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PACIFIC EIDER BREEDING BIOLOGY AND HABITAT USE ON THE SEWARD PENINSULA, ALASKA

A

THESIS

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By

Anne Christine Seguin, B. S.
Fairbanks, Alaska

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PACIFIC EIDER BREEDING BIOLOGY AND HABITAT USE

ON THE SEWARD PENINSULA, ALASKA

RECOMMENDED: Philip S. Gipson

Samuel J. Harbo, Jr.

P. H. Mickelson

Chairman, Advisory Committee

P. H. Mickelson

Program Head, Wildlife and Fisheries

Wayne D. Myers

Deputy Director, Division of Life Sciences

APPROVED: K. B. Mather

Vice Chancellor for Research and Advanced Study

August 13, 1981

Date

ABSTRACT

Habitat use and productivity of breeding Pacific Eiders (Somateria mollissima v-nigra) on Cape Espenberg, Alaska, were examined during 1976 and 1977. Eiders nested on an island (0.33 ha) and the mainland. Island nesting eiders (density: 975 nests per hectare) initiated egg-laying earlier, had larger clutch sizes, and were more successful at nesting than eiders nesting on the mainland. Plant species cover, frequency of occurrence, and height indicated that some eiders nested in drier sites on the mainland than did Glaucous Gulls (Larus hyperboreus). On the mainland, shorelines had the greatest density of eider and gull nests. The most successful mainland eider nests were located on peninsulas. Eider nests isolated by water barriers suffered less partial predation, and had higher nesting success than less isolated ones. Clutch size and nesting success of early nesting eiders on the mainland was greater than late nesters only in 1977 when gulls and eiders initiated nests earlier than in 1976.

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Dr. D. Murray of the University of Alaska verified my identification of the vascular plant collection from Cape Espenberg.

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INTRODUCTION

There are four recognized races of Common Eider *Somateria mollissima* in North America: the American Eider (*S. m. dresseri*), Hudson Bay Eider (*S. m. sedentaria*), Northern Eider (*S. m. borealis*), and Pacific Eider (*S. m. v-nigra*). The fifth race, *S. m. mollissima*, is found along the coasts of northern Europe (Bellrose 1976).

Although considerable information has been compiled on the European Eider and the American Eider, the remaining three races have not received much attention.

The purpose of my research was to document habitat use and productivity of the Pacific Eider along the coast of the Chukchi Sea at Cape Espenberg. The effect of relationships between nesting conspecifics and Glaucous Gulls (*Larus hyperboreus*) on various aspects of eider breeding biology was addressed.

STUDY AREA

Cape Espenberg (66° 36'N, 163° 58'W), approximately 50 km southwest of Kotzebue, Alaska, extends about 13 km into western Kotzebue Sound. The Cape is relatively narrow, having a width of about 1.5 km for most of its length.

Plots 1 and 2 were established in 1976. Both Plots 1 and 2, alternatively called the mainland study areas, contained several ponds and lakes, tussocks, hummocks, and tundra ridges. Usually these habitats were found in strips roughly paralleling the longitudinal axis of the Cape. Plot 3 was an island in a large lake slightly south of Plot 2. The locations of the Cape and three study plots are shown on Figure 1.

The vegetation types composed a mosiac arranged as a series of beach ridges and intervening depressions. The older ridges were towards the interior of the Cape; the youngest were dunes near the coast (Anderson et al. 1974). The older beach ridges, synonomous here with tundra ridges, were characterized by *Loiseleuria procumbens*, *Cassiope tetragona*, *Arctostaphylos* spp., *Vaccinium vitis-idaea*, *V. uliginosum*, *Ledum palustre*, *Rubus chamaemorus*, *Betula* sp.

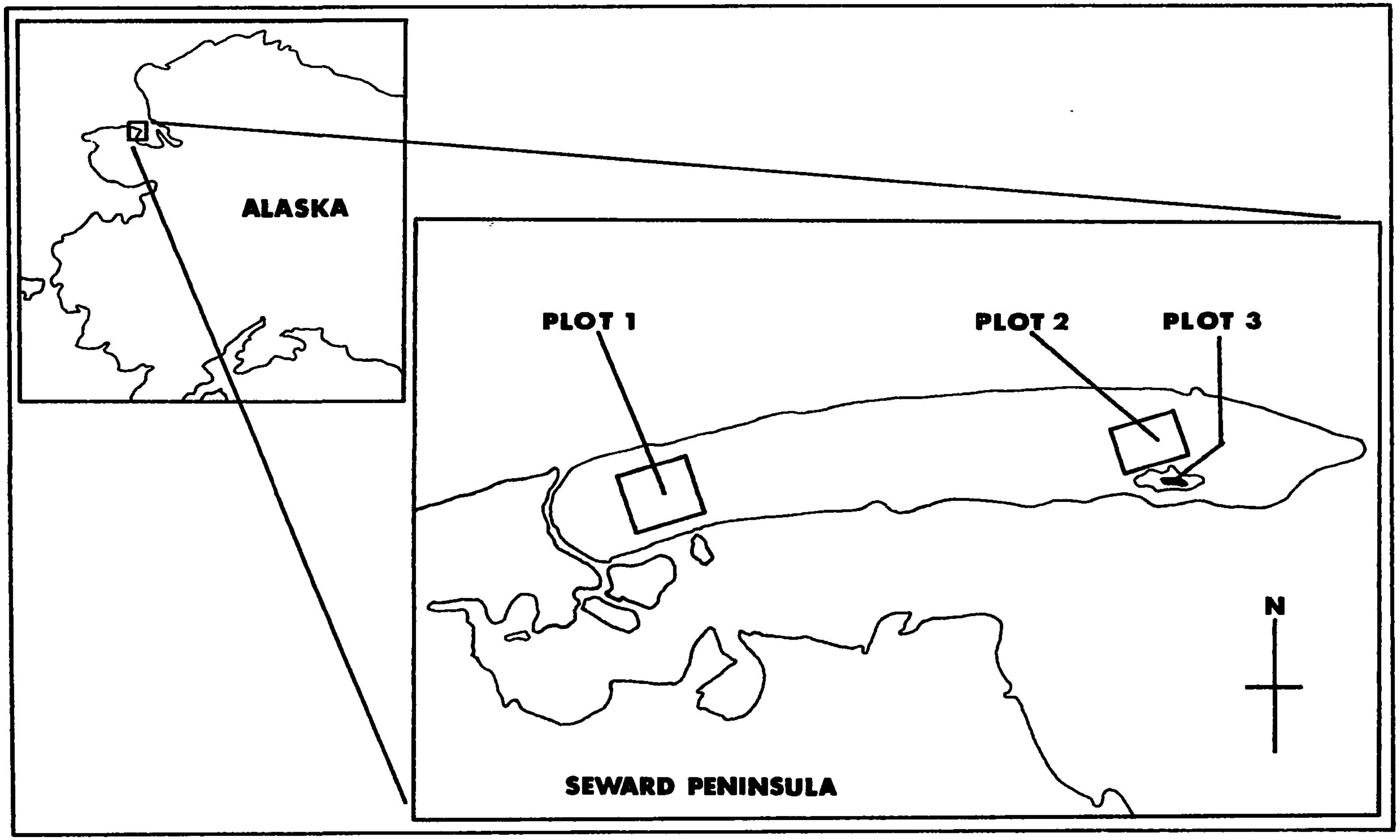

Figure 1. Location of study plots in 1976 and 1977 on Cape Espenberg, Alaska.

(probably B. nana), Pedicularis lanata, P. capitata, Armeria maritima, Salix spp., Stellaria humifusa, Campanula uniflora, Tofieldia pusilla, and Luzula confusa.

Sand dunes near the coast supported Elymus arenarius, Poa eminens, Lathyrus maritimus, and Honckenya peploides.

Ridges intermediate in age between these two extremes supported Potentilla villosa, Vaccinium vitis-idaea, Empetrum nigrum, Aster sibiricus, Sedum rosea, Androsace chamaejasme, Epilobium angustifolium, Myosotis alpestris, Taraxacum kamtschaticum, Ranunculus pedatifidus, Angelica lucida, and Draba hirta.

Juncus arcticus and Castilleja elegans were found in troughs between the coastal dunes. Troughs between ridges on the remainder of the Cape contained ponds or lakes, hummock-marshes, wet sedge meadows, and damp areas. Polemonium acutiflorum, Cardamine pratensis, Saxifraga exilis, Cochlearia officinalis, Chrysanthemum arcticum, Saussurea nuda, Primula borealis, Rumex arcticus, Parnassia palustris, and Iris setosa frequented shorelines.

Hummocks supported Vaccinium uliginosum, Betula sp. (probably B. nana), Empetrum nigrum, Ledum palustre, Tripleurospermum phaeocephalum, Artemesia Tilesii, Rubus chamaemorus, Stellaria humifusa, Saxifraga exilis, Ped-icularis lanata, Chrysosplenium tetradum, Stellaria monantha, Poa arctica, and Senecio congestus.

Emergent species included Caltha palustris, Ranunculus

Pallasii, Potentilla palustris, and Hippuris vulgaris.

Tussocks often were found on the sides of tundra ridges. The damp areas between tussocks harbored Andromeda polifolia and Pedicularis sudetica.

The only shrubs of appreciable height were willows (Salix spp.) that sometimes grew in sheltered areas, such as between beach ridges or on the south side of Plot 3. They generally were 1 m or less in height.

Thirty-four avian species nested on Cape Espenberg (Schamel et al. 1978), including Parasitic Jaegers (Stercorarius parasiticus) and Glaucous Gulls (Larus hyperboreus). In 1976 fourteen pairs of jaegers nested on the Cape; sixteen pairs did so in 1977 (Schamel et al. 1978). About 300 pairs of Glaucous Gulls nested on Espenberg in 1976 and 1977. Although jaegers were seen taking some eggs and young birds, gulls were observed taking many more. Glaucous Gulls were the major avian species preying on eider eggs and ducklings on Cape Espenberg.

Melchior (1974) found a tundra shrew (Sorex arcticus), a tundra vole (Microtus oeconomus), arctic ground squirrels (Citellus parryi), reindeer (Rangifer tarandus), and red or arctic foxes (Vulpes vulpes or Alopex lagopus) on the Cape. In 1976 arctic ground squirrels, a few tundra voles, two moose (Alces alces), one reindeer, and several red foxes were seen. Both red and arctic foxes, reindeer, arctic ground squirrels, one moose, and one grizzly bear

(*Ursus arctos*) were present in 1977, but no voles were either trapped or observed (Schamel et al. 1978).

In both years of this study moose spent only a few days on the Cape. Bear sign was first seen on 20 August 1977. It was sighted repeatedly until late September, when the field season ended.

The reindeer range leased to the Goodhope family includes Cape Espenberg. In 1972 the herd numbered 2517 animals (Melchior 1974). Although in 1976 only one yearling male was seen on the Cape, in 1977 at least 1200 reindeer used it (Schamel et al. 1978) during 9-25 July. The same number of animals were present in 1978 (Schamel et al. 1978).

Study Plots

An extensive hummocky marsh was present in the northern half of Plot 1. Unlike Plot 2, the southwestern quarter of Plot 1 was covered with dead vegetation. The ground here was uneven and, except for small (less than or equal to 4 m in diameter) and deep (at least 1 m) water-filled holes, relatively dry. The plants may have been killed by salt water incursions from a nearby slough.

Plot 2 also had a large hummocky marsh, but fewer eiders nested here than in the Plot 1 marsh. However, Plot 2 was less than 0.5 km from a red fox den. In 1976 the den was active, and if it was active in previous years it may have influenced the distribution of nearby nesting waterfowl. Sargeant (1972) suggested that since dens are the focal points of fox activity, predation may be higher near dens than away from them.

Both in 1976 and 1977 Plot 1 covered 117.5 ha. However, in 1977 time constraints necessitated reducing the size of Plot 2 to 84.6 ha from 100.6 ha in 1976.

Plot 3 was an island in a large lake. The lake was approximately 970 m long and 240 m across at the widest point. This plot was well drained, and had no standing water. Its plant species are described in the chapter on habitat. The longest and widest points of the island measured 175 m and 24 m, respectively, yielding an area of approximately 0.33 ha. The island was at least 53 m from the nearest lake shore.

P. Mickelson visited the island periodically in 1976: 28 June and 8, 15, 19, and 26 July. The next year it became the third plot of the present study.

METHODS

Field Methods

Mainland

With two exceptions, nests in Plot 1 and 2 were found using a 50 m rope. It was stretched between two people with occasionally a third party positioned at the 25 m mark. With it either dragging on or slightly above the ground, investigators walked easterly and westerly until each plot was covered in its entirety (Table 1).

Instead of using a rope in Plot 2 during 1976 or in the Plot 1 marsh during 1977, two or three people walked abreast looking for nests. Investigators searching Plot 2 were approximately 7-12 m apart. In the marsh of Plot 1, they examined all possible nesting sites.

When a female eider flushed, the area was searched for a nest. Glaucous Gull nests were easily found due to the size of the nest and visibility of the adult birds.

Undoubtedly, a number of Common Eider nests were overlooked. Nests with little down and no attendant female or with a female that would not flush probably were missed during the initial search, although a number

Table 1. Activity schedule for 1976 and 1977 on Cape Espenberg, Alaska.

Event	1976	1977
Length of field season	4 June- 1 September	19 May-26 September
Plot 1 dragged for nests[a]	20,22 June	21-24 June
Plot 2 dragged for nests[a]	1,2,4 July	26,27,29 June 1,3 July
Plot 3 searched for nests	28 June[b] 8,15,19,26 July[b]	8-10, 12 July 22,23 August

[a]Nest search done by investigators walking side-by-side or dragging a rope between them.

[b]By P. G. Mickelson.

of such nests were detected at the time by careful observation. Likewise, nests that were initiated and destroyed before or after the plots were dragged were probably overlooked unless, as in the case of Common Eiders, they had copious amounts of down.

During both 1976 and 1977 each nest was assigned a number and the date, number of eggs, location, and flotation position to estimate incubation stage (Westerskov 1950) were recorded. We did not float eggs in every newly found nest in 1976 although it was done in 1977.

Tongue depressors were used as nest markers, and placed within one meter of the nest. Species, nest number, and date found were written on the markers.

In 1976 nest locations were recorded on hand-drawn maps showing lakes and a few other topographic features. That year most tongue depressors were placed about 20 cm from the edge of the nest. Many were removed, presumably by the incubating bird or avian predators. Because of loss of markers and inadequate maps, a number of 1976 Plot 1 nests could not be relocated.

To avoid similar confusion in 1977, a grid of stakes, each about 100 m apart, was established in Plots 1 and 2. Nests were precisely located by noting the distance and approximate compass direction from the nearest two grid stakes. As the inter-stake distances were known, the spatial distribution of nests could later be plotted on paper. In the field, only approximate distances and compass directions were necessary to relocate a nest. This procedure proved effective.

Although in 1977 markers were placed approximately one meter from nests and inserted about 12 cm into the ground, some loss still occurred. Fortunately, all 1977 nests with missing tongue depressors could be found again using the grid maps.

Each nest was revisited until it either hatched, or was destroyed. During nest checks the date, number of eggs and/or young, number of membranes (Girard 1939), and probably cause of egg or chick mortality were recorded, as well as incubation stage (Westerskov 1950).

Investigators walked through most of each plot while revisiting marked nests. As few additional gull or eider nests were found during this process, I felt the time and effort involved in dragging again was unwarranted.

In 1977 Common Eider and Glaucous Gull nests were placed in one or more of the following habitat categories:

Hummock. A somewhat flat-topped hillock about 0.75-2 m in diameter and 0.50 m in height. Most were found in marshy areas and, consequently, were surrounded by water for at least part of the field season.

