166

1 Range.

Characteristics of Nesting Site

A majority of the Emperor Goose nests studied were located on elevated shorelines, 78 percent being less than 30 feet from water. Water bodies near the nest sites averaged 85 feet in diameter. We believe a definite selection exists, for nests sites near water but this is hard to prove as all available nesting terrain is situated near water. Williams and Sooter (1940) observed a relationship between site location and proximity of water in Canada Geese. Klopman (1958) observed that "nest sites near water offer better visibility for gander and incubating goose than do sites situated elsewhere. They also provide the young,

particularly, with a quick escape from mammalian predators, and afford immediate access to a food source (in some areas) and to bathing".

Nearly all nest sites discovered were elevated above the surrounding terrain. Elevated sites offer the incubating female a clearer view of the surroundings and some protection against predation. This supposition is borne out by the fact that no adult females were found killed on the nest by a predator. A number of investigators have stressed visibility at the nest site as a requirement for nesting (Steel et al., 1957; Dow, 1943; Koesack, 1950; Miller and Collins, 1953; Williams and Sooter, 1940; Williams and Marshall, 1937; Naylor, 1953). At Kokechik Bay the most successful nests were located on pingo mounds, which offer best visibility. Poorest visibility existed on elevated shorelines where nests had the lowest nesting success (Table 6).

At Kokechik Bay many nest sites were found which had been used during previous years. One site had been used for 4 years, at least 3 by Emperor Geese.

Only one White-fronted Goose (Anser albifrons) nest was found on the study area in 1971. This nest site was typical of those preferred by Emperor Geese. It is possible that White-fronted Geese are not numerous on the study area because of active competition for nest sites with Emperor Geese. Whitefronts nest scatteringly, also contributing to their low numbers on the relatively small study area. Cackling Geese prefer islands for nesting, possibly because they are too small to defend against foxes. Ryder (1967) found that Arctic Foxes did not harass Ross' Geese when nesting was confined to islands.

Table 6. Nesting success of Emperor Geese in relation to nest location.

Nest Location	Successful Nests	Unsuccessful Nests	Percent Successful
Peninsula	12	3	75
Elevated shoreline	54	16	68
Top of pingo mound	33	6	88
Side of pingo mound	12	1	92
Marsh hummock	13	2	85
Islet	--	--	--
Total	124	28	82

Dimensions of Emperor Goose nests in relation to habitat type are presented in Table 7. There appears to be no significant difference in inside diameters of nests among the various habitat types. The average outer diameter of those nests built in the lowland pingo tundra is much less than that for other types. This difference may reflect the greater sample size from this area. The thicker nests built in lowland pingo tundra may be influenced by the greater effects of wind on this area. Most nests located in lowland pingo tundra are built on tops and sides of pingo mounds, which rise 5 to 10 feet above the terrain. With this increase in elevation, effects of wind and driving rain would be felt much more than in flat habitats.

The average depth of nest cup was less in those nests built in the tidal grassland, which may suggest an adaptation for keeping eggs dry under conditions of increased moisture in this area.

Table 7. Dimensions of Emperor Goose nests in relation to habitat types (measurements in millimeters).

	Tidal Grassland	Lowland Pingo Tundra	Carex lyngbyei Marsh
Inside diameter	171.5(13)[1]	152.3(44)	163.3(9)
Range	125-210	85-210	125-210
Outside diameter	249.5(8)	170.6(26)	231.2(4)
Range	175-410	135-325	200-265
Thickness of nest wall	92.0(5)	104.0(25)	81.2(4)
Range	50-125	30-200	30-110
Depth of cup	71.0(12)	85.3(43)	83.5(4)
Range	48-100	33-115	60-125

1 Sample size.

Headley (1967) stated, "unlike black brant, emperor geese are not gregarious nesters, but several pairs may nest in close proximity to each other." We agree that the Emperor Goose is not a gregarious nester, but some gregarious habits are certainly not alien to it. On the study area in 1971, eleven instances were recorded in which nests were less than 50 feet apart. The greatest "nearest-neighbor" distance recorded in 1971 was 925 feet.

Emperor and Cackling Geese exhibit tolerance towards each other but the authors do not know what interactions exist between Black Brant and Emperor Geese. During an examination of one Emperor Goose nest, the flushed goose wandered over to an incubating Cackling Goose less than 30 yards away. Even though the female Emperor was less than a foot away, the female Cackling gave no indication of annoyance.

Incubation

Egg Characteristics

Headley (1967) observed that distinquishing the eggs of Emperor Geese from those of Cackling Geese and Whitefronts was difficult. Although this observation is true, to a certain extent, it is not impossible to separate eggs of these species. Emperor Goose eggs have a grainy texture while all others are smooth. By learning to distinquish the various types of down and feathers associated with each species' nest, we found it easy to separate Emperor eggs from all other species. It is impossible to separate the eggs of Emperor Geese, Cackling Geese, and Black Brant by size alone (Table 8).

Bent (1962) found the mean size of 109 Whitefront eggs to be 79.0 x 52.5 mm. Headley (1967) determined the dimensions for 138 Emperor Eggs. All of his measurements differ from ours but this discrepancy attests to our larger sample size.

Table 8. Dimensions of goose and brant eggs measured at Kokechik Bay, 1971 (measurements in millimeters).

	Emperor Goose	Cackling Goose	Black Brant
Sample Size	160	114	88
Mean egg size	79.9 x 52.1	73.8 x 48.0	69.7 x 43.2
Longest egg	86.0 x 55.5	79.8 x 49.1	77.4 x 45.2
Shortest egg	70.7 x 50.2	63.0 x 45.5	64.9 x 45.3
Widest egg	80.7 x 56.1	75.4 x 52.3	68.1 x 57.5
Narrowest egg	74.8 x 47.9	64.2 x 43.4	66.4 x 43.1

During the first few days after an Emperor Goose egg is laid it is pure white. As incubation continues, the egg becomes stained until it is a dull buffy brown with numerous streaks of dark brown.

The average weight of 18 Emperor eggs was 115.5 gm. (95-160). Ten Cackling Goose eggs had an average weight of 79.3 gms. (68-90). These samples are too small to determine species accurately by egg weights alone. During the 1972 field season more eggs will be weighed to enlarge the sample size for this part of the study.

Clutch Size

The modal clutch size for Emperor Geese nesting at Kokechik Bay in 1971 was 4 and the mean was 4.16 (Table 9). Mean clutch size of 106 nests examined off the study area was 5.07 as compared to 4.16 for 131 nests located on the study area itself. The authors believe this discrepancy followed because of their disturbance of nests on the study area leading to a larger loss of eggs to predation. During the 1972 field season, 4 plots will be set up near the study area to investigate the effect of human disturbance on clutch size and nesting success. By varying the number of visitations to each plot, it may be possible to learn what effect human disturbance has on productivity.

Ryder (1967) observed that clutch sizes tend to be smaller in response to late seasons or as a result of heavy predation at the beginning of the nesting season. Since we were not present during the early incubation stage, we have no data for predation that occurred during this period. However, it was obvious that early nest predation had occurred on Black Brant.

By relating clutch size to the date when the first egg was laid, it was determined that the later clutches started in the season the fewer eggs they had (Table 10). This is a definite advantage to the nesting female when one considers the short period in which she has to raise her brood to fledging stage. Ryder (1967) determined that the nesting cycle in Ross' Geese could be shortened as much as a week by a smaller clutch.

The relation between clutch size and nest location is presented in Table 11. Although there appears to be no significant difference between clutch sizes, it should be noted that the highest clutch sizes were recorded in areas which offered the most protection, i.e., pingo mounds and marsh hummocks (Table 6).

Incubation Period

The incubation period for Emperor Geese has been calculated to be 24 days (Headley, 1967; Dement'ev and Gladkov, 1952).

Behavior

Headley (1967) stated, "no nesting territories appear to be established by emperor geese". Tugarinov (1941) observed male Emperor Geese driving off not only strange males but all other avian intruders approaching the female. Tugarinov's observations were made before incubation had begun and he does not mention any behavior, indicative of territoriality, after this period.

Table 9. Clutch size observations of Emperor Goose, Yukon-Kuskokwim Delta, Alaska

Year	Location	Clutch Size Frequency[1] 1	2	3	4	5	6	7	8	9	10	Total Nests	Total Eggs	Average Clutch Size
1963	Kokechik Bay[2]		2	3	2	3		3				13	57	4.38
1964	Clarence Rhode N.W.R.[3] North Unit			1	4	6						111	49	4.45
1965	Kashunuk River[3]			4		1	1					6	23	3.83
1966	Kokechik Bay[4]			2	6	7	7	1	5			28	154	5.50
	Baird Inlet[5]					3	1		1			5	29	5.80
	Kashunuk River[5]				4	6	1		1			12	60	5.00
1967	Clarence Rhode N.W.R.[3] North Unit		2	3	6	10	3	1				25	112	4.48
1968	Clarence Rhode N.W.R.[3] North Unit	1		3	5	7	4	4		1		25	126	5.04
1969	Clarence Rhode N.W.R.[3] North Unit	1	3	15	16	31	24	8			1	99	481	4.86
1970	Clarence Rhode N.W.R.[3] North Unit		1	4	5	10	3	2		1		26	125	4.81
1971	Kokechik Bay study area	5	16	21	36	27	19	4	3			131	545	4.16
	Kokechik Bay, off Study Area	4	2	21	12	26	18	12	5	3	3	106	538	5.07
Overall Average Clutch Size														4.78

Table 9. Continued.

1 Data include clutches examined during incubation, but as predation losses may not be obvious, the actual number of eggs laid may be higher than totals indicate.

2 Alaska Nest Record Scheme, University of Alaska, College, Alaska. From Headley (1967.

3 Annual reports, Clarence Rhode National Wildlife Range, Bethel, Alaska.

4 Headley (1967).

5 Dr. Calvin J. Lensink, U. S. Fish and Wildlife Service, Bethel, Alaska; tabulated in Headley (1967).

Table 10. Size of 67 clutches of Emperor Geese in relation to laying date of first egg.

Laying Date of First Egg	Mean Clutch Size
May 22–May 24	8.00
May 25–May 27	7.25
May 28–May 30	6.22
May 31–June 2	5.45
June 3–June 5	4.57
June 6–June 8	3.92
June 9–June 11	3.00
June 12–June 14	3.00
June 15–June 17	3.00

Table 11. Clutch size of Emperor Geese in relation to nest location.

Nest Location	Clutch Size Frequency								Totals		
	1	2	3	4	5	6	7	8	Eggs	Nests	Average Clutch
Peninsula		1	1	4	1	2			38	9	4.22
Elevated shoreline	1	7	11	7	12	4	1	2	183	45	4.07
Islet									0	0	0.00
Top of pingo mound		2	3		5	5			68	15	4.53
Side of pingo mound				3	2	1		1	36	7	5.15
Marsh hummock			1	1		1			13	3	4.34
Totals									338	79	

In several instances the authors have observed Emperor Geese, as well as Cacklers, passing in close proximity to occupied nests without any apparent hostility towards the transients. Both adults spent most of the day at the nest site, females incubating while males stand or feed nearby. Periodically the male leaves the nest site but returns immediately if the female is disturbed.