Island. Usually these were approximately 1-2 m in diameter, and found near pond and lake shores.

Land. Any extensive area (approximately $\geq$ 600 m^2) that was not covered by water. This category included tussocks, some sedge mounds, and tundra ridges.

Peninsula. A projection into a pond or lake.

Sedge Mound. A slightly raised area covered by a dense sward of *Carex* spp. and possibly *Eriophorum* spp.; in marshes often these were barely above the water level at the start of the nesting season.

Shoreline. A strip no more than 5 m wide surrounding ponds and lakes.

Tundra Ridge. Well drained sandy ridges in the interior of the Cape. These were stabilized by various plant taxa.

Tussocks. "More or less columnar masses of tightly interwoven plants that stand above the substrate" (Johnson et al. 1966). The depressions between neighboring tussocks were usually covered with graminoids.

Minimum water depth and minimum distance from an edge of a hummock, island, or sedge mound supporting an eider or gull nest to $\leq$ 10 cm of water were recorded, or estimated at the time each nest hatched or, in the case of unsuccessful nests, when hatch would have occurred.

The same year, nest vegetation was sampled and exact location determined after the young left the nest. A hoop one meter in diameter was centered over the nest, and percent ground cover for all plant taxa and unvegetated portions (e. g. water, mud) of the quadrat was estimated. Plant specimens were identified using Hulten (1968), and verified by D. Murray of the University of Alaska Herbarium. Median shoot height was visually estimated with the aid of a ruler.

Percent ground cover and median vegetation height measurements were completed for 131 Common Eider and 40 Glaucous Gull nests.

Island

P. G. Mickelson visited the island in 1976 (Table 1). The following year I checked it once during incubation and once after hatch (Table 1).

The following description applies to the 1977 field season.

To find nests during the July visit, two people walked side-by-side along the length of the island. Because of its small size, we probably found every nest containing down present at that time. However, nests with no down, and destroyed before the visit or initiated afterwards would have been missed.

Before the search began, the plot was gridded with stakes to aid in nest relocation. Assigned nest number, species, number of eggs and/or young, and fate, if determinable, were recorded for each nest.

Eggs from 67 Common Eider and 1 Glaucous Gull nests were floated (Westerskov 1950).

Analysis

Habitat

Vegetation

My estimates of plant ground cover by species changed as the 1977 field season progressed. Often the raw percent cover values of a taxon in a quadrat assigned in the field did not sum to 100 percent. To correct this, the raw values for each quadrat were summed and divided into 100, generally yielding a different constant for each quadrat. When the raw values were multiplied by the appropriate constant, the then adjusted percent cover values would sum to 100 percent. Relative proportions between taxa in a given quadrat did not change after this manipulation. Because plant ground cover was generally uni-dimensional, I feel that manipulation of the data in this way gave a more precise cover value for each species.

All taxa assigned a raw percent cover value less than one percent in the field were arbitrarily given a raw percent cover value of 0.5. If multiplication with the quadrat-specific constant yielded an adjusted percent cover value greater than one, the calculated value was used. The lowest adjusted value given was one percent, even if the calculated value was less than one.

As percentages usually are not normally distributed, an arcsine transformation was applied to the adjusted percent cover values of vascular taxa to aid in the statistical analysis (Zar 1974).

Nesting Density

From aerial photographs taken in 1976 and ground truthing done in 1977, P. G. Mickelson and D. M. Tracy constructed a habitat map of Cape Espenberg (Schamel et al. 1978). It was used to calculate 1977 nesting densities for Common Eiders and Glaucous Gulls.

Unfortunately, some ponds were incorrectly located on the section of map containing Plot 1. Ponds were essentially the only landmarks visible on the base map, and contributed markedly to habitat mapping accuracy. Because of this, I did not calculate nesting densities by habitat for Plot 1.

In Plot 2, the area of each habitat category on the map--land, tundra ridges, tussocks, marsh hummocks, and shoreline--was cut out and pieces were placed in five appropriate groups. The weight of each group was converted to an area measurement.

By dividing the number of nests in each habitat by the area of the habitat, nesting densities for Common Eiders and Glaucous Gulls were determined.

Nesting density of Common Eiders on Plot 3 was calculated in a similar fashion. The area of the island was estimated by dividing it into rectangles and summing the results. Division of the number of nests present in July by the total area yielded the nesting density.

Phenology

There is a controversy as to when Common Eiders commence incubation. A number of investigators maintain that usually eiders start incubating by the time the third or fourth egg has been laid (Gross 1938, Belopol'skii 1957, Cooch 1965). However, a bird sitting on a clutch is not necessarily incubating because it may not be applying maximum body heat to the eggs (Pettingill 1970).

Synchrony of hatch is not always indicative of when incubation began. Clicking noises made by the chicks a few days before they hatch can either speed up or retard development enabling the clutch to hatch synchronously (Vince 1969). Thus, even though Choate (1966) and Milne (1963) found eggs in most Common Eider clutches hatch within 24 hours of each other, it does not necessarily show that incubation began with the last egg laid.

Many researchers use Kendeigh's (1963) definition of incubation, i. e. the interval between the laying of the last egg and the hatching of that egg. Milne (1963), using Kendeigh's definition, reported an incubation period of 25.9 days for 61 Common Eider nests. Choate (1966) defined incubation period as being from the deposition of the last egg to "date of hatch", a period of 26 days for S. m. dresseri in Maine. Schamel (1974) also found the incubation period of S. m. v-nigra to be 26 days.

I used Choate's (1966) definition of incubation period and length, and assumed one egg was laid per day (Beetz 1916, Milne 1963, Cooch 1965, Sabean 1972). Guignion (1967) and Bourget (1970) followed the same procedure.

In 1977 I floated eggs from 67 Common Eider nests and 1 Glaucous Gull nest on Plot 3 to calculate initiation and hatch dates (Westerskov 1950). Because many eider nests contained unusually large clutches suggesting intra-specific nest parasitism, all eggs of a clutch of six or more eggs were floated; otherwise only one egg per clutch was done. If time incubated differed between eggs of a large clutch, the most frequent value was assigned to the nest. A maximum of eight days was assigned for laying regardless of clutch size.

I used Strang's (1976) interval of 27 days between the day the last egg was laid to the day the last chick emerged as the incubation period for Glaucous Gulls. Uspenski (1956) stated that incubation begins when the first egg is laid; he calculated an incubation period of 28 days, but only had a sample size of three nests. Hortling (1929-1931 cited by Uspenski 1956) reported 27-28 days of incubation. One egg is laid every 1 1/2 to 2 days (Uspenski 1956).

Production

Although there are dangers in drawing conclusions from nesting success data without taking the exposure time of each nest into account, Mayfield's (1961, 1975) method could not be applied to my data.

Many of the destroyed nests were found in that condition and, since initiation dates and dates of predation were unknown, could not be assigned exposure values. As such, these nests would have to be excluded from analysis. This, in turn, would leave a greater proportion of successful nests in the data set than in the population from which it was drawn, biasing the calculations towards a higher survival rate than was actually the case.

Eider nests initiated early and late in the nesting season may have different clutch sizes and probabilities of hatching. To investigate this, I designated a 1977 nest initiated before 20 June as an early nest; a late nest was initiated after that date. Similarly, in 1976 a clutch begun before 26 June was called early with the remainder designated as a late clutch. These dates were somewhat arbitrarily chosen after examining the initiation-over-time curves.

Terms used to describe nest fate are:

Successful. A nest known to have hatched at least one young. Either young or membrane(s) (Girard 1939) were seen in the nest.

Unsuccessful. A nest which did not hatch any young.

Destroyed. A nest that lost all eggs to predators.

RESULTS AND DISCUSSION

Habitat

Vegetation

Common Eiders nest in many different plant communities throughout their range. The more southerly subspecies *Somateria mollissima dresseri* and *S. m. mollissima* generally have more plant cover over the nest than do *S. m. sedentaria*, *S. m. borealis*, and *S. m. v-nigra*.

The subspecies found along northeastern North America, *S. m. dresseri*, has been found nesting under raspberry (*Rubus idaeus*) bushes (Sabean 1972), gooseberry (*Ribes cynosbati*) thickets (Paynter 1951), coniferous woods (Guignion 1967, Sabean 1972), cow parsnip (*Heracleum maximum*), and grasses (Choate 1966, Clark 1968).

In Scotland, *S. m. mollissima* nests in "medium heather", "rushes and heather", and "rushes in waterways" communities (Milne 1963). Andersson (1968 cited by Ahlen and Andersson 1970) saw ducks incubating eggs under dense juniper bushes and shrubs in addition to those on sparsely vegetated islands in southern Sweden. Tussocks, overhanging rocks, tufts of grasses and shrubs provide nesting cover in Murman, U. S. S. R. (Belopol'skii 1957).

The Northern Eider S. m. borealis, even though nesting on open tundra and slopes (Belopol'skii 1957), use rocks or similar structures as shelter from the weather (Cooch 1965, Hagelund and Norderhaug 1975). Edwards (1957) found many eiders nesting on high rocky islands with ledges and rocks. No nests were seen on relatively smooth and rounded islands. In Spitsbergen many nests were found in a sward of Festuca rubra (Ahlen and Andersson 1970).

Nests of the Pacific Eider S. m. v-nigra have been found under overhanging rocks, under bushes, on beaches, in short grasses (Gabrielson and Lincoln 1959 cited by Schamel 1974), in clumps of Elymus arenarius and Honckenya peploides, and among debris at the high water mark along the coast (Schamel 1974).

Mainland

Ninety-five vascular plant taxa were identified from the 1976 and 1977 field seasons. Thirty-two taxa were present around Common Eider and/or Glaucous Gull nests (Table 2).

To facilitate data collection, some species were grouped in their respective genera. Species of Stellaria, Carex, Eriophorum, Arctostaphylos, Epilobium, and Ped-

Table 2. Frequency of occurrence and percent cover of vascular plant taxa near Common Eider and Glaucous Gull nests on Cape Espenberg, Alaska.

	Percent Occurrence			Percent Cover (Mean ± S. D.)		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Betulaceae						
Betula sp.	67.94 (89[b])	***	22.50 (9[b])	14.2 ± 5.5	***	3.9 ± 0.9
Caryophyllaceae						
Stellaria sp.	18.32 (24)	**	37.50 (15)	1.5 ± 0.3	*	5.0 ± 5.5
Compositae						
Artemesia Tilesii	10.69 (14)	**	30.00 (12)	34.2 ± 16.4	NS	38.7 ± 8.9
Chrysanthemum arcticum	9.92 (13)	*	25.00 (10)	4.0 ± 1.2	NS	9.0 ± 4.0
Petasites frigidus	1.53 (2)	NS	5.00 (2)	2.3 ± 0.5	NS	3.9 ± 0.1
Tripleurospermum phaeocephalum	1.53 (2)	***	32.50 (13)	1.0 ± 0.0	NS	8.2 ± 3.5

Table 2 (Cont'd)

	Percent Occurrence			Percent Cover (Mean ± S. D.)		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Cruciferae						
Cochlearia officinalis	5.34 (7)	***	52.50 (21)	2.1 ± 0.4	NS	3.8 ± 1.3
Cyperaceae						
Carex spp.	85.50 (112)	**	30.00 (12)	34.4 ± 20.8	**	3.6 ± 1.8
Eriophorum spp.	3.05 (4)	NS	0.00 (0)	4.4 ± 1.6	-	-
Empetraceae						
Empetrum nigrum	62.60 (82)	***	17.50 (7)	6.9 ± 3.4	NS	3.8 ± 1.8
Ericaceae						
Andromeda polifolia	31.30 (41)	***	2.50 (1)	1.1 ± 0.2	-	1.0 ± -
Arctostaphylos spp.	24.43 (32)	*	7.50 (3)	2.3 ± 0.4	NS	1.9 ± 0.1
Cassiope tetragona	6.87 (9)	NS	0.00 (0)	3.4 ± 2.0	-	-
Ledum palustre	51.15 (67)	***	5.00 (2)	1.6 ± 0.2	NS	1.0 ± 0.0

Table 2 (Cont'd)

	Percent Occurrence			Percent Cover (Mean ± S. D.)		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Loiseleuria procumbens	2.29 (3)	NS	0.00 (0)	13.5 ± 21.1	-	-
Vaccinium uliginosum	32.06 (42)	***	2.50 (1)	2.9 ± 0.9	-	9.0 ± -
Vaccinium vitis-idaea	54.20 (71)	***	10.00 (4)	2.8 ± 1.1	NS	2.1 ± 0.5
Gramineae	38.93 (51)	***	92.50 (37)	8.1 ± 7.4	***	45.6 ± 15.0
Onagraceae						
Epilobium spp.	3.82 (5)	NS	12.50 (5)	5.2 ± 8.1	NS	5.3 ± 3.6
Polemoniaceae						
Polemonium acutiflorum	32.06 (42)	***	65.00 (26)	2.7 ± 0.8	***	11.1 ± 4.3
Polygonaceae						
Polygonum viviparum	0.76 (1)	-	0.00	1.0 ± -	-	-

Table 2 (Cont'd)

	Percent Occurrence			Percent Cover (Mean ± S. D.)		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Rumex arcticus	1.53 (2)	NS	7.50 (3)	18.9 ± 0.3	NS	38.7 ± 12.2
Ranunculaceae						
Caltha palustris	6.11 (8)	NS	7.50 (3)	3.4 ± 0.5	NS	1.3 ± 0.1
Rosaceae						
Potentilla palustris	52.67 (69)	NS	65.00 (26)	5.9 ± 4.2	NS	9.4 ± 2.9
Rubus chamaemorus	45.80 (60)	**	22.50 (9)	4.0 ± 1.3	*	8.5 ± 3.0
Salicaceae						
Salix spp.	47.33 (62)	NS	32.50 (13)	10.3 ± 7.3	NS	7.2 ± 3.8
Saxifragaceae						
Chrysosplenium tetrandum	1.53 (2)	NS	2.50 (1)	1.0 ± 0.0	-	5.0 ± -
Saxifraga exilis	5.34 (7)	-	0.00	1.0 ± 0.0	-	-

Table 2 (Cont'd)

	Percent Occurrence			Percent Cover (Mean ± S. D.)		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Scrophulariaceae						
Pedicularis spp.	2.29 (3)	-	0.00	1.5 ± 0.2	-	-
Umbelliferae						
Angelica lucida	0.76 (1)	NS	7.50 (3)	2.0 ± -	-	11.1 ± 4.7

[a]NS $P > 0.05$
* $0.01 < P < 0.05$
** $0.001 < P < 0.01$
*** $P < 0.001$

[b]Number of nests.

icularis found on Cape Espenberg are given in Table 3.

Eriophorum spp. may have been overlooked in dense stands of Carex spp., Pedicularis spp., Polygonum viviparum, and Saxifraga exilis may also have been inadvertently omitted from some samples. Unless flowering, the latter three taxa were relatively inconspicuous. Consequently, these groups have been omitted from this discussion.

Percent occurrence of Angelica lucida, Cassiope tetragona, Chrysosplenium tetrandum, Loiseleuria procumbens, Caltha palustris, Epilobium spp., Petasites frigidus, Potentilla palustris, Rumex arcticus, and Salix spp. did not differ significantly between eider and gull nests (Table 2). Percent cover of the latter six taxa was the same at both gull and eider nests (Table 2). Because of small sample sizes, percent cover values of Angelica lucida, Cassiope tetragona, Chrysosplenium tetrandum, and Loiseleuria procumbens could not be tested statistically.