The authors believe that only the female incubates. When approached, the female presses close to the ground with neck stretched forward or slightly to one side. In areas of dense vegetation, she is extremely difficult to locate, her head and neck closely resembling a piece of driftwood. Undisturbed females, when leaving the nest, generally cover the clutch by pulling down and vegetation over it.

It is possible to approach to within 3 feet of the nest before the female flushes. Flushing distance is influenced by weather, caution of the observer, and stage of incubation. After the female flushes, she bends close to the ground with head and neck outstretched, and usually heads for the nearest body of water. There she parades back and forth, occasionally nibbling at vegetation. About 45 minutes later, she returns, immediately turns the eggs with her bill, squats on the nest and resumes the normal incubation posture.

The male of the pair is frequently in attendance at the nest site. When much disturbed, the pair moves a short distance form the nest, takes flight, and goes out of sight. Twenty to 30 minutes later they return, alight several hundred yards from the nest, and gradually walk back to it.

During the late incubation stage, both sexes are extremely attentive and reluctant to leave the nest site. Actual defense of the nest was observed twice. One of these observations involved a female nesting within 100 feet of the campsite. She did not flush even through I (DIE) approached to within 1 foot of her nest. When I reached out to move her off the nest, she reared up, spread her wings and began hissing at me. When I backed off she settled back down on her eggs. The second case of defense was not as elaborate and the female immediately withdrew when I reached out to touch her goslings. Perhaps the female near camp had become so used to our presence that she did not display a normal behavior pattern.

Hatching Period

Pipping of Emperor eggs was first observed on June 30. First pipping of Black Brant and Cackler eggs was observed on June 26 and July 2, respectively. The hatching period for Emperors extended from June 28 to July 15, with a modal hatching date of July 5 (Table 12).

Emperor goslings are totally helpless until dry. They dry quickly and are capable of leaving the nest a few hours after hatching when both adults take the goslings to water. If approached, one of the pair, usually the male, flys off while the other leads the goslings away from the observer. In a few instances, adults with young were observed adopting abandoned goslings that were unable to keep up with their real parents. Emperor goslings take readily to water and sometimes dive if harassed by predators.

Table 12. Chronological frequency of hatching in Emperor Geese, 1971.

Date	Number Eggs Hatched	Percent Eggs Hatched	Cumulative Percent Hatched
June 28	10	2.95	2.95
29	0	—	2.95
30	0	—	2.95
July 1	39	11.50	14.45
2	52	15.34	29.79
3	39	11.50	41.29
4	8	2.36	43.65
5	36	10.62	54.27
6	38	11.22	65.49
7	30	8.85	74.34
8	37	10.92	85.26
9	13	3.84	89.10
10	20	5.90	95.00
11	0	—	95.00
12	0	—	95.00
13	0	—	95.00
14	2	0.59	95.59
15	15	4.41	100.00

Modal Hatching date = July 5

Fate of Nests

Each of 152 Emperor nests was visited at irregular intervals in 1971 until its fate was determined. Results appear in Table 13.

The authors recognized that the presence of an observer in the field can, in itself, affect the rate of nesting success. Repeated flushing of birds from nests, and trails left as a result of human visits, can cause an increase in predation losses. Once, our disturbance of the female caused the destruction of an entire clutch. On July 2, I (DIE) located a Whitefront nest (#152) with 2 new goslings and 2 eggs. After examining the nest, I covered the young and left. While examining an Emperor nest, 100 feet away, I noticed 2 Glaucous Gulls (Larus hyperboreus) diving near the Whitefront nest I had just left. I ran at the gulls, but they had consumed the two goslings before I could chase them away. After covering the pipped eggs remaining in the nest, I returned to the Emperor nest to finish examination. As soon as I had settled down, 2 Glaucous Gulls swooped down and took the 2 eggs remaining in the Whitefront nest. I am not sure if the same pair of gulls was involved both times.

This all took place in spite of the fact that I had covered the nest each time, which leads me to believe that Glaucous Gulls rely on hearing more than eyesight to locate nests. This is the only explanation I can offer for the gulls' behavior as there were none within 300 yards of the Whitefront nest when I first flushed the female.

On numerous occasions the authors have observed Glaucous Gulls flying over open nests at less than 30 feet. Their behavior patterns led us to believe that they were not aware of the unprotected eggs.

Successful Nests

Successful nests were recognized by their appearance after the eggs were hatched. In most cases, shells of hatched eggs were crushed, apparently by weight of the adult brooding the young before abandoning the nest. Usually only bits of shell or egg membrane remained. Some nests had been torn up by predators after the eggs had hatched, but characteristic remains of hatched eggs were still present. Nests in which at least one egg hatched are termed successful in this report. Nest success for Emperor Geese was 81.6 percent in 1971 (Table 13). Headley (1967) determined that 75 percent of the nests started in 1966 were successful. Nesting success of Cacklers and Black Brant was considerably lower than that of Emperors (Appendix 5).

Unsuccessful Nests

Abandoned.--Only one Emperor nest (.66%) was found abandoned in 1971. The direct cause of the abandonment is believed to be Parasitic Jaegers (Stercorarius parasiticus). An Emperor nest with 6 eggs was located within the nesting territory of a pair of Parasitic Jaegers. Four of the eggs were broken open and contained partially consumed embryos. The other two eggs were still in the nest and both contained dead empryos. From the condition of the embryos, it was determined that the abandonment occurred during the last few days of June.

Table 14. Fate of Emperor Goose eggs, Kokechik Bay, 1971.

Fate	Number	Percent
Hatched	217	81.00
Missing[1]	33	12.30
Broken	1	.37
Abandoned	3	1.11
Destroyed by predator	11	4.10
Infertile or addled	2	.75
Other[2]	1	.37
Total	268	100.00

1 Probably includes eggs carried off by Glaucous Gulls or Arctic Foxes.

2 Egg found buried underneath nest scrape.

Ryder (1967) thought it useless to evaluate yearly production of Ross' Geese from brood counts made when goslings were three or more weeks old because of "flock clumping" between brooding and nonbrooding flocks. Flock clumping also occurs in Emperor Geese but not until goslings are considerably older than 3 weeks. Thus it is usually possible to separate individual broods up to 6 weeks after hatching. Brood sizes calculated from data collected during ground surveys are consistly higher than brood sizes observed during aerial surveys (Table 15 and 16), because it is extremely difficult to count individual young in broods numbering more than 5 from aircraft. Thus broods over 5 are excluded unless all individuals can be counted, resulting in lower brood sizes from aerial surveys. Brood sizes for July and August 1971 are lower than nearly every other year during the same two months.

Aerial brood surveys were conducted by Dr. C. J. Lensink and the senior author on July 25 and August 14, 1971. Both surveys covered the area from Baird Inlet to Kokechik Bay. The mouths of all large rivers and most of the Bering Sea coast were surveyed. The average number of young per brood for the entire area surveyed did not change significantly between the two time periods (Table 16). However, the average brood size observed at Kokechik Bay decreased from 3.26 on July 25 to 2.54 on August 14. Average brood size, observed on the rest of the area surveyed, increased from 3.13 on July 25 to 3.29 on August 14. Sample sizes were similiar in both instances. The decrease in brood size at Kokechik Bay reflects the difficulty encountered in distinquishing brood sizes during the second survey, thus reducing the number of large broods included in calculations.

Table 15. Results of ground brood surveys for Emperor Geese on the Yukon-Kuskokwim Delta.

Date	Location	Frequency by Size of Brood 1	2	3	4	5	6	7	8	Grouped Young Pairs	Grouped Young Young	Totals Broods	Totals Young	Yg/Br
1961	Clarence Rhode N.W.R.[1]											42	159	3.79
1963	Clarence Rhode N.W.R.[1]											15	54	3.60
1965														
July	Clarence Rhode N.W.R.[1]		6	10	4	9		1	1	10	43	41	161	3.93
	Old Chevak area[2]		2	2	2	5		1	1	5	22	18	80	4.45
Totals:	July											59	241	4.09
Aug.	Old Chevak area[2]		1	2	3	4						11	44	4.00
Totals:	July and August											70	285	4.07
1966														
July	Kolomak River[1]	8	12	18	24	23	9	2	3			99	389	3.93
	Old Chevak area[2]	2	9	7	17	12	3	1	1	8	24	60	226	3.77
Totals:	July											159	615	3.86
Aug.	Old Chevak area[2]		1	7	2	9	5			7	28	31	134	4.33
Totals:	July and August											190	749	3.94
1967	Clarence Rhode N.W.R.[1]	1	2	3	4	5	1			3	10	19	71	3.74
1968	Clarence Rhode N.W.R.[1]	1	6	5	7	10	2					31	118	3.81
1969	Clarence Rhode N.W.R.[2]	2	5	9	19	14	6	2		12	50	69	285	4.13
1970	Clarence Rhode N.W.R.[1]	2		2	4	3	2			15	58	28	109	3.89

Table 15. Continued.

Date	Location	Frequency by Size of Brood 1	2	3	4	5	6	7	8	Grouped Young Pairs	Grouped Young Young	Totals Broods	Totals Young	Yg/Br
1971														
July														
5-13	Kokechik River		1	2	1	1						5	17	3.40
8-10	Old Chevak area[3]		5	3	4							12	35	2.91
31	Kokechik River			2	2	5	1			5	16	15	61	4.06
Totals:	July											32	113	3.53
August														
5-7	Kokechik River	1	5	7	4	7	2					26	95	3.65
Totals:	July and August											58	208	3.59

1 Annual reports, Clarence Rhode National Wildlife Range, Bethal, Alaska. 1967-1970 surveys taken in late June and early July.

2 Headley (1967).

3 Data supplied by Christian Dau, Wildlife Assistant, Clarence Rhode National Wildlife Range.

Table 16. Results of aerial brood surveys for Emperor Geese on the Yukon-Kuskokwim Delta.

Date	Location	Frequency by Size of Brood 1	2	3	4	5	6	7	8	Grouped Young Pairs	Grouped Young Young	Totals Broods	Totals Young	Yg/Br
1964														
July	Clarence Rhode N.W.R.[1]	3	3	34	34	20	11	1				106	420	3.96
1965														
July	Kokechik River area[1]	2	8	14	17	5	2			4	13	48	175	3.64
1966														
July 16	Clarence Rhode North Unit Coast[2]	2	11	16	23	9	3					64	227	3.55
	Kokechik River Area[2]	1	4	5	14	3	5					32	125	3.91
July 29	Kokechik River area[2]	1	3	8	9	4	8			2	7	33	135	4.09
Totals: July	Kokechik River area											65	260	4.00
	All areas surveyed											129	487	3.77
Aug.	Clarence Rhode South Unit Coast[2]	3	1	7	2							13	34	2.62
	Clarence Rhode North Unit Coast[2]	2	1		2							5	12	2.40
	Kokechik River area[2]			3	1							4	14	3.50
Totals: August												22	60	2.73
Sept.	Clarence Rhode North Unit Coast[2]	5	10	2	2							19	39	2.05

Table 16. Continued.