Andromeda polifolia, Arctostaphylos spp., Empetrum nigrum, Ledum palustre, Vaccinium uliginosum, V. vitis-idaea, Rubus chamaemorus, Betula sp. (probably B. nana), and Carex spp. occurred significantly more frequently around Common Eider nests. Betula sp. and Carex spp. covered a greater percent of ground around eider nests than around gull nests. The converse was true for Rubus chamaemorus (Table 2).

Grass spp., Polemonium acutiflorum, and Stellaria

Table 3. Plant genera near Common Eider and Glaucous Gull nests not identified to species during data collection on Cape Espenberg, Alaska.

Genus	Species on Cape
Arctostaphylos	*A. alpina*
	A. rubra
Carex	*C. aquatilis*
	C. chordorrhiza
	C. Gmelini
	C. rariflora
	C. rostrata[a]
	C. saxatilis
	C. sitchensis[a]
Epilobium	*E. angustifolium*
	E. palustre[a]
Eriophorum	*E. angustifolium*
	E. russeolum
	E. Scheuchzeri
Pedicularis	*P. capitata*
	P. labradorica
	P. lanata
	P. parviflora
	P. sudetica
Stellaria	*S. crassifolia*[a]
	S. humifusa
	S. monantha

[a]Specific identification questionable.

spp. covered more extensive areas near Glaucous Gull nests than near eider nests. Artemesia Tilesii, Chrysanthemum arcticum, Cochlearia officinalis, Tripleurospermum phaeocephalum, grass spp., Polemonium acutiflorum, and Stellaria spp. were associated more frequently with gull nests than eider nests (Table 2).

Differences in frequency and percent ground cover between plant taxa at eider and gull nests could be caused by birds utilizing different habitats, avian activities at the nest, or a combination of both.

Although habitats did overlap, eiders nested more often in dry areas than did Glaucous Gulls (Table 4). In Plot 1, gulls nested significantly more often on islands, whereas eider utilized sedge mounds more often than did gulls. Gulls in Plot 2 favored islands, shorelines, and peninsulas more than did eiders which nested mostly on hummocks, tussocks, and land. As summer progressed and the standing water level decreased, it was apparent that most islands, shorelines, and peninsulas remained wetter than did sedge mounds, tussocks, and land.

Plant taxa in the vicinity of the nests reflect a difference in soil moisture (Table 5). Most plant species characteristic of eider nests are indicative of well drained areas such as heathlands (Polunin 1960), although Vaccinium uliginosum and V. vitis-idaea are found in both dry and moist areas (Porsild 1973). Rubus chamaemorus was an

Table 4. Distribution of Common Eider and Glaucous Gull nests by habitat on Cape Espenberg, Alaska, during 1977.

	Percent Occurrence					
	Plot 1			Plot 2		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Hummock	58.93 (66)[b]	NS	43.48 (10)	57.14 (56)	***	17.19 (11)
Island	0.00	***	17.39 (4)	3.06 (3)	***	25.00 (16)
Land	8.03 (9)	NS	0.00	19.39 (19)	***	0.00
Peninsula	4.46 (5)	NS	4.35 (1)	9.18 (9)	***	43.75 (28)
Sedge Mound	23.21 (26)	*	0.00	1.02 (1)	NS	0.00
Shoreline	34.82 (39)	NS	56.52 (13)	29.59 (29)	***	70.31 (45)

Table 4 (Cont'd)

	Percent Occurrence					
	Plot 1			Plot 2		
	Common Eider	P[a]	Glaucous Gull	Common Eider	P[a]	Glaucous Gull
Tundra Ridge	0.00	NS	0.00	3.06 (3)	NS	0.00
Tussocks	6.25 (7)	NS	0.00	11.22 (11)	*	0.00

[a]NS $P > 0.05$
* $0.01 < P < 0.05$
** $0.001 < P < 0.01$
*** $P < 0.001$

[b]Number of nests.

Table 5. Habitats of plant species having a significantly different frequency of occurrence or percentage ground cover between Common Eider and Glaucous Gull nests on Cape Espenberg, Alaska.

Taxon	Habitat
Andromeda polifolia	peat bogs (Hulten 1968)
Arctostaphylos spp.	dry sandy places (Hulten 1968)
Artemesia Tilesii	subsp. *Tilesii*: sandy places (Hulten 1968) subsp. *elatior*: lowlands (Hulten 1968)
Chrysanthemum arcticum	moist meadows or gravels (Porsild 1973)
Cochlearia officinalis	"not too dry places" (Porsild 1973)
Empetrum nigrum	heaths (Hulten 1968)
Ledum palustre	heaths, dry rocky places (Hulten 1968)
Polemonium acutiflorum	wet meadows, along streams (Hulten 1968)
Rubus chamaemorus	moist peaty and turfy places (Porsild 1973)
Stellaria spp.	*S. crassifolia*: wet places (Hulten 1968) *S. humifusa*: occasionally flooded meadows (Porsild 1973) *S. monantha*: stony places in mountains and on tundra (Hulten 1968)

Table 5 (Cont'd)

Taxon	Habitat
Tripleurospermum phaeocephalum	seashores (Hulten 1968)
Vaccinium uliginosum	acid soil, dry as well as moist places (Porsild 1973)
Vaccinium vitis-idaea	as for V. uliginosum

exception. However, this species in association with Arctostaphylos spp., Empetrum nigrum, Ledum palustre, Vaccinium uliginosum, and V. vitis-idaea may indicate a change from bog-like to heath-like conditions (Polunin 1960). Such a change may be occurring at some Common Eider nesting sites on Cape Espenberg.

Polemonium acutiflorum and Stellaria spp. were the only taxa that had significantly more ground cover and occurred more often at Glaucous Gull nests than at eider nests (Table 2). Both taxa are found on wet sites (Table 5). Chrysanthemum arcticum and Cochlearia officinalis are characteristic of damper sites. Unfortunately, Artemesia Tilesii was not identified to subspecies, and, thus, cannot be used as a measure of soil moisture.

In addition to habitat differences between eider and gull nest sites, there is evidence that feces and possibly unutilized food promotes plant growth and perhaps occurrence. Porsild (1973) states that Cochlearia officinalis is highly nitrophilous and "is much favored by the manure of nesting sea-birds". Likewise, Uspenski (1956) notes that C. arctica grows luxuriantly near Glaucous Gull nests because of the fertilizing effect of their droppings.

Judging from their behavior, gulls should provide more nutrients to nearby vegetation than should Common Eiders. As both parents share incubation duties (Uspenski 1956), incubating gulls have an opportunity to feed, whereas incubating eiders feed little if at all (Cooch 1965, Schamel 1974, Korschgen 1977). Differences in nutrient output should be reflected by nutrient input. Also, gull chicks remain in or near the nest for 42-48 days (Uspenski 1956); a female eider and brood leave the nest approximately 24 hours after hatch (Milne 1963, Guignion 1967).

In addition to feces, nutrients from unconsumed food would be available to plants near Glaucous Gull nests. In 1976 I found unused food beside several nests containing chicks. However, I do not know how long it remained before it was eaten.

Decomposition of accumulated nesting materials may promote plant growth. Although Cooch (1965) and Belopol'skii (1957) reported that eider nests used repeatedly for several years were surrounded by a ring of detritus, no organic accumulation was seen at eider nests on Cape Espenberg. In contrast, Glaucous Gull nests were built on mounds of dead vegetation, much of it probably accumulated during previous nesting seasons. Nutrients released from nesting material should affect nearby plants.

The vegetation was significantly higher ($P < 0.05$, t-test) around Glaucous Gull nests (15.10 ± 12.55 cm [S. D.], $n = 40$) than around Common Eider nests (11.00 ± 8.14 cm, $n = 128$). Vegetation heights were measured after the birds left the nest in order to minimize disturbance. I do not know if the difference in height was present while both bird species were nesting.

Plant species which had a significantly greater frequency of occurrence at eider nests include many of what Polunin (1960) called low arctic heathland dominants. He states that the typical height for this community is 8-15 cm, a range that includes median vegetation height near Cape Espenberg eider nests.

Differences in mean vegetation height at Common Eider and Glaucous Gull nests probably are due to species composition and differential nutrient input from the nesting birds.

Island

Vascular plant taxa included *Artemesia Tilesii*, *Salix* sp., *Angelica lucida*, *Epilobium angustifolium*, and *Rumex arcticus*. In addition, grass spp., *Rubus chamaemorus*, *Ledum palustre*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Betula* sp. (probably *B. nana*), *Empetrum nigrum*, and *Andromeda polifolia* were found interspersed primarily near the middle of the island.

Willows (*Salix* sp.) were located on the southcentral portion of the island. Between 8-12 July 1977 they were the tallest plants present, approximately 35-55 cm high. At that time and probably throughout the nesting season, willows provided the tallest and densest nesting cover.

Although by late August clumps of <u>Artemesia</u> <u>Tilesii</u> were approximately 65-75 cm high, in mid-July most were no more than 20 cm tall.

Even though many eiders nested among <u>Artemesia</u> clumps, it seemed that nests were most dense under the willow shrubs.

Nesting Density

Mainland

Land, as defined in Methods, comprised 57 percent of Plot 2 in 1977, followed by tussocks (32 percent), hummocks (29 percent), tundra ridges (19 percent), and shorelines (5 percent). The number of Common Eider and Glaucous Gull nests in each habitat, with one exception, was not directly proportional to the area of each habitat (Table 6). Only the number of Glaucous Gull nests on hummocks was proportional to the area of that habitat (Table 6).

Eiders nested on shorelines and hummocks at the expense of land, tundra ridges, and tussocks (Tables 6, 7). The greatest density of gull nests was on shorelines (Table 7). No gulls nested on tussocks, land, or tundra ridges (Tables 6, 7). The gulls neither avoided nor preferentially selected hummocks as nesting sites (Table 6).

In Scotland, eiders favored habitats less prone to

Table 6. Number of nests observed and expected if the number of nests in a habitat were directly proportional to the area of the habitat. "P" is the probability the observed and expected values were statistically different by chi-square analysis in Plot 2 on Cape Espenberg, Alaska, in 1977.

	Hummocks	Land	Shoreline	Tundra Ridge	Tussocks
Common Eider					
Observed Nests	56	19	29	3	11
Expected Nests	28.4	55.4	4.6	18.5	31.2
P[a]	***	***	***	***	***
Glaucous Gull					
Observed Nests	11	0	45	0	0
Expected Nests	18.6	36.2	3.0	12.1	20.4
P[a]	NS	***	***	***	***

[a] NS $P > 0.05$
*** $P < 0.001$

Table 7. Number and density of Common Eider and Glaucous Gull nests by habitat in Plot 2 during 1977 on Cape Espenberg, Alaska.

	Hummocks	Land	Shoreline	Tundra Ridge	Tussocks
Common Eider					
Number of Nests	56 (57.1)[a]	19 (19.4)	29 (29.6)	3 (3.1)	11 (11.2)
Density[b]	228.3	39.7	732.2	18.8	40.8
Glaucous Gull					
Number of Nests	11 (17.2)[c]	0 (0)	45 (70.3)	0 (0)	0 (0)
Density[b]	48.9	0	113.6	0	0

[a]Percentage of total eider clutches (98).

[b]Number of nests per 10^6 m^2.

[c]Percentage of total gull clutches (64).

predation for nesting (Gorman 1974). Birds nested more densely in rushes and long heather than in dunes, medium heather, short heather, or grass. No nests in rushes or long heather were destroyed by predators, but up to 67 percent of clutches in the remaining habitats were destroyed in one year of the study. Gorman (1974) concluded the pattern of habitat selection by Common Eiders is of selective value as the areas selected most frequently offered the greatest protection against nest predation. He believes that the most popular habitats provided better cover than did the less popular ones.

The high densities of eiders and gulls on shorelines could mean: 1) both species choose similar nesting habitats, given the range of habitats available on Cape Espenberg, 2) the overlap in preferred nesting habitats between gulls and eider, if it does exist, is only partial, or 3) eiders select nesting sites near Glaucous Gull colonies.

The third explanation for the pattern of habitat use is that eiders choose nesting sites near gull colonies. Glaucous Gulls usually initiate clutches before eiders (Belopol'skii 1957, Schamel 1974); on Cape Espenberg it appears that wherever Glaucous Gulls nested eiders would nest nearby. For example, several large lakes were present in Plot 1, but by far the majority of gulls and eiders nested on hummocks. Conversely, the greatest densities of gull and eider nests in Plot 2 were along shorelines even though many hummocks were present. The eiders may have been selecting nest sites near gull colonies rather than a given habitat (such as shorelines or hummocks), or a combination thereof.

Eider-larid interactions are more fully discussed in the following chapters.

Island

At the time of the July 1977 visit (Table 1), there were 322 Common Eider and 2 Glaucous Gull nests on Plot 3, an area of approximately 0.33 ha. This is a density of about 975 eider nests per hectare or 9.75 nests per 10 m^2.

It seemed that eider nests were densest under the willow shrubs of Plot 3.

Most other island colonies with published density figures have fewer eiders per hectare than did Plot 3 of this study: 250 nests on the Farne Islands, U. K. (Marshall 1967), 41-96 nests on the Maine coast, U. S. A. (Choate 1966), 5-7 nests in Alaska, U. S. A. (Schamel 1974), and 12 nests on the Nova Scotia coast, Canada (Sabean 1969). However, in West Spitsbergen, Norway, Ahlen and Andersson (1970) researched a colony with more than 3,333 nests per hectare.

The nesting season was advanced by the time I visited the island. Probably some eider nests were initiated and destroyed previous to mid-July and, consequently, not included in the density calculations. Because of this, I suspect more than 9.75 eider nests per 10 m^2 were initiated during the nesting period.

In 1976 only one active Glaucous Gull nest was found (P. Mickelson, pers. comm.).

Phenology

Perrins (1970), in a general paper on avian breeding seasons, stated that the amount of food available to the female while she is forming eggs, age of the female, and duration of the pair bond help determine laying dates. Spurr and Milne (1976) considered only Common Eiders. Their findings were that age, body weight, and time of pair formation affected laying date. First-time breeders, birds below average body weight, and individuals paired after mid-winter tended to lay later than experienced breeders, heavier birds, or those having a mate before mid-winter.

Late seasons may result in a reduction of the proportion of laying females (Cooch 1965, Dau 1976, Milne 1976) or mean clutch size (Dau 1976, Milne 1976).

Weather

Reliable weather data for Cape Espenberg was spotty in 1976 and 1977 due to equipment problems. Consequently, the climatological data presented is from Kotzebue, a city approximately 50 km northeast of Cape Espenberg.

Even though the Cape and Kotzebue are both on Kotzebue Sound and relatively close geographically, weather conditions did differ in 1976 and 1977. Judging from KOTZ radio station weather reports for Kotzebue, Espenberg seemed to have less fog and overcast than did Kotzebue. In spite of discrepancies, though, Kotzebue weather does roughly represent the conditions on Cape Espenberg.

The weather data presented in Tables 8 and 9 were summarized from the U. S. Department of Commerce pamphlets (1977, 1978) on Kotzebue climatological data for 1976 and 1977.

Mainland

Average monthly temperatures during May-August were lower in 1976 than in 1977 based on National Weather Service records for Kotzebue (Table 8). Fred Goodhope (pers. comm.), a long-time summer resident of Cape Espenberg, commented that spring and early summer of 1976 were colder than most years.

The condition of the ice adjoining the north shore of the Cape reflected temperature differences between 1976 and 1977. Ice did not disintegrate or blow away until 18 July 1976; in 1977 this occurred by 19-25 June.

Nest initiation in 1976 was later than in 1977. The first Common Eider and Glaucous Gull nests containing at

Table 8. Climatological data for Kotzebue, Alaska, April-October 1976 and 1977.[a]

	Temperature (°C)						Precipitation (mm)		Wind (km/hr)	
	1976			1977			Total Water Equivalent		Average Speed	
	Average Monthly	Highest Extreme	Lowest Extreme	Average Monthly	Highest Extreme	Lowest Extreme	1976	1977	1976	1977
April	-14.4	-1.1	-33.9	-15.8	2.8	-30.6	1.3	10.7	15.1	18.5
May	-1.1	9.4	-10.6	-0.8	11.7	-16.1	3.0	7.9	21.2	22.0
June	4.1	18.3	-1.1	6.6	17.2	-2.8	17.3	0.5	18.3	23.2
July	10.5	21.2	-1.1	14.9	28.9	1.1	29.5	0.3	21.6	20.9
August	12.9	18.9	6.1	14.9	23.3	5.0	12.2	18.0	16.4	21.6
September	7.0	15.0	0.6	6.6	15.6	-3.9	34.0	109.5	19.6	27.4
October	-4.0	6.7	-17.2	-4.1	7.8	-18.9	11.4	28.7	27.8	23.8

[a]From U. S. Department of Commerce (1977, 1978).

Table 9. Climatological data for Kotzebue, Alaska, 1941-1970.[a]

	Average Monthly Temperature (•C)	Precipitation--Total Water Equivalent (mm)	Mean Wind Speed (km/hr)
April	-10.6	8.4	20.6
May	-0.7	10.2	17.7
June	6.4	13.2	19.8
July	11.6	39.4	20.9
August	10.4	57.4	21.4
September	5.1	36.3	21.1
October	-4.7	38.9	22.0

[a]From U. S. Department of Commerce (1977).

least one egg were found 10 June and 9 June, respectively, in 1976. The next year the first Common Eider nest was seen on 4 June (D. Matkin pers. comm.). In 1977 the first Glaucous Gull nest was discovered 31 May (D. Schamel pers. comm.). These trends were followed in Plot 2 and possibly Plot 1 (Table 10).

Frequency distributions of Common Eider and Glaucous Gull nest initiation for both 1976 and 1977 are presented in Figures 2 to 4. Hatching dates of Common Eider nests are similarly shown in Figure 5.

When these distributions were compared statistically, both Common Eiders and Glaucous Gulls were found to have initiated egg laying significantly earlier in 1977 than in 1976 ($P < 0.05$, Mann-Whitney U test). However, these results could be an artifact of the sampling methods.

The distributions presented in Figures 2, 3, and 4 represent nests with both a known date of initiation (e. g. 15 June) (here designated as Type A) and those having a range of dates during which initiation occurred (e. g. before or on 1 July) (Type B). Most nests in the latter category were found destroyed; hence, their exact initiation dates were unknown. Type B nests were assigned the latest plausible date as the date of initiation.

In 1977 investigators spent much time in the study plots prior to systematically searching for nests. This was not the case in 1976. Thus, in 1977 the initiation

Table 10. Earliest known nest initiation and hatch dates in Plot 2 during 1976 and 1977 on Cape Espenberg, Alaska.

	Initiation		Hatch	
	1976	1977	1976	1977
Common Eider	11 June	31 May	10 July	1 July
Glaucous Gull	2 June	30 May	-	-

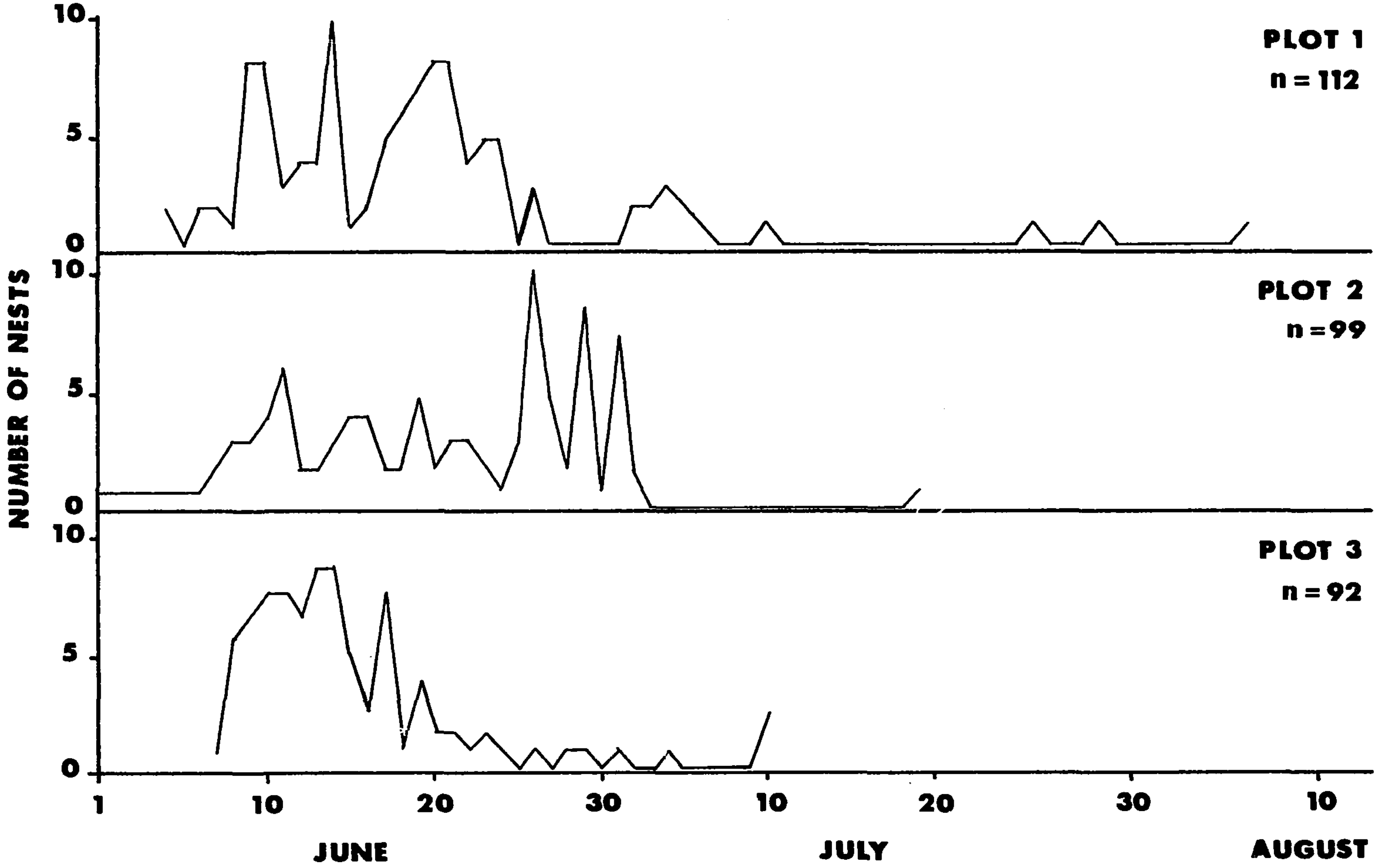

Figure 2. Common Eider nest initiation dates in 1977 on Cape Espenberg, Alaska.

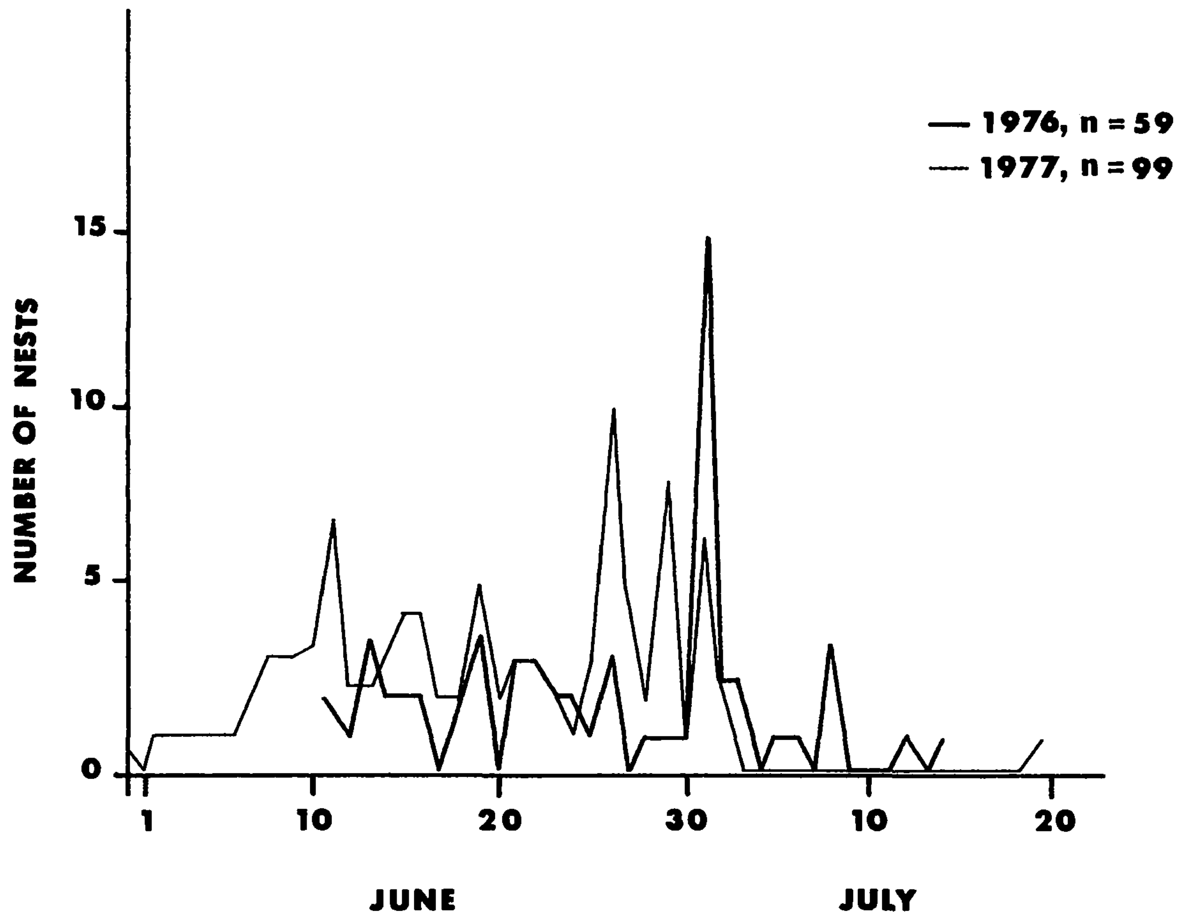

Figure 3. Common Eider nest initiation dates in Plot 2 on Cape Espenberg, Alaska.

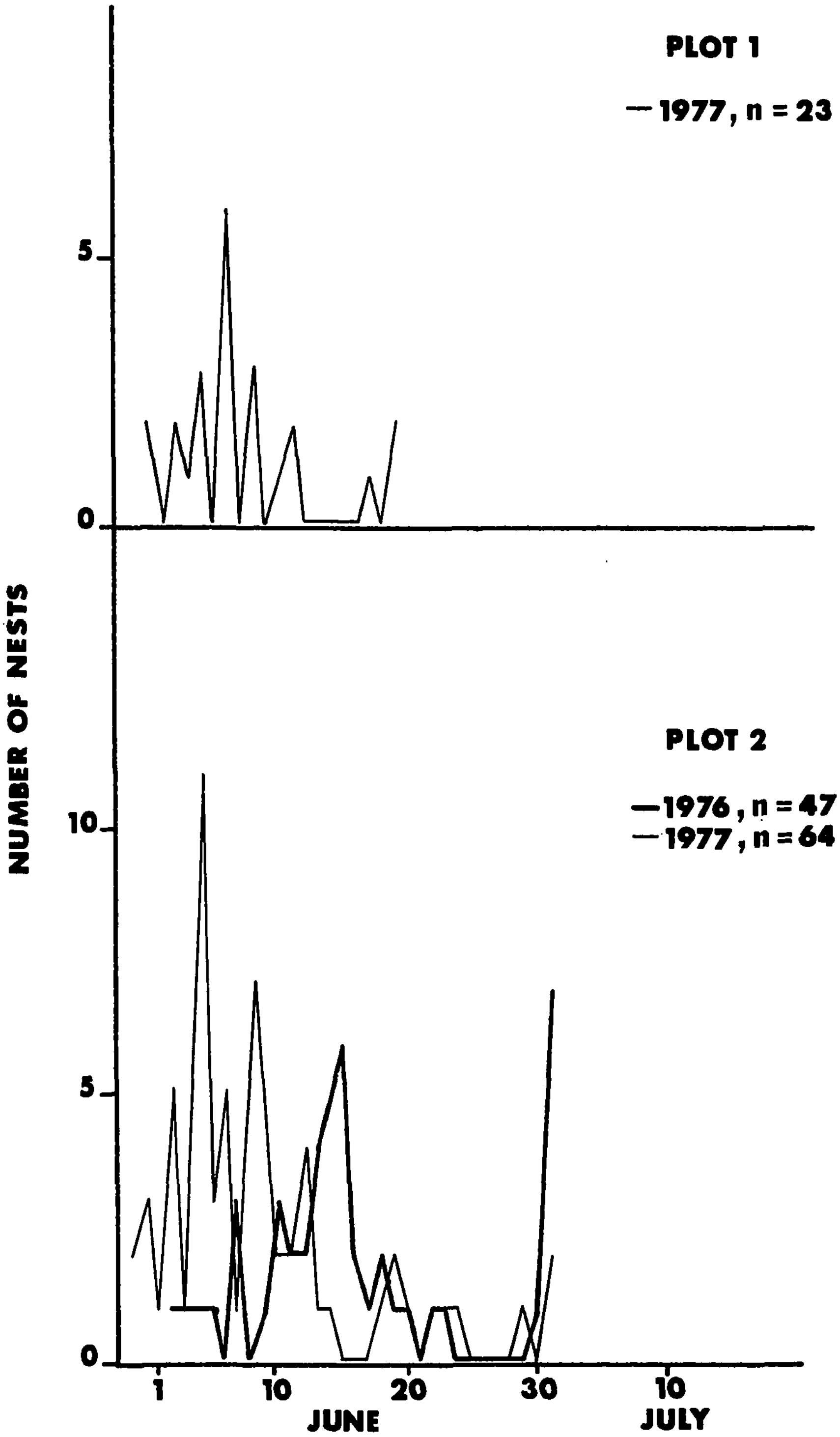

Figure 4. Glaucous Gull initiation dates during 1976 and 1977 on Cape Espenberg, Alaska. Data from Plot 1 for 1976 omitted because of ambiguous nest data.