Date	Location	Frequency by Size of Brood 1	2	3	4	5	6	7	8	Grouped Young Pairs	Young	Totals Broods	Young	Yg/Br
	Izembek N.W.R.[3]	16	22	23	15	3						79	204	2.58
Total: Sept.												98	243	2.48
Oct.	Izembek N.W.R.[3]	11	20	11	7	1	1					51	113	2.22
1967 Sept.	Izembek N.W.R.[3]	4	10	5	5	7						31	94	3.03
Oct.	Izembek N.W.R.[3]	3	5	6	6	4	1	1				26	88	3.38
Nov.	Izembek N.W.R.[3]	2	1	2	2	1						8	23	2.88
1968	Izembek N.W.R.[3]											40	113	2.83
1969	Clarence Rhode N.W.R.[1]											85	349	4.11
1970	Clarence Rhode N.W.R.[4]	17	14	27	16	8	1			2	5	83	236	2.84
1971 July 25	Clarence Rhode North Unit Coast	11	21	34	24	15	1			17	36	106	332	3.13
	Kokechik River Area	2	15	20	12	8	2					59	192	3.26
Totals: July												165	524	3.18
Aug. 14	Clarence Rhode North Unit Coast	1	27	39	27	16	1			14	17	111	366	3.29
	Kokechik River area	2	10	24	18	16	1			10	14	71	180	2.54
Totals: August												182	546	3.00

Table 16. Continued.

1 Annual reports, Clarence Rhode National Wildlife Range, Bethel, Alaska.

2 Headley (1967).

3 Personnal communication from Palmer C. Sekora, Aleutian Islands N.W.R., Cold Bay, Alaska, to Dr. C. J. Lensink, Clarence Rhode N.W.R., Bethel, Alaska (1968).

4 No date given for survey, but probably late fall.

Brood Losses

Predation.— Of the predators on the breeding grounds, the Glaucous Gull has the greatest effect on brood mortality. Gulls dive repeatedly at a family group until the young become separated from their parents. With a swoop, a gull picks up a gosling, tosses back its head, and the gosling disappears down its gullet. When harassed by avian predators, adult geese often divert an attack by jumping towards the predator. During the first few weeks of life, Emperor goslings are also vulnerable to jaegers. Headley (1967) observed a jaeger carrying an Emperor gosling it had captured. Emperor goslings can dive and sometimes do to avoid predators. Goslings are much more vulnerable to predation when travelling across mud or low grass.

Emperor Goslings more than 3 weeks old are difficult for Glaucous Gulls to swallow whole. Gulls kill older Black Brant goslings by one of two methods.

1) When a gosling becomes separated from the brood, a gull will hover over it, repeatedly pecking at the back of the gosling's head until it is dispatched.

2) Otherwise, a gull chases a gosling until it bogs down in mud, then drops beside it and pecks at the visceral region until the gosling is dead.

No instances of brood mortality by abandonment, in and of itself, or accidents were recorded in 1971.

Movements

A few days after hatching, the family group moves to the coast to feed for a few days before moving to larger river courses. On the larger rivers they join with other family groups to prepare for the annual moult. Though many families are joined together, each family stays as a separate entity within the group. Family groups spend the moulting period together and do not venture far from water. The authors believe that family groups of Emperor Geese may move as far as 5 miles from their nest site to moulting areas.

Physical Attributes

Growth and Development

Emperor Geese have the longest preflight period of any on the Delta, calculated to be 45 days (Headley, 1967). Cackling Geese have a preflight period of 42 days (Nelson and Hanson, 1959).

The weight gain of Emperor goslings is extremely rapid. The average weight of 6 goslings at hatching was 74 grams. By the end of the third week, gosling weight had increased over tenfold (Table 17). Male goslings increased in weight at a slightly faster rate than females. Goslings weighed as much as adults by the end of fledging stage.

Total tarsus and mid-toe growth of young Emperors is also rapid. Some Class II goslings have mid-toe and total tarsus measurements which exceed the mean measurements from adults. Since only weights were available for Class I and Class III goslings, growth rate during these periods is not known. Also, there is too much overlap between measurements for age classes to determine age class accurately by measuring structures. Data were not recorded for wing, tail, or total length because of extreme variability in these structures related to different hatching dates.

Sex Ratios

Sex of all Emperors caught in banding drives was determined by presence or absence of a penis. A 1:1 ratio was shown in Class II goslings from a sample of 92 males and 85 females. The adult sex ratio, determined from banding samples, was also 1:1. The samples may be too small to indicate a differential mortality should it exist between the sexes.

Color

Emperor Goose goslings are all dark grey with a white area behind the bill. At 2 weeks of age the grey turns to light silver color, giving way to a beautiful silver blue of contour feathers when the goslings reach the fledging stage.

Interspecific Relationships

Parasitism

Table 18 presents data on number of internal parasites found during autopsy of 8 Emperor Geese in 1968. Many gizzard worms were observed in a 6-week-old male Emperor collected during a banding operation in 1971. Evidence of mortality or emaciation resulting from parasite infections of Emperor Geese is lacking. Hopefully additional specimens can be examined in 1972 to determine frequency and kind of infestation.

Predation

Only three adult Emperor Geese were found dead on the study area in 1971

Table 17. Physical measurements of Emperor Geese in Yukon-Kuskokwim Delta region, Alaska.