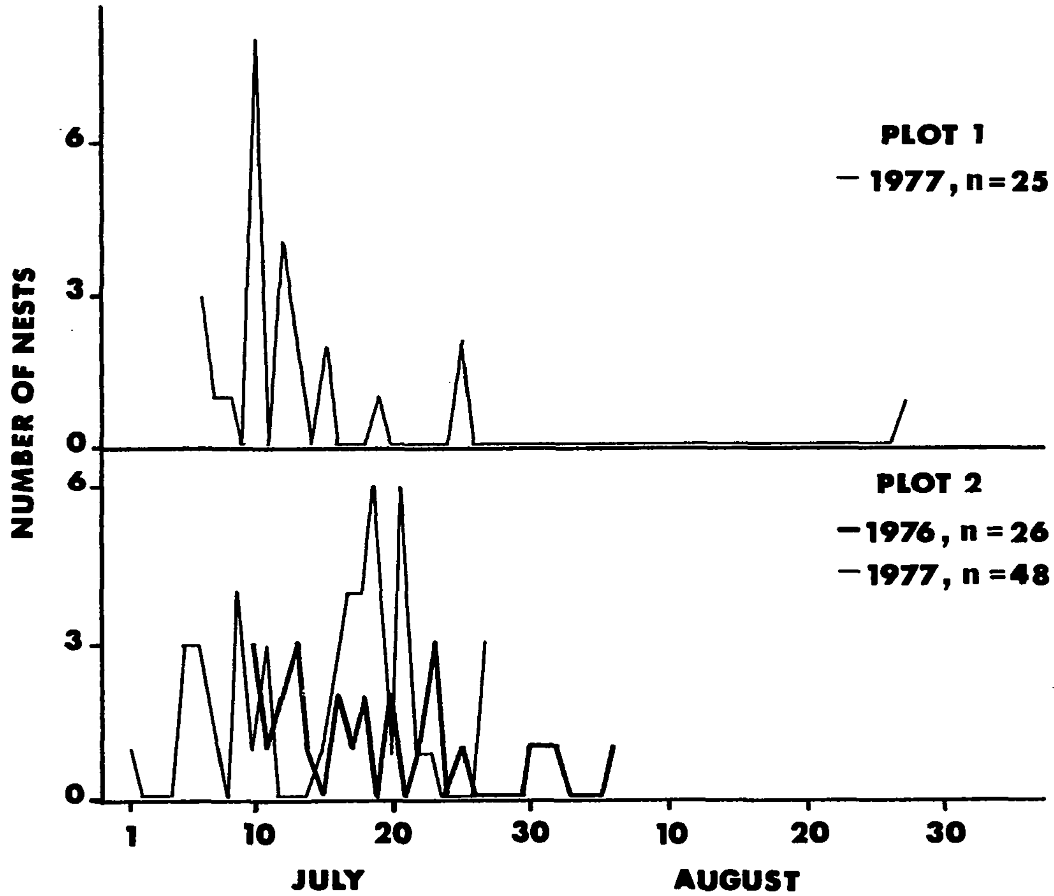

Figure 5. Common Eider hatch dates during 1976 and 1977 on Cape Espenberg, Alaska. Data from Plot 1 for 1976 omitted due to ambiguities.

dates of more early nests could be recorded as a single date even if these nests were destroyed by the time the plot was searched thoroughly. In 1976 nests initiated and destroyed before the plots were searched for nests by the rope dragging method might have been assigned initiation dates many days later than the true dates.

Alternatively, only nests with known dates of initiation, i. e. Type A nests, could have been used to compare both field seasons. However, for reasons outlined above, a greater proportion of the early nests in 1977 would be included in the statistical analysis than for 1976. Although biases are present when both Type A and B nests are combined and statistically compared, probably it is a more realistic method than comparing only Type A nests. When initiation dates for 1976 and 1977 are ranked for a Mann-Whitney U test, probably the test will show more overlap between years when Type B nests are included in the analysis.

To summarize, the data suggest that: (1) initiation of laying for both eiders and gulls was later in 1976 than in 1977 and (2) hatching dates for eider clutches were the same both years of the study.

Eider nests with both a range of hatching dates (Type B) and known hatching dates (Type A) were used to test differences in hatching chronology between 1976 and 1977. No significant difference was found ($P > 0.05$, Mann-Whitney

U test).

When the same test and significance levels were applied to nests with known hatching dates (Type A) only, no significant difference was present. This was expected as actual hatching dates (Type A) were known for all 1976 Plot 2 nests; in 1977 92 percent (n = 44) of Plot 2 nests were in this category.

If an incubating eider or her clutch are protected by nearby nesting Glaucous Gulls, selection should favor relatively short eider-gull internest distances. Assuming nest sites were limiting, eiders nesting earlier probably would be closer to the nearest active gull nest than would later nesting ducks. No such relationship existed in either Plot 1 or 2 during 1977 ($P > 0.05$, ANOVA) (Fig. 6). Two explanations are: (1) eider nest sites near Glaucous Gull nests were not limiting or (2) eiders do not consider the nearest gull nest when choosing a nest site.

The majority of eider nests were initiated within 40 m of the nearest active gull nest: 62 percent in Plot 1 and 51 percent in Plot 2. This could represent similar habitat needs or an interspecific attraction.

Common Eider initiation and hatching dates differed little between habitats in 1977. Because habitat differences in nesting chronology, if present, might only be a few days, only nests with known dates of initiation or hatch (Type A) were compared. Including nests with a

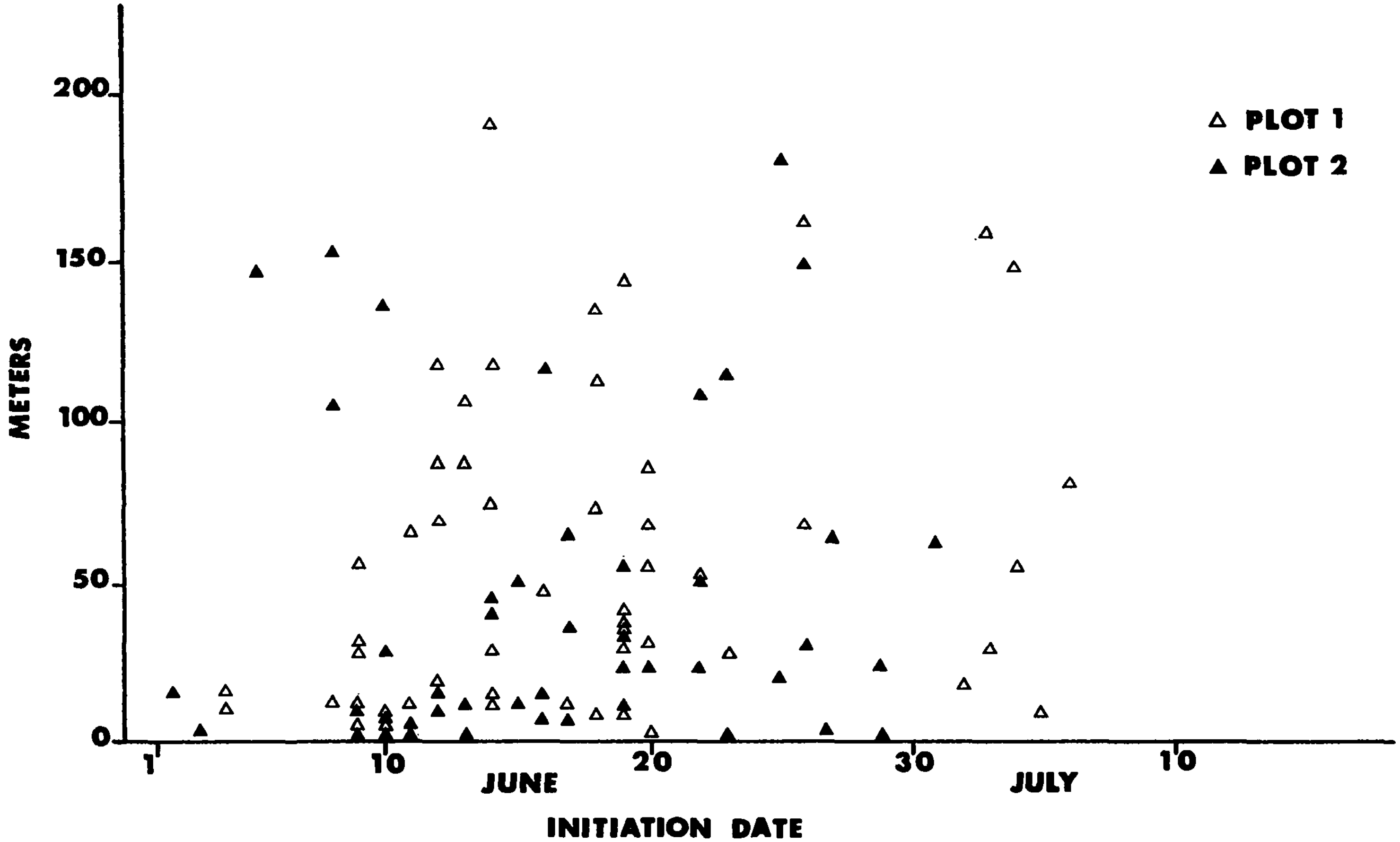

Figure 6. Relationship between date of Common Eider nest initiation and distance from that clutch to the nearest Glaucous Gull nest present when the clutch was initiated during 1977 on Cape Espenberg, Alaska. The gull clutch may or may not have been destroyed by the time the eider clutch was initiated.

range of possible initiation or hatch dates (Type B) might obliterate such a nuance.

Of those habitats in Plot 1 with a sufficient number of nests to test, only nests on peninsulas were initiated significantly before those on land (Table 11). Comparison of initiation dates between hummock, island, land, peninsula, shoreline, tussock, and sedge mound habitats in Plot 2 revealed that island nests were initiated significantly earlier than those on hummocks ($0.01 < P < 0.05$, Mann-Whitney U test). The sedge mound category was omitted from the analysis of Plot 2 nests due to insufficient sample size; the island-tundra ridge couplet could not be considered for the same reason.

Insufficient sample size limited the statistical comparison of hatching dates by habitat for both Plot 1 and 2. Hummock-peninsula, hummock-sedge mound, hummock-shoreline, peninsula-sedge mound, peninsula-shoreline, and sedge mound-shoreline comparisons for Plot 1 revealed no significant differences between the habitats in question ($P > 0.05$, Mann-Whitney U test). The results of comparisons within Plot 2 are presented in Table 12.

When a significant difference was found, the habitat associated more closely with water had the earlier initiation or hatching date: nests on peninsulas were initiated and hatched earlier than those on land, island nests contained eggs before those on hummocks, and shoreline

Table 11. Results of Mann-Whitney U-test comparing Common Eider nest initiation dates in Plot 1 by habitat during 1977. Includes only nests with known dates of initiation on Cape Espenberg, Alaska.

	Hummock (n = 37)	Island (n = 0)	Land (n = 4)	Peninsula (n = 5)	Sedge Mound (n = 18)	Shoreline (n = 28)	Tussocks (n = 3)
Island (n = 0)	-						
Land (n = 4)	NS[a]	-					
Peninsula (n = 5)	NS	-	*[b]				
Sedge Mound (n = 18)	NS	-	NS	NS			
Shoreline (n = 28)	NS	-	NS	NS	NS		
Tussocks (n = 3)	NS	-	c	NS	NS	NS	

Table 11 (Cont'd)

	Hummock (n = 37)	Island (n = 0)	Land (n = 4)	Peninsula (n = 5)	Sedge Mound (n = 18)	Shoreline (n = 28)	Tussocks (n = 3)
Tundra Ridge (n = 0)	-	-	-	-	-	-	-

[a]NS $P > 0.05$

[b] * $0.01 < P < 0.05$; peninsula nests initiated earlier than land nests.

[c]Sample size insufficient.

Table 12. Results of Mann-Whitney U-test comparing Common Eider nest hatching dates in Plot 2 by habitat during 1977. Includes only nests with known dates of initiation on Cape Espenberg, Alaska.

	Hummock (n = 23)	Island (n = 2)	Land (n = 3)	Peninsula (n = 5)	Sedge Mound (n = 1)	Shoreline (n = 15)	Tussocks[d] (n = 3)
Island (n = 2)	NS[a]						
Land[d] (n = 3)	NS	b					
Peninsula (n = 5)	NS	b	*[c]				
Sedge Mound (n = 1)	b	b	b	b			
Shoreline (n = 15)	NS	NS	*	NS	b		
Tussocks (n = 3)	NS	b	d	*	b	*	

Table 12 (Cont'd)

	Hummock (n = 23)	Island (n = 2)	Land (n = 3)	Peninsula (n = 5)	Sedge Mound (n = 1)	Shoreline (n = 15)	Tussocks[d] (n = 3)
Tundra Ridge (n = 0)	-	-	-	-	-	-	-

[a]NS $P > 0.05$

[b]Sample size insufficient.

[c] * $0.01 < P < 0.05$

[d]Land and tussocks categories contain identical nests.

nests hatched earlier than did land nests (Tables 11, 12).

Island

In 1977 Common Eiders initiated egg laying earlier in Plot 3 than in Plots 1 and 2 ($P < 0.05$, Mann-Whitney U test) (Fig. 2).

Nest types A and B were used for the analysis causing the same problem mentioned previously. The areas searched first would be more likely to yield overall earlier dates of initiation because nests found destroyed at the time of searching would be assigned an earlier date than a similar nest found later. In this case systematic searching of the mainland plots began approximately two weeks before that on the island. Consequently, the mainland sample should be biased towards earlier initiation dates than that of the island. The analysis indicated the opposite was true. As such, the results of the analysis should be valid.

To minimize disturbance, the island was visited for only a short time in July and again after hatch in August (Table 1). Because of the brief visits and nature of the resulting data, it is not possible to compare hatching dates per se of the Mainland Plot and Plot 3. It was not known if all the Plot 3 nests used in the calculations hatched.

Mann-Whitney U tests were conducted on Types A and B nests of the Mainland Plot and Plot 3. In this way the nests that hatched before we visited Plot 3 were included in the analysis. Type B nests on the Mainland were included so as not to bias hatching dates towards the latter part of the nesting season. No significant difference was found between the hatching dates of Plot 3 and the Mainland ($P > 0.05$).

Although the range of initiation dates was similar for the island and the mainland plots, nest initiation on the island appears to be more synchronous (Fig. 2). During 8-17 June, 76 percent of the Plot 3 sample nests were initiated. The proportions for Plots 1 and 2 were 41 and 34 percent, respectively.

The reason for the greater synchrony may be related to the water barrier between the island nests and the foxes on the mainland. Once the ice bridge to the island had melted (between about 10-19 June), foxes would have had to swim in order to reach the island. Although there have been reports of foxes swimming (Barry 1966, Ahlen and Andersson 1970, Banfield 1974), other observations indicate it may not be a routine occurrence (Strang 1976, Eisenhauer 1977). Ryder (1967) found that arctic foxes visited an island only when there was an ice bridge from the mainland to the island.

The evidence suggests that if food is readily available both on and off an island, a fox will avoid the island. On Cape Espenberg there were many nests present which presumably represented an adequate food base for the foxes. This may have reduced predation pressure on birds nesting within Plot 3. If this was indeed the case, fewer nests would have been destroyed by foxes necessitating fewer renesting attempts compared with nests on the mainland. Such a situation could explain the more synchronous nest initiation on Plot 3.

Foxes were important predators of mainland nests. They were commonly seen removing and caching eggs (pers. obs., Schamel et al. 1978).

Clutch Size

There are several measures of clutch size and each represents a different aspect of a species' productivity. For this reason I have calculated three measures of Common Eider clutch size:

1. the maximum number of eggs, whether incubated or not, in a nest
2. the minimum number of incubated eggs in a nest
3. the maximum number of incubated eggs in a nest

Presumably, the difference between maximum and minimum incubated clutch size is due to predators removing less than the entire clutch from a nest.

Many factors may influence clutch size such as genetics (Ahlen and Andersson 1970), climate (Milne 1974, Schamel 1974), age (Krebs 1971), and food availability and subsequent condition of the female (Milne 1974, Ashcroft 1976, Korschgen 1977). Once the eggs are laid, predators often remove one or more eggs from a clutch. Unless this can be detected and incorporated into the calculations, clutch size data are subject to error depending on the number of researcher visits to the nest, stage in the breeding cycle when the visits are made, and predator activity. In addition to these biases, inconsistencies in calculating mean clutch size (such as including or excluding destroyed clutches, renesting attempts, or dump nests) render accurate comparisons of clutch size between studies somewhat unreliable.

The values of the different measures of clutch size in this study are, with the exception of Plot 3, within the ranges reported in other studies (Table 13). The high density of 9.75 nests per 10 m^2 in Plot 3 and large average clutch size is not surprising: Marshall (1967) found that larger mean clutch sizes are associated with high eider nesting densities, probably due to multiple laying by early breeders and possibly a form of social stimulation.

On Cape Espenberg, where the presence of a water barrier discouraged fox travel, the actual density of breeding eiders and presence of nesting Arctic Terns (Sterna paradisaea) may have helped maintain the high mean clutch size. Terns often mobbed jaegers and gulls that flew near Plot 3. Low predation pressure would decrease the proportion of renesting attempts on the island. Second clutches may be smaller than initial ones, although conclusive evidence is lacking (Sarbello 1973).

The incidence of partial predation probably was less on the island than on the mainland. This might have

Table 13. Common Eider clutch sizes.

Clutch Size	Location	Comments	Source
5.6 ± 1.2 (n=10), 4.9 ± 1.1 (n=14)	Alaska, U.S.A.	($\bar{x}$ ± 95% C. L.); only incubated nests	Schamel (1974)
5.15	White Sea, U.S.S.R.	"Clutches containing eggs in various stages of preservation"	Belopol'skii (1957)
4.32, 3.86, 3.52	Barents Sea, U.S.S.R.	"Clutches containing eggs in various stages of preservation"	Belopol'skii (1957)
4.46 ± 0.1 (n=99) to 4.75 ± 0.1 (n=92)	Scotland, U.K.	Completed clutches only	Milne (1963)
3.81 ± 1.24 (n=345), 3.79 ± 1.23 (n=272)	Maine, U.S.A.	Completed clutches only	Choate (1966)

Table 13 (Cont'd)

Clutch Size	Location	Comments	Source
4.33 ± 0.07 (n=315)	Maine, U.S.A.	Completed clutches only	Guignion (1967)
4.35 ± 0.05 (n=376)	Nova Scotia, Canada	Completed clutches excluding known double clutches	Sabean (1969)
4.94 ± 1.80 (n=393) to 4.30 ± 1.73 (n=61)	Greenland	($\bar{x}$ ± S. D.)	Meltofte (1978)
2.95 (n=2661)	West Spitsbergen, Norway	Incubated clutches only	Ahlen and Andersson (1970)
4.11 ± 1.27 (n=164) to 3.53 ± 1.22 (n=317)	Maine, U.S.A.	Incubated clutches only; excluded clutches of more than 7 eggs	Clark (1968)

Table 13 (Cont'd)

Clutch Size	Location	Comments	Source
3.56 ± 0.10 (n=134)	New Brunswick, Canada	May include incomplete clutches or those that lost eggs before censused	Paynter (1951)
3.44 (n=1598)	Northwest Territories, Canada	Completely destroyed nests excluded	Cooch (1965)
4.40 ± 0.93 (n=709)	Scotland, U.K.	($\bar{x}$ ± S.D.); incubated clutches only	Milne (1974)

contributed to the relatively higher mean clutch size of Plot 3 nests.

Sleptsov (1948 cited by Belopol'skii 1957) and Ahlen and Andersson (1970) discovered that the number of torn follicles in the ovaries of Common Eiders generally exceeded the number of eggs found in their nests. Although some eggs are likely laid in other nests, partial clutch predation is responsible for the loss of eggs in a clutch. Belopol'skii (1957) stated that clutch size was dependent on predation, as did Ahlen and Andersson (1970). The latter authors found that in colonies of equal density those colonies which contained nesting Arctic Terns suffered lower rates of egg loss than colonies that did not.

Maximum Number of Eggs

The maximum number of eggs seen in a nest did not differ between the mainland study plot in 1977, i. e. t-tests comparing clutch sizes in Plot 1-Plot 2, Plot 1-Mainland, and Plot 2-Mainland revealed no significant differences ($P > 0.05$). However, Plot 3 eider clutches were much larger than those of Plot 1, Plot 2, or the Mainland ($P \ll 0.001$, t-test) (Table 14).

The maximum number of eggs seen in Plot 2 eider nests was the same in both 1976 and 1977 ($P > 0.05$, t-test). This suggests that the late 1976 season did

Table 14. Maximum number of eggs in Common Eider nests on Cape Espenberg, Alaska.[a]

Year	Plot 1	Plot 2	Mainland	Plot 3
1976	c	4.1 ± 1.4[b] (43)	c	-
1977	3.9 ± 2.2 (95)	4.2 ± 1.6 (82)	4.0 ± 1.9 (177)	6.2 ± 3.2 (204)

[a]Some eggs may not have been incubated.

[b]Mean ± S. D., sample size in parentheses.

[c]Omitted due to nest identification difficulties.

not cause a decrease in the number of eggs per eider nest, although perhaps the proportion of eggs laid in nests not belonging to the layer was greater in 1976 than in 1977.

Minimum Incubated Clutch Size

Minimum incubated clutch sizes were significantly different between 1977 Plot 1-Plot 3, Plot 2-Plot 3, and Mainland-Plot 3 ($P \ll 0.001$, t-test) (Table 15). No differences occurred between 1977 Plot 1-Plot 2, Plot 1-Mainland, or Plot 2-Mainland ($P > 0.05$, t-test).

The minimum incubated clutch size of 1976 Plot 2 eider nests was the same as that of 1977 Plot 2 nests ($P > 0.05$, t-test).

Because Plot 3 was only worked between 8-12 July (Table 1), there is little useful information on the number of eggs lost per clutch over time. This may help to explain why Plot 3 nests had a higher minimum incubated clutch size than did Plot 1, Plot 2, or Mainland nests in 1977.

This measure, if sampling error was nil, is equal to the number of eggs hatched per nest.

Maximum Incubated Clutch Size

Maximum incubated clutch size followed the same

Table 15. Incubated clutch sizes of Common Eiders on Cape Espenberg, Alaska.

Plot	Year	Clutch Size	
		Maximum[a]	Minimum[b]
1	1976	c	c
	1977	4.8 ± 1.8 (44)[d]	4.4 ± 1.8 (45)
2	1976	4.3 ± 1.2 (39)	4.2 ± 1.2 (39)
	1977	4.6 ± 1.5 (53)	4.1 ± 1.5 (60)
Mainland	1976	c	c
	1977	4.7 ± 1.6 (97)	4.2 ± 1.6 (105)
3	1976	-	-
	1977	7.2 ± 3.1 (49)	7.2 ± 3.0 (52)

[a]Maximum number of eggs incubated in a nest.

[b]Minimum number of eggs incubated in a nest.

[c]Omitted due to nest identification difficulties.

[d]Mean ± S. D., sample size in parentheses.

trends as did minimum incubated clutch size.

Maximum clutch sizes were significantly different between 1977 Plot 1-Plot 3, Plot 2-Plot 3, and Mainland-Plot 3 ($P \ll 0.001$, t-test) (Table 15). No differences occurred between 1977 Plot 1-Plot 2, Plot 1-Mainland, or Plot 2-Mainland ($P > 0.05$, t-test).

This measure, if sampling error did not exist and if a hen laid all her eggs in one nest, is equal to the number of eggs laid by a female eider.

Nesting Chronology

In 1977 early eider nests, i. e. those initiated before 20 June, in Plot 2 and the Mainland Plot had significantly higher maximum incubated and minimum incubated clutch sizes than did nests initiated later ($P < 0.05$, t-test). In Plot 1 there were no significant differences in incubated clutch sizes between early initiated nests and later initiated nests ($P > 0.05$, t-test).

The tendency for mean clutch size to decrease during the breeding season in eiders was documented by Cooch (1965), Milne (1963), Schamel (1974), Choate (1966), Dau (1976), Meltofte (1978), and Milne (1974). This was attributed to renesting (Milne 1974, Cooch 1965), partial clutch predation (Milne 1963, Milne 1974), or a greater proportion of younger birds or birds with small energy reserves nesting later (Milne 1974).

Milne (1974) adapted Ryder's (1970) hypothesis to eiders. Ryder suggested that the clutch size of Ross' Goose (Anser rossii) evolved in relation to the energy stores of the female when she arrives on the nesting grounds. The energy reserves are used for egg production and maintenance of the female during incubation.

Milne (1974) suggests the range of clutch sizes found within an eider population reflects the ability of different hens to store energy. This, in turn, is dependent on sufficient food intake in order for the female to accumulate fat. The male is important during this time because he lessens the interruptions to her feeding due to courting males (Ashcroft 1976). Females that feed less effectively might take longer to prepare for laying, accumulate smaller fat reserves, produce fewer and smaller eggs, or incubate less attentively (Milne 1974). Hens pairing after mid-winter have a high probability of laying late or not at all (Spurr and Milne 1976), reflecting the relationship between pairing and nutrient accumulation.

Early 1976 Plot 2 eider nests, those initiated before 23 June, had the same maximum incubated clutch size as did nests initiated after that date ($P > 0.05$, t-test). Similarly, no difference in minimum incubated clutch size was apparent between early and late nests that year. This could be due to two factors.

First, sampling method may be involved. Data presented in the Phenology section suggested that eiders nested later in 1976 than in 1977. If this were the case, systematic searching of Plot 2 for nests would have occurred later in the eider breeding cycle in 1976 than in 1977 (Table 1). If early nesting eiders actually laid more eggs than later nesters but lost them before the plot was dragged, no difference could have been discerned. Also, because there were fewer visits per nest in 1976, there was a greater chance of eggs being laid or removed without the investigator's notice.

Second, would-be early nesters in 1976 might have resorped one or more eggs waiting for environmental conditions conducive to nesting (Milne 1974). A similar strategy is used by Lesser Snow Geese (Anser caerulescens caerulescens) (Ankney 1974). This would have brought the maximum and possibly the minimum incubated clutch size of the earlier nesting birds closer to that of later nesting hens.

Habitat

The maximum incubated clutch size was the same for all habitats (Table 16). No significant difference between the eight categories existed in Plot 2 or the Mainland Plot ($P > 0.05$, t-test).

Table 16. Maximum incubated clutch size of Common Eiders on Cape Espenberg, Alaska, by habitat during 1977.

Habitat	Clutch Size: Plot 2	Clutch Size: Mainland
Hummock	4.7 ± 1.7 (30)[a]	4.7 ± 1.8 (56)
Island	4.5 ± 0.2 (2)	4.5 ± 0.2 (2)
Land	4.0 ± 1.3 (8)	4.2 ± 1.2 (11)
Peninsula	4.3 ± 0.8 (6)	4.8 ± 1.4 (10)
Sedge Mound	b	5.1 ± 1.9 (14)
Shoreline	4.7 ± 1.7 (30)	4.7 ± 1.8 (56)
Tussocks	4.3 ± 0.9 (4)	4.4 ± 0.8 (7)
Tundra Ridge	5.0 ± 1.4 (2)	5.0 ± 1.4 (2)

[a]Mean ± S. D., sample size in parentheses.

[b]Insufficient sample size.

Significant differences in minimum clutch size by habitat were present both in Plot 2 and the Mainland Plot. Eider clutches on shorelines had significantly more eggs than did those found on the land habitat category in the Mainland Plot and Plot 2 ($P < 0.05$, t-test) (Tables 17, 18). Within Plot 2 eider nests on land had a smaller minimum incubated clutch size than did nests on hummocks, islands, and shore ($P < 0.05$, t-test) (Table 18). This suggests that nest sites not closely associated with water are more susceptible to partial clutch predation than are those near or in marshes or ponds.

Eiders nesting on hummocks, islands, or sedge mounds, i. e. habitats generally associated with shorelines or marshes, seem to gain some protection from partial predation by water depth and distance to the nearest dry area (e. g. hummock, sedge mound, land) (Table 19). Although maximum clutch size was the same for both distance and depth categories, those nests on hummocks, islands, or sedge mounds surrounded by shallow and narrow stretches of water lost more eggs by partial predation than did those on sites more isolated by water ($P < 0.05$, t-test).

Internest Distances

Distance to the nearest Glaucous Gull nest did not affect the maximum or minimum incubated clutch size of

Table 17. Results of Student's t-tests comparing minimum incubated clutch size of Common Eiders on Cape Espenberg, Alaska, between habitats in the Mainland Plot during 1977.

	Hummocks	Islands	Land	Peninsula	Sedge Mound	Shore	Tussocks	Tundra Ridge
Hummocks	4.3 ± 1.7[a] (51)							
Islands	NS	4.3 ± 0.6 (3)						
Land	NS	NS	3.3 ± 1.1 (12)					
Peninsula	NS	NS	NS	4.1 ± 1.0 (13)				
Sedge Mound	NS	NS	NS	NS	4.4 ± 2.1 (16)			
Shore	NS	NS	*[b]	NS	NS	4.4 ± 1.5 (43)		

Table 17 (Cont'd)

	Hummocks	Islands	Land	Peninsula	Sedge Mound	Shore	Tussocks	Tundra Ridge
Tussocks	NS	NS	NS	NS	NS	NS	3.7 ± 1.2 (9)	
Tundra Ridge	NS	NS	NS	NS	NS	NS	NS	3.5 ± 0.7 (2)

[a]Mean ± S. D., sample size in parentheses.

[b]$0.01 < P < 0.05$.

Table 18. Results of Student's t-tests comparing minimum incubated clutch size of Common Eiders on Cape Espenberg, Alaska, between habitats in Plot 2 during 1977.

	Hummocks	Islands	Land	Peninsula	Sedge Mound	Shore	Tussocks	Tundra Ridge
Hummocks	4.2 ± 1.7[a] (29)							
Islands	NS	4.3 ± 0.6 (3)						
Land	*[b]	*	3.0 ± 0.9 (10)					
Peninsula	NS	NS	NS	3.9 ± 1.1 (9)				
Sedge Mound	c	c	c	c				
Shore	NS	NS	*	NS	c	4.2 ± 1.3 (21)		

Table 18 (Cont'd)

	Hummocks	Islands	Land	Peninsula	Sedge Mound	Shore	Tussocks	Tundra Ridge
Tussooks	NS	NS	NS	NS	NS	NS	3.2 ± 1.2 (6)	
Tundra Ridge	NS	NS	NS	NS	o	NS	NS	3.5 ± 0.7 (2)

[a]Mean ± S. D., sample size in parentheses.

[b]$0.01 < P < 0.05$.

[c]Insufficient sample size.

Table 19. Common Eider clutch size compared with minimum water depth and minimum distance at the time of hatch between the hummocks, islands, or sedge mounds supporting the nests and nearest emergent ground during 1977 on Cape Espenberg, Alaska, using Student's t-test.

	Depth $\leq$ 10 cm, Distance < 2 m	Depth > 10 cm, Distance $\geq$ 2 m	P[a]
	Maximum Clutch Size		
Plot 2	4.5 ± 1.5 (25)[b]	5.3 ± 1.9 (8)	NS
Mainland	4.6 ± 1.8 (59)	5.3 ± 1.7 (13)	NS
	Minimum Clutch Size		
Plot 2	3.9 ± 1.4 (24)	5.3 ± 1.9 (8)	*
Mainland	4.1 ± 1.7 (60)	5.3 ± 1.8 (12)	*

[a]NS $P > 0.05$
* $0.01 < P < 0.05$

[b]Mean ± S. D., sample size in parentheses.

a Common Eider nest ($P > 0.05$, simple linear regression and t-test) (Fig. 7). This also held for Plots 1, 2, and Mainland. Proximity to a gull nest did not affect the number of eggs lost from a clutch due to partial predation.