		Weight[1] (gm)	Culmen (mm)	Nares (mm)	Mid-toe (mm)	Diagonal Tarsus (mm)	Total Tarsus (mm)
Sample	1	24	9	9	9	9	9
	2	24	11	11	11	11	11
	3	2	--	--	--	--	--
	4	3	--	--	--	--	--
	5	97	28	28	28	28	28
	6	85	26	26	26	26	26
	7	8	--	--	--	--	--
	8	5	--	--	--	--	--
Mean	1	2506	39.7	33.2	74.1	74.5	88.1
	2	2028	38.7	30.4	70.3	70.4	82.8
	3	766	--	--	--	--	--
	4	870	--	--	--	--	--
	5	1224	27.2	20.7	61.0	67.5	78.4
	6	1134	27.5	21.3	70.0	63.2	82.7
	7	1752	--	--	--	--	--
	8	1678	--	--	--	--	--
Range	1	2150-3123	33.4-43.7	29.0-43.1	68.9-78.5	70.0-78.0	84.0-94.4
	2	1525-2333	34.2-41.5	28.0-32.0	62.0-74.5	66.0-73.0	74.0-94.4
	3	681-851	--	--	--	--	--
	4	851-908	--	--	--	--	--
	5	625-2156	21.0-31.1	17.5-28.2	50.5-76.2	56.7-76.8	67.0-89.2
	6	600-1702	22.0-30.5	17.0-27.1	54.5-79.4	58.3-78.9	69.0-85.0
	7	1589-2270	--	--	--	--	--
	8	1589-1759	--	--	--	--	--

1 Includes weights obtained during banding operations (boat) near Old Chevak 1967-70.

Table 17. Continued.

Sample: 1. Adult male
2. Adult female
3. Class I male (2-3 weeks old)
4. Class I female
5. Class II male (4-5 weeks old)
6. Class II female
7. Class III male (6-7 weeks old)
8. Class III female

Table 18. Acquisition of helminths by Emperor Goose goslings on the Clarence Rhode N.W.R., Alaska, 1968.[1]

Date of Collection	Cestodes	Intestinal Trematodes	Caecal Trematodes	Caecal Nemantodes	Gizzard Nematodes
7/18	3	0	0	0	0
7/20	12	0	0	0	0
7/20	7	0	0	3	0
7/21	9	0	0	2	1
7/30	some	0	0	31	2
8/5	many	23	0	4	17
8/9	many	0	74	0	13
8/11	many	0	33	0	45

[1] Data from Annual report, 1969, Clarence Rhode N.W.R., Bethel, Alaska

(Table 19). Evidence led us to believe they were all Arctic Fox kills. Numerous fox trails crisscross the area and most fox kills seem to be near these trails. A few inactive dens were found near the study area but only 1 fox was observed during the summer.

A few, scattered shotgun shells were found around the area indicating that some birds may have been shot by hunters, probably Eskimos from Hooper Bay. The junior author found an abandoned camp site with remains of numerous bird eggs and one bird skeleton. Most of the Eskimo kill of Emperors occurs in the spring when the population is at its lowest point (Klein, 1966). Headley (1967) observed three Eskimo boats loaded with dead geese on the Kolomak River in August 1966. He estimated that several hundred birds had been killed, mostly Emperors. He thought the annual kill by Eskimos, at that time, was not detrimental to the species.

Table 19. Analysis of waterfowl mortality at Kokechik Bay study area, 1971.

Species	Age	Sex	Date Found	Estimated Date of Death	Remains Found	Cause of Death
Emperor	Ad	--	6/28	6/14	Wings, legs	Fox
Emperor	Ad	--	6/28	6/14	Wings, legs, sternum	Fox
Black brant	Ad	--	6/28	--	"	Fox
? eider	Ad	--	6/28	--	Wings, legs, skin	Fox
? eider	Ad	--	6/28	6/14	Wings, tail sternum	Fox
Cackler	Ad	--	6/28	6/14	Intact except skull	Fox
Emperor	Ad	--	6/29	--	Wings, sternum, ribs	Fox
Emperor	Chick	--	6/29	6/27	Intact	Broken egg
? eider	Ad	--	6/29	--	Feathers, skin	Man
Black brant	Chick	--	7/1	6/30	Intact	Shellbound
Black brant	Ad	--	7/1	--	Intact	?
Cackler	Ad	--	7/2	--	Wings, back, sternum	Fox
Greater Scaup	Ad	Male	7/16	7/9	breast, viscera	Gull

A total of 16 Glaucous Gull nests and 1 Long-tailed Jaeger nest were found near the study area in 1971. Unfortunately a large colony of Glaucous Gulls near the area was not visited. A noticeable increase in the number of Glaucous Gulls occurred at the beginning of the hatching period for Emperor Geese. On numerous occasions as many as 20 gulls flew aroung overhead as I (DIE) searched for nests. For a large number, I sometimes stopped and waited for them to move on. We made numerous observations of young waterfowl being snatched off the water and devoured by this large predator. However, no observations were made of Glaucous Gulls killing Emperor young.

Competition

Emperor Geese nesting at Kokechik Bay share similiar nesting niches with Cackling Geese, Black Brant, Spectacled Eider, Common Eider, and occasionally White-fronted Geese. All are potential competitors for nesting sites, but no evidence of competition between these species was recorded in 1971.

Banding Operations

Very few Emperor Geese have been banded either in North America or Russia. Information gained from banding records is essential for life-table construction, determination of migration routes, and mortality. Because of the low number of Emperor Geese that have been banded, one of the future objectives of this study will be to band as many Emperors as possible.

The authors participated in 5 banding drives near Old Chevak in 1971. A total of 121 Emperors, 78 Cacklers, and 579 Black Brant were trapped. We banded all of the Emperors and Cacklers but only the yearling Brant. Trap mortality was low, 7 Emperor Goslings and 1 Cackler gosling, trampled by adults and other young in the trap.

PLANS FOR FUTURE FIELD SEASONS

Many questions about ecology, productivity, and behavior of the Emperor Goose on its Kokechik Bay nesting grounds are yet to be answered. Preliminary conclusions reported here must be verified or rejected as more data are gathered and analyzsed. Other questions and points essential to the better understanding of this species are outlined below. Most of them will be illuminated or settled only by intensive investigations on the breeding range, and in some cases on the wintering range and migration routes.