Similarly, proximity to another nesting eider did not affect the minimum clutch size of eiders in the above three plots ($P > 0.05$, simple linear regression and t-test) (Fig. 8). However, there was an inverse relationship between maximum eider clutch size and distance to the nearest nesting eider (Fig. 8). This relationship was significantly different from a slope of zero for Mainland Plot ($P < 0.001$, simple linear regression and t-test). The slopes of the individual regression lines for Plots 1 and 2 were not significantly different from zero ($P > 0.05$, simple linear regression and t-test).

The regression lines of Figure 8 and the statistical tests show that ducks nesting close together lay more eggs (maximum clutch size) than do those nesting further apart, presumably near the periphery of the colony. Even though this was the case, the number of eggs incubated after partial predation had removed some (minimum clutch size) was the same regardless of eider internest distances. Therefore, those birds nesting close together suffered more partial predation than did those nesting more than 42 m apart (Fig. 8). If foxes were primarily responsible for removing less than whole clutches, their activity in

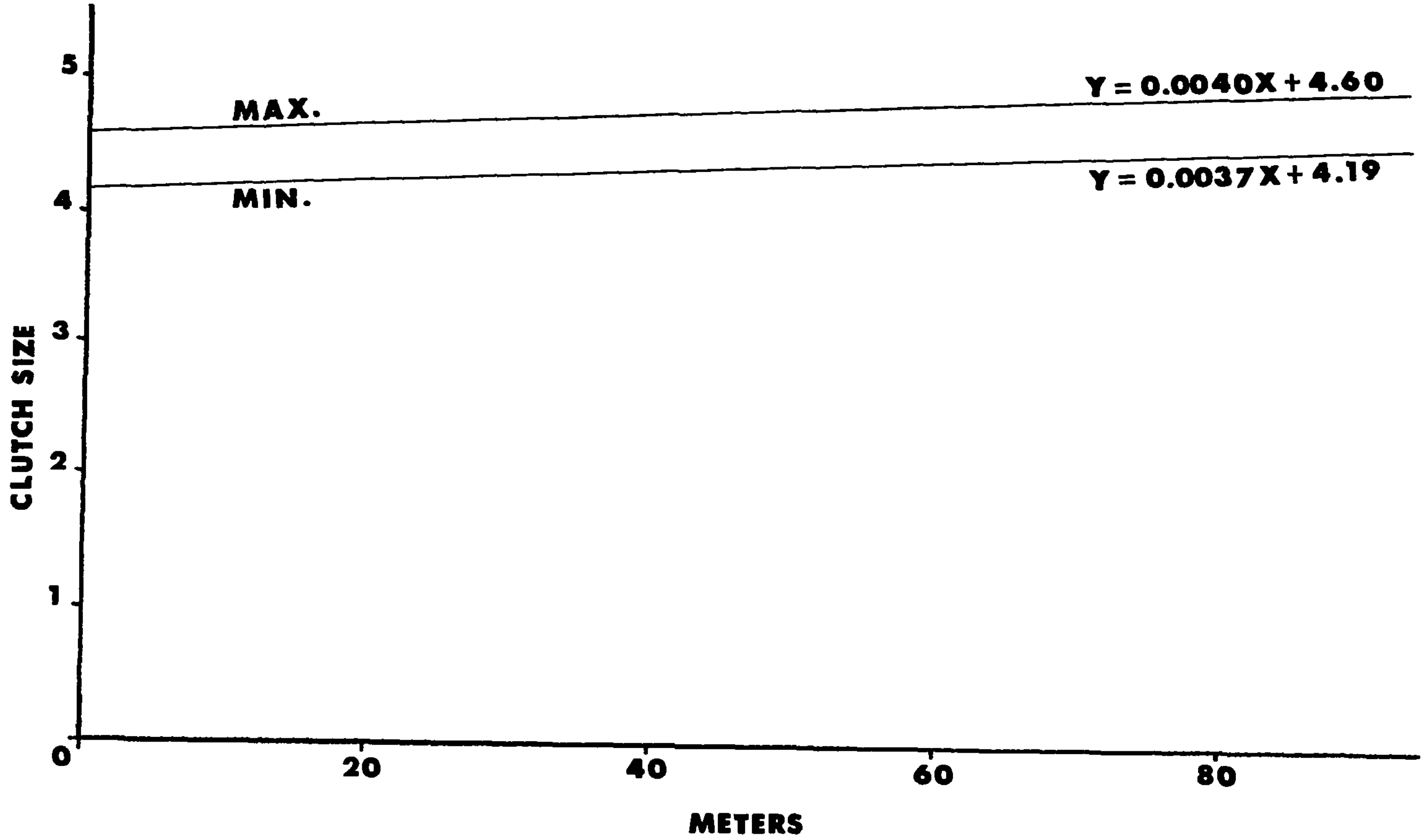

Figure 7. The relation of distance to nearest Glaucous Gull nest with minimum and maximum Common Eider incubated clutch size in the Mainland Plot on Cape Espenberg, Alaska. See Appendix I for coordinates.

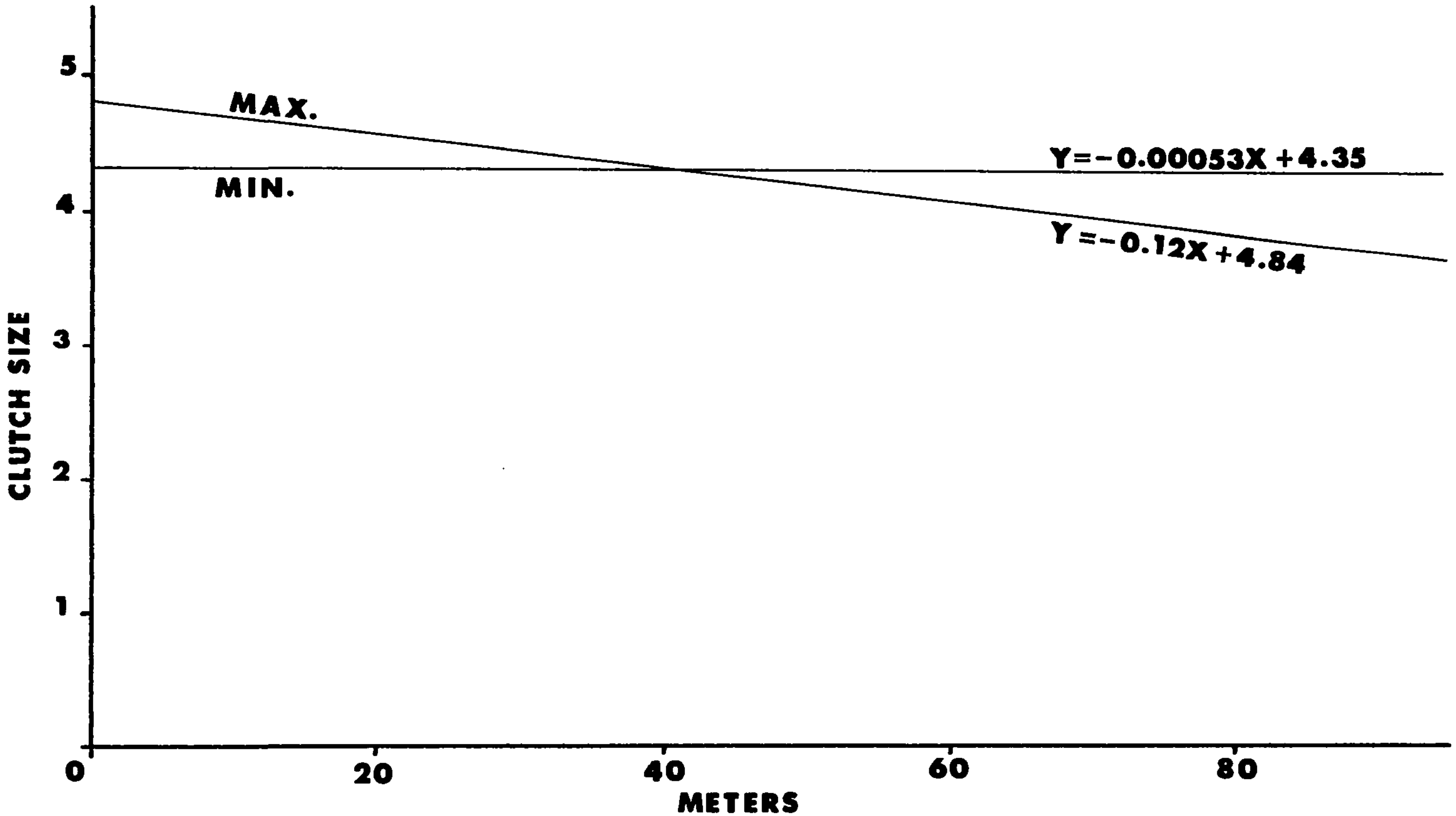

Figure 8. The relation of distance to nearest Common Eider nest with minimum and maximum Common Eider incubated clutch size in the Mainland Plot on Cape Espenberg, Alaska. See Appendix I for coordinates.

a dense nesting area probably would cause many hens to flush and leave their eggs uncovered. This probably would facilitate hunting by foxes as well as any nearby gulls or jaegers (cf. Bandy and Bandy 1978). Despite this, 78 percent of eiders nested within 42 m of each other (Appendix II).

The spacing of colonially nesting birds is a compromise between selection for clumping to permit joint defense against predators and selection for the dispersal of cryptic nests to avoid predator detection (Horn 1968).

Ahlen and Andersson (1970) and Belopol'skii (1957) believe that large, densely populated breeding colonies of eiders are important to deter predators. Eiders nesting close together will chase gulls destroying nearby nests (Bourget 1970), but observations off the coast of Maine show that the usual response of incubating eiders to gulls destroying a nearby nest is to either sit undisturbed or to make threatening movements toward the predator (Bourget 1970). However, as eiders will attack avian predators near their own nests (Schamel 1974, Campbell 1975), a dense colony of eiders may be more intimidating to a predator than a sparse one. Tenaza (1971) concluded that Adelie Penguins (Pygoscelis adeliae) nesting just far enough apart to allow incubating birds to touch bills lost fewer eggs and possibly chicks than did those nesting further apart. Under these conditions avian predators landing in the colony were always within pecking distance.

Nesting Success

Human disturbance can reduce nesting success (Choate 1967, Guignion 1967, Sabean 1972, Robert and Ralph 1975, Bart 1977), but in some situations it does not (Milne 1963, Gillett et al. 1975). Nesting success figures often are not directly comparable because variables such as amount of disturbance and exposure time (Mayfield 1961, Mayfield 1975) often cannot be standardized.

Nesting success values for Cape Espenberg eiders, between 23 and 91 percent (Table 20), generally fall within the range reported in other studies: 14.7-39.9 percent in Maine (Clark 1968), 35.9-39 percent in Maine (Choate 1966), 44.9 percent in Maine (Bourget 1970), 13-52 percent in Quebec (Guignion 1967), 60-68 percent in Scotland (Milne 1963), 24.5 percent in Nova Scotia (Sabean 1972), 40-93 percent in West Spitsbergen (Ahlen and Andersson 1970), 52-69.9 percent in Spitsbergen (Hagelund and Norderhaug 1975), and 56.1-70.2 percent in Scotland (Milne 1965).

The percentage of successful and unsuccessful clutches in Plot 2 was almost identical in 1976 and 1977 (Table 20). This is somewhat surprising because there were no foxes

Table 20. Fate of Common Eider clutches on Cape Espenberg, Alaska.

	Fate			
	Successful[a]	Unsuccessful	Unknown	Total
	Plot 2, 1976			
Initiation Date Known	26	9	6	41
Initiation Date Unknown	0	17	1	18
	26 (44%)	26 (44%)	7 (12%)	59
	Plot 1, 1977			
Initiation Date Known	22	38	3	63
Initiation Date Unknown	3	44	0	47
	25 (23%)	82 (75%)	3 (3%)	110
	Plot 2, 1977			
Initiation Date Known	44	25	4	73
Initiation Date Unknown	4	20	2	26
	48 (48%)	45 (45%)	6 (6%)	99

Table 20 (Cont'd)

Fate			
Successful[a]	Unsuccessful	Unknown	Total
Plot 3, 1977[b]			
153 (91%)	10 (6%)	6 (3%)	169

[a]Hatched one or more eggs.

[b]A sample of nests present.

denning near the plot in 1977, but there were in 1976. One or more arctic foxes were in the plot in 1977. Undoubtedly their presence added to the loss of eider eggs and clutches.

Eskimos took eggs in Plot 1 during 1977. To the best of my knowledge, they did not collect eider eggs from the entire plot, but may have contributed to the relatively low proportion of successful nests there. The data from 1976 in this plot are unreliable and preclude any comparisons between the two nesting seasons.

The proportion of successful nests was much greater on the eider island than on either of the mainland plots ($P \ll 0.001$, chi-square test) (Table 20). Nesting success for eiders on Plot 3 was among the highest reported in the literature, possibly due to the lack of mammalian predators and the high density of nesting females. A colony of Arctic Terns on the island may have helped reduce the incidence of avian predation. Ahlen and Andersson (1970) found that eider nests in Arctic Tern colonies were the most successful of those in the different nesting conditions they examined. Hagelund and Norderhaug (1975) concur. They found many nests within tern colonies, ostensibly because terns chase away Glaucous Gulls and Parasitic Jaegers.

Terns may be a mixed blessing, however. Although in the Canadian Maritime provinces and New England states nesting Common Terns (<u>Sterna hirundo</u>) drive away Greater Black-backed Gulls (<u>Larus marinus</u>), they harass eiders as well, possibly resulting in the high observed rates of nest abandonment (Clark 1968). Despite abandonments, eider success in both years of Clark's study was still higher than that on similar islands without nesting terns but with nesting gulls.

Nesting Chronology

In 1977 eiders that initiated their clutches before 20 June were more successful than were birds nesting after that date ($P < 0.05$, chi-square test). This was true for both Plot 1 and 2. However, in 1976 early nesting eiders in Plot 2 were as successful as later ones ($P > 0.05$, chi-square test). The lateness of the 1976 season may have contributed to this. The would-be early nesting females may have used up much of their stored energy waiting for environmental conditions conducive to nesting (Milne 1974). This could have reduced their clutch size and amount of energy reserves needed for incubation to a level equivalent to that of the later nesting birds.

Others have reported lowered nesting success for nests initiated during the later part of the nesting season (Guignion 1967, Milne 1974). However, Sabean (1972) found that nesting success was lowest at the beginning of the season and highest at the end. He attributes this to greater vegetation cover, lowered aggressiveness of gulls, and greater food availability to gulls later in the season.

Habitat

Significant differences in nesting success between certain habitats were present in both Plots 1 and 2 (Tables 21, 22). With the exception of more successful peninsula than hummock nests, each habitat category having significantly greater nesting success was more closely associated with water. The less successful nests tended to be in considerably drier habitats.

Differences in nesting success between habitats could be a result of age, experience, amount of fat reserves, or length of the pair bond. These differences might be reflected in the choice of nesting habitat.

Depth and expanse of water between a nest and nearest dry area affected nesting success, as it did minimum clutch size and partial clutch predation (Table 23). Nests on hummocks, islands, or sedge mounds isolated by a relatively deep and wide channel of water were more successful than those that were not (Table 23). Water barriers should only affect fox predation, i. e. terrestrial predators as opposed to avian predators.

Good nesting cover can increase nesting success.

Table 21. Fate of Common Eider clutches by habitat in Plots 1 and 2 during 1977 on Cape Espenberg, Alaska.