A. Climate.

1. Snow and ice conditions. Time of breakup.

2. Effects of temperature, wind, and precipitation on reproduction in general.

3. Response to hours of daylight.

B. Vegetation.

1. Qualitative and quantitative description of flora. Floral types, percentages of area.

2. What is nature and extent of available nesting cover?

C. Nesting ecology.

1. Factors involved in nest-site selection.

2. Factors limiting nest density.

3. Extent of renesting and success of renesting.

4. Effect of late seasons on nesting success.

5. Factors relating to dump-nesting.

6. Extent of interspecific competition for nest sites.

7. Effects of intraspecific competition on nest distribution and density, clutch size, and nesting success.

8. Fidelity of a pair for a particular nest site.

9. Effect of human disturbance on nest predation and desertion.

D. Reproduction physiology.

1. What is minimum breeding age? What percent of population of 1, 2, and 3-year birds are breeding?

2. What is length of egg laying period?

3. What is physiological status upon arrival on breeding grounds? How related to age?

4. What percent of returning population is nonbreeders?

5. Will Emperor Goose respond to robbed clutch by laying more eggs?

E. Behavior.

1. Pair behavior throughout breeding season.

2. How long do mated pairs and family groups remain intact?

3. Will Emperor Goose hatch or desert a hyperclutch (dump nest)?

F. Migration and movements.

1. Correlation of migration with weather.

2. What proportion of first year birds return to natal area?

3. Movement and flock concentration behavior on nesting grounds.

4. Do spring arrival dates relate to age classes or family groups?

G. Moult.

1. How does moult progress in goslings, breeders, subadults, nonbreeders?

2. How is moult related to hatching?

H. Foods.

1. What are the foods used by all age classes?

2. Is food supply a factor influencing nesting density and productivity?

3. What effects do Emperor Geese have on their food supply?

4. Does interspecific competition exist for available food supply?

METHODS FOR FUTURE FIELD SEASONS

To investigate points above identified as A2 and F1, we will collect climatic data for all field seasons.

B2, C1, C2, C5, C6, C7. We will collect data on nest distribution and density, and investigate food supplies and vegetation distribution and characteristics. Numbers, distribution and activity of predators will be studied.

C8, D1, D2, D4, E1, E2, F2, F3. Many of these questions can be studied by observations of birds to be marked as shown here:

1. Monel leg bands, for all birds handled, to be placed on right leg of females and left leg of males.

2. Colored plastic leg bands

Color(s)	Sex, Age Class, and Year to be applied		
Red	Female	Adult	1972
White	Male	Adult	1972
Green	Female	Adult	1973
Blue	Male	Adult	1973
Pink	Female	Adult	1974
Black	Male	Adult	1974
Red and Yellow	Female	Class III	1972
White and Yellow	Male	Class III	1972

Green and Yellow	Female	Class III	1973
Blue and Yellow	Male	Class III	1973
Pink and Yellow	Female	Class III	1974
Black and Yellow	Male	Class III	1974

Bands to be placed above Monel band in males and below Monel band in females. Yellow bands of Class III goslings to be placed on leg that does not have a Monel band (left leg of females and right leg of males).

3. Fingerling fish tags (#1) for goslings too small for regular band.

Number(s)	Position	Sex	Year
2-1 to 2-25	Left foot (web)	Male	1972
2-26 to 2-50	Right foot (web)	Female	1972
3-1 to 3-25	Left food (web)	Male	1973
3-26 to 3-50	Right foot (web)	Female	1973
4-1 to 4-25	Left foot (web)	Male	1974
4-26 to 4-50	Right foot (web)	Female	1974
5-1 to 5-25	Left food (web)	Male	1975
5-26 to 5-50	Right foot (web)	Female	1975

4. Neck bands.

Number	Sex	Age	Year
1-20	Female	Adult	1972
21-25	Male	Adult	1972
26-46	Female	Adult	1973
47-52	Male	Adult	1973
53-73	Female	Adult	1974
74-78	Male	Adult	1974
79-99	Female	Adult	1975
100-104	Male	Adult	1975

Neck Bands are to be applied only to nesting pairs trapped at nest site.

5. Dyes injected into eggs 2-8 days before hatching

C3, D5, E3. Observations of natural situations, and manipulation of clutches.

G1, D3, H1. Observations of marked birds and from live-trapped birds and collected specimens.

H2, H3. Vegetation plots and transects. Measurement of vegetation growth. Soil analysis and effect of fertilization by goose droppings.

C9. Lay out plots with approximately same number of nests in each. Vary the number of visitations and record clutch sizes and nest and egg fate.

PLANS FOR 1972

It is planned to have one observer arrive on the Kokechik Bay study area before the geese arrive in spring to record phenomena associated with their arrival and pre-nesting behavior. Emperor Goose behavior, by individuals and groups, will be noted throughout the nesting period. Small tents or other devices will be used for behavior observations.

Emphasis will be on trapping and marking of Emperors of all ages. Falconers' bow traps will be used at nests. Drives and corral traps will be used to catch geese during the flightless period.

The study area will be systematically searched for nests at least twice while geese are incubating. Brood counts will be made throughout the summer and efforts made to make more ground surveys than in 1971.

If the observer arrives in time, plots will be set up to measure the extent and persistence of snow cover in the various habitat types.

SUMMARY

The breeding ground ecology of Emperor Geese was observed during the 1971 season. The study area of 1.75 square miles was located approximately 20 miles north of Chevak on Kokechik Bay, Alaska. Topics of investigation included nesting density and success, nest site selection, incubation, brood sizes, and predation on Emperor Geese.

An average density of 170 geese (87 Emperor) and brant nests per square mile was recorded in 1971. Nesting density appeared to be related to habitat type and number of other birds already nesting in the area. Emperor Geese preferred elevated shorelines for nesting sites but highest nesting success was recorded on pingo mounds. The peak of clutch initiation occurred on June 4, and the peak of hatching was July 5. The laying, incubation, and hatching period for all Emperor Goose clutches covered 54 days.

Nesting success for Emperor Geese was 81.6 percent with an average clutch size of 4.16. A negative correlation exists between laying date of first egg and final clutch size. Brood averaged 3.5 in July and 3.1 in August. A few hours after hatching, adults lead their young to the coast. A few days later they move to the larger rivers were the moult takes place.

Predation of eggs and goslings was primarily restricted to Glaucous Gulls. Data collected during banding drives indicate that goslings grow rapidly and approach adult proportions by the end of the sixth week of life.

Observations of bird species seen each day, bird mortality, and weather conditions were made throughout the study. A habitat analysis was initiated and will be continued through 1972.

The 1972 field research will repeat much of that for 1971. Emphasis will be placed on behavioral observations, nest trapping and marking female Emperors, and banding Emperors. A vegetational analysis will be continued throughout 1972.

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APPENDICES

Appendix 1. Clutch size observations of waterfowl nests discovered at Kokechik Bay, 1971.

Species	Clutch Size Frequency 1	2	3	4	5	6	7	8	9	10	Total Eggs	Total Nests	Average Clutch
Emperor Goose	9	18	42	48	53	37	16	8	3	3	1083	237	4.57
Cackling Goose	2	4	10	9	11	4	2				169	42	4.02
Black Brant	3	6	17	12	6						144	44	3.27
Whitefronted Goose		3	3	2			1				30	9	3.33
Pintail						1	3	3	1		60	8	7.50
Green-winged Teal							1				7	1	7.00
Greater Scaup						3	2	2		2	68	9	7.55
Oldsquaw					2	4	2	1			56	9	6.23
Common Eider			1		4	1	1				36	7	5.14
Spectacled Eider		1	8	6	12	4					134	31	4.33

Appendix 3. Chronological frequency of hatching of goose and brant eggs at Kokechik Bay, 1971 (exclusive of Emperor Geese).

	Black Brant Eggs			Cackling Goose Eggs		
	Number	Percent Hatched	Cum. Percent	Number	Percent Hatched	Cum. Percent
6/26	4	4.00	4.00	0	0.00	0.00
6/27	4	4.00	8.00	0	0.00	0.00
6/29	8	8.00	16.00	0	0.00	0.00
7/1	16	16.00	32.00	0	0.00	0.00
7/2	0	0.00	32.00	23	18.40	18.40
7/3	0	0.00	32.00	2	1.60	20.00
7/4	32	32.00	64.00	20	16.00	36.00
7/5	10	10.00	74.00	9	7.20	43.20
7/6	5	5.00	79.00	0	0.00	43.00
7/7	4	4.00	83.00	19	15.20	58.40
7/8	0	0.00	83.00	9	7.20	65.60
7/9	1	1.00	84.00	20	16.00	81.60
7/10	5	5.00	89.00	11	8.80	90.40
7/11	4	4.00	93.00	0	0.00	90.40
7/14	7	7.00	100.00	0	0.00	90.40
7/16	0	0.00	100.00	6	4.80	95.20
7/17	0	0.00	100.00	2	1.60	96.80
7/20	0	0.00	100.00	4	3.20	100.00
Totals:	100	100.00		100	100.00	

Appendix 4. Fate of goose and brant eggs laid, 1971 (exclusive of Emperor Geese).

	Cackling Goose		Black Brant		White-fronted Goose	
Fate	Number	Percent	Number	Percent	Number	Percent
Hatched	117	72.7	112	87.6	0	0.0
Missing	36	22.4	14	11.0	0	0.0
Broken	0	0.0	0	0.0	0	0.0
Abandoned	0	0.0	1	0.7	0	0.0
Destroyed by predator	5	3.1	0	0.0	4	100.0
Infertile or addled	2	1.2	0	0.0	0	0.0
Dead embryo	0	0.0	1	0.7	0	0.0
Other	1	0.6	0	0.0	0	0.0
Totals	161	100.0	128	100.0	4	100.0

Appendix 5. Fate of goose and brant nests started, 1971 (exclusive of Emperor Geese).

	Cackling Goose		Black Brant		White-fronted Goose	
Fate	Number	Percent	Number	Percent	Number	Percent
Successfully hatched	38	66.7	37	42.5	0	0.0
Destroyed						
Glaucous Gull	0	0.0	0	0.0	1	100.0
Parasitic Jaeger	0	0.0	0	0.0	0	0.0
Unknown bird	1	1.7	0	0.0	0	0.0
Arctic Fox	0	0.0	0	0.0	0	0.0
Unknown	18.	31.6	50.	57.5	0	0.0
Abandoned	0	0.0	0	0.0	0	0.0
Flooded out	0	0.0	0	0.0	0	0.0
Totals	57	100.0	87	100.0	1	100.0

Appendix 6. First flowering dates for common plant species.

Date	Location	Species
6/17	Bethel	Rubus chamaemoris
6/20	Old Chevak	Petasites frigidus
6/23	Study Area	Primula borealis
6/25	"	Petasites frigidus
6/26	"	Sedum rosea, Pedicularis kanei
6/28	"	Rubus chamaemoris
7/1	"	Eriophorum scheuchzeri
7/2	"	Barbarea orthoceras
7/4	Study Area	Trientalis europea, Polemonium acutiflorum
7/8	"	Valeriana capitata
7/12	"	Potentilla egedii egedii
7/23	"	Achillea borealis
8/1	"	Ligusticum scoticum
8/4	"	Parnassia palustris

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