	Hummock	Island	Tussock	Shore	Peninsula	Land	Sedge Mound	Total
Successful[a]	44	2	4	29	9	4	7	99
Unsuccessful	74	1	12	34	3	22	19	165
Unknown	4	0	2	5	2	2	1	16
	122	3	18	68	14	28	27	280

[a]Hatched one or more eggs.

Table 22. Common Eider nesting success by habitat[a] on Cape Espenberg, Alaska, during 1977. Habitat pairs not listed had similar nesting success, i. e. $P > 0.05$.

Habitat		
More Successful	Less Successful	P[b]
	Plot 1	
Peninsula	Hummock	*
Peninsula	Land	*
	Plot 2	
Hummock	Land	*
Peninsula	Land	*
Shoreline	Land	*
	Mainland	
Peninsula	Hummock	*
Peninsula	Land	**
Peninsula	Sedge Mound	*
Peninsula	Tussocks	*
Shoreline	Land	*

[a]Hummock, island, land, peninsula, sedge mound, shore, and tussocks habitats within Plots 1, 2, and Mainland compared by chi-square test.

[b] * $0.01 < P < 0.05$
** $0.001 < P < 0.01$

Table 23. Common Eider nesting success compared with minimum water depth and minimum distance at the time of hatch between the hummocks, islands, and sedge mounds supporting the nests and nearest emergent ground during 1977 on Cape Espenberg, Alaska, using chi-square tests.

	Depth $\leq$ 10 cm, Distance < 2 m	Depth > 10 cm, Distance $\geq$ 2 m	Total	P[a]
		Plot 1		
Successful Nests[b]	17	2	19	NS
Unsuccessful Nests	60	2	62	
	77	4	81	
		Plot 2		
Successful Nests	21	5	26	NS
Unsuccessful Nests	23	1	24	
	44	6	50	

Table 23 (Cont'd)

	Depth $\leq$ 10 cm, Distance < 2 m	Depth > 10 cm, Distance $\geq$ 2 m	Total	P[a]
		Mainland		
Successful Nests[b]	38	7	45	*
Unsuccessful Nests	83	3	86	
	121	10	131	

[a]NS $P > 0.05$
* $0.01 < P < 0.05$

[b]Hatched one or more eggs.

Guignion (1967) reported that eiders nesting under conifers blown down by the wind were 51 percent successful, whereas those ducks nesting in deciduous woods were only 12.5 percent successful. He attributes the difference to the amount of protection each habitat offered from predators.

Shrubs, because their stems and branches hindered access to nests, contained more successful nests than herbaceous cover in Clark's (1968) study. Choate (1966) found that nesting success under shrubs and cow parsnip (Heracleum maximum) was the highest of his habitat categories. Cow parsnip provided more concealment than did any other cover plant.

Clark (1968) reported that overhead concealment of a clutch at the time of initiation affected nesting success. Similarly, Gorman (1974) believes that an advantage of a popular habitat for nesting eiders is the amount of cover it provides. He found that there was a general inverse relationship between the percentage of nests destroyed by crows (Corvus corone) in any habitat and the density of nests in that habitat. He states that the pattern of habitat selection shown by the birds had adaptive value, as the areas selected most often offered the greatest protection against nest predation.

Not all researchers agree that cover and nesting success are necessarily related. Milne (1974) found no difference in hatching success for nests under different amounts of overhead cover. Guignion (1967) discovered that nesting success was slightly better for those nests not hidden by the surrounding vegetation.

Internest Distances

The distance an eider on Cape Espenberg nested from its nearest conspecific or Glaucous Gull did not affect its nesting success (Tables 24, 25). Other researchers report that this is not always the case. During one year of Clark's (1968) study, the success of eider nests within approximately 2 m of an incubating eider was much higher than those more than about 3 m away. Also, clutches initiated within approximately 3 m of more than two incubating hens appeared to be significantly more successful than those initiated at a greater distance. Clark thought these results might be due to mutual defense or optimum cover for the nests.

However, he too found that gull nest proximity did not affect eider nesting success. The number of gull nests within about 5 m of an eider nest did not increase its chances for success.

The findings of Sabean (1972) and Kistchinski and Flint (1974) contradict Clark's results. The latter authors reported that more Spectacled Eider nests outside gull territories in Siberia were destroyed than those

Table 24. Results of Student's t-tests comparing Common Eider nesting success with distance (in meters) between an eider nest and nearest previously initiated Glaucous Gull nest during 1977 on Cape Espenberg, Alaska.[a]

Fate		
Successful[b]	Unsuccessful	P[c]
	Plot 1	
19.5 ± 19.7[d] (16)	12.9 ± 13.2 (28)	NS
	Plot 2	
52.5 ± 96.1 (25)	35.1 ± 22.3 (14)	NS
	Mainland	
39.6 ± 77.1 (41)	20.3 ± 19.6 (42)	NS

[a]Gull clutch may have been destroyed by the time of eider clutch initiation.

[b]Hatched one or more eggs.

[c]NS $P > 0.05$

[d]Mean ± S. D., sample size in parentheses.

Table 25. Results of Student's t-tests comparing Common Eider nesting success with distance (in meters) between an eider nest and nearest conspecific during 1977 on Cape Espenberg, Alaska.[a]

Fate		
Successful[b]	Unsuccessful	P[c]
	Plot 1	
51.1 ± 45.9[d] (22)	61.4 ± 52.3 (31)	NS
	Plot 2	
37.6 ± 41.9 (30)	62.2 ± 60.4 (17)	NS
	Mainland	
43.3 ± 43.7 (52)	61.7 ± 54.7 (48)	NS

[a]Conspecific clutch may have been destroyed by the time of eider clutch initiation.

[b]Hatched one or more eggs.

[c]NS $P > 0.05$

[d]Mean ± S. D., sample size in parentheses.

inside. In Nova Scotia eider nests within 3 m of a gull nest had higher percent success but not significantly higher (Sabean 1972).

GENERAL DISCUSSION

Many researchers have addressed the subject of Common Eider and gull associations in different parts of the world. Often eiders and gulls nest in close proximity. Why a hen should nest closely to at least a potential threat to the survival of her clutch and brood is often unclear. Some possible reasons relevant to Cape Espenberg are:

1. Eider ducklings imprinted to their nest site consider gulls as part of the habitat causing them later to breed only near nesting gulls (Koskimies 1957).

2. Both Common Eiders and Glaucous Gulls prefer to nest in the same kind of habitat.

3. Each species has some different and some similar preferred nesting habitats. These often are juxtaposed.

4. Nesting within a gull's territory affords protection to the female eider and clutch from other gulls (Kistchinski and Flint 1974).

5. Gulls function as sentinels (Vermeer 1968) or protectors (Bianki 1967) of the hen and/or clutch.

Hilden (1965) suggested that the presence of other animals in addition to landscape, terrain, nest sites, and lookout sites may be involved in avian habitat recognition. Koskimies (1957) extended this concept to eiders saying that larid colonies may feature in habitat selection by nesting eiders. This may indeed be true. Individually recognizable hens have been observed nesting in the same areas for several years (Cooch 1965, Milne 1974). It is possible that gull colonies may be part of the nesting habitat sought by a hen hatched in a larid colony herself. Even if the habitat recognition hypothesis is true, it serves to explain only one of the proximate causes of eider habitat use rather than the ultimate evolutionary cause(s) of this behavior.

Possibly both Common Eiders and Glaucous Gulls prefer to nest in the same type of habitat. Indirect evidence from New Brunswick suggests that competition for the same nesting habitat may be real. On Kent Island, New Brunswick, an increase in the number of nesting Herring Gulls accompanied a shift of the nesting habitat of Common Eiders (Grubb 1974). In 1948 Paynter (1951) reported that eiders were nesting primarily on the treeless end of the island. By 1973 most eiders were nesting under trees and gulls were nesting in the open (Grubb 1974).

Grubb (1974) suggested that Herring Gulls were responsible for the change in habitat use by the eiders. The abundance of nesting gulls may have forced eiders to seek greater nesting cover to reduce gull predation on eggs

(Choate 1967, Bourget 1973). Reed (1973 cited by Grubb 1974) suggested that aggressive territorial gulls may keep eiders from nesting close to them.

Possibly the preferred nesting habitats of gulls and eiders only partially overlap, or, even if different, are near each other in space. In both cases the two species would nest in the same vicinity. Many instances of gull-eider breeding associations have been documented involving Glaucous Gulls (Olson 1954), Herring and Greater Black-backed Gulls (Choate 1966, Munro and Bedard 1977), and Herring Gulls (Paynter 1951).

By nesting near gulls, both the survival of incubating eider hens, eggs, or young may be increased.

Some authors have postulated that an eider and clutch may gain protection by nesting within a gull's territory (Clark 1968, Bourget 1970, Schamel 1974). The argument is that a pair of gulls protecting their nest will inadvertently protect the nesting eider and clutch from predators. Studies have been inconclusive on this issue. Schamel (1974) found that successful Pacific and King Eider nests were significantly closer to active Glaucous Gull nests than unsuccessful nests. Clark (1968) saw five cases of eider nests apparently being protected by territorial gulls. His data suggested that nesting within approximately 5 m of either a Herring or Greater Black-backed Gull nest increased eider nesting success, but other factors confounded the data.

Many studies have attributed large losses of eggs and ducklings to gulls (Belopol'skii 1957, Odin 1957, Dietz 1967, Guignion 1967, Vermeer 1968, Bourget 1970, Schamel 1974); others have not (Hilden 1964, Anderson 1965). Somewhat surprisingly, in an undisturbed situation Glaucous Gulls, one of the most predatory gull species (Bull and Farrand 1977), do not necessarily destroy unattended eider clutches (Schamel 1974, Campbell 1975).

Other examples of protective nesting associations are known. In northeastern Greenland Common Eider clutches were as close as 0.5 m from the reach of a line of tethered huskies as well as near buildings (Meltofte 1978). Protection from arctic foxes was the most probable cause of the association as foxes had taken some eider nests nearby.

Larids may warn hen eiders of the whereabouts of a predator or perhaps help drive it away. Glaucous Gull colonies discourage at least some avian predators. Jaegers, predators of both eggs and ducklings, seem to avoid Glaucous Gull colonies (Strang 1976). Schamel (1974) saw resident Glaucous Gulls chasing non-resident conspecifics, Pomarine Jaegers (*Stercorarius pomarinus*), Parasitic Jaegers, and Long-tailed Jaegers (*S. longicaudus*) from a barrier island in the Beaufort Sea.

Uspenski (1956) stated that arctic foxes avoid Glaucous Gull nests. Kistchinski and Flint (1974) believe they will drive away foxes and skuas. The large size of the gull and diminutive size of this fox may help explain the aversion. Red foxes may not be as reluctant to enter colonies as they weigh almost twice as much as arctic foxes (Banfield 1974). Perhaps this is why Tinbergen (1972) concluded that nesting Black-headed Gulls (Larus ridibundus), small relative to Glaucous Gulls, were virtually defenseless against red foxes despite similar behavior towards these predators in nesting colonies (Kruuk 1964, Strang 1976).

Even if a gull colony does not deter foxes, the gulls may still serve as sentinels for other nearby birds. The swooping, circling, and noisy flight of the birds would mark the location of the fox (Patton and Southern 1977).

Sargeant and Eberhardt (1975) found that penned red foxes attacked most ducks from a rear or lateral position. If a bird faced the fox or acted aggressively, usually the fox withdrew. Ludwig (1971) reported a similar reaction when the cock of a pair of Ring-necked Pheasants (Phasianus colchicus) acted aggressively towards a red fox. If eiders and red or arctic foxes react similarly, the gulls diving at or circling a fox would mark its location and perhaps allow the hen eider to turn on the nest to face an intruding fox. Even if eiders do not defend their nest under these conditions, a fox probably would have little chance to ambush an incubating bird.

Because habitats used heavily by gulls--shorelines, hummocks, islands, and peninsulas--had higher nesting success (Table 22) and lower levels of partial clutch predation for eider nests than did those on land, a habitat unused by gulls, reasons exist to suspect gulls may be influencing the choice of eider nesting habitat.

Breeding Glaucous Gulls on Cape Espenberg affect the choice of nesting habitat by Common Eiders in one of two ways:

1. Eiders were partially excluded from habitats used by gulls.
2. Eiders were not excluded at all from habitats used by gulls.

If gulls were partially excluding eiders from habitats supporting high eider nesting densities and success (e. g. shorelines, hummocks), early nesting eiders should have initiated more frequently here than in habitats supporting few nests and with lower nesting success (e. g. land). This premise assumes that competition for nesting sites in the habitats with high nesting success occurred. In this way, early nesters would have a selective advantage over late nesters because they would occupy superior nesting sites. However, eider nest initiation dates were the same for shoreline, hummocks, and land (Table 12).

Thus it appears that gulls were not excluding eiders, either totally or partially, from "good" nesting habitats on Cape Espenberg. Eiders would nest in drier and less successful areas whether or not gulls are present. The two species here have incompletely overlapping nesting habitat preferences.

Birds may be nesting on land for a variety of reasons. Krebs (1971) found a greater proportion of young, i. e. yearling, Great Tits (Parus major) nesting in hedgerows, where overall fledging success was lower, than in woodlands. Also newly formed pairbonds may result in female eiders getting less food because of harassment by other males than would hens of a longer paired couple (Ashcroft 1976, Spurr and Milne 1976). Thus new breeders may nest on land because of inexperience, or perhaps a lower level of aggression related to age or nutritional plane. Maybe land nests are occasionally more successful than others, especially if clutches of the more colonially nesting hens are destroyed or removed from time to time.

During the two-year time frame of this study, clutches of land nesting eiders suffered more partial predation and lower success than did those on hummocks, shorelines, islands, and peninsulas (Table 22). All more successful habitats were closely associated with water.

The length of absence and distance the hen must travel from the nest to bathe and drink could affect the welfare of the clutch. A hen will attack a gull near her nest (Ahlen and Andersson 1970, Bourget 1970, Schamel 1974, Campbell 1975) and a duck nesting on land probably would have to go further to drink and bathe. As such they would likely be away from the nest longer and less likely to see egg predators than would females nesting near water. Gulls or jaegers probably would have a better chance of taking an egg under these circumstances.

Water may be a deterrent to foxes. Clutches on hummocks, islands, or sedge mounds surrounded by at least a 2 m expanse of water more than 10 cm deep were more successful (Table 23) and suffered less partial clutch predation than were those that were less isolated (Table 19). Water barriers should only affect land predators; predation by avian predators such as jaegers and gulls should not differ.

Foxes were the primary mammalian predator. Some authors (Rearden 1951, Schofield 1960, Sargeant 1972) maintain that foxes (red) avoid water but others (Storm et al. 1976) are more equivocal. The literature on arctic foxes is also unclear (Barry 1966, Ryder 1967, Ahlen and Andersson 1970, Banfield 1974, Strang 1976). The ambiguity may be related to food availability. Assuming an aversion to water does exist, a fox would be more likely to prey on nests surrounded by water when food in drier areas was scarce. On this basis, it appears that during June and July food was not limited. Even though foxes on the Cape could jump at least 3.4 m over marshy ground and were seen walking through water and mud up to their bellies (Schamel et al. 1978), moats still afforded some protection to eider clutches.

Could the absence of Glaucous Gull clutches and broods be responsible for the lower success and higher partial clutch predation of eiders on land? This was not the case on Cape Espenberg. There was no relationship between number of eggs lost from an eider clutch due to partial predation and distance to the nearest gull nest (Fig. 7). Likewise nesting success was not affected by the eider-nearest gull nest distance (Table 24). Elsewhere, however, Kistchinski and Flint (1974) found that clutches of Spectacled Eiders (*Somateria fischeri*) more than 7 m from a Herring or Glaucous Gull nest were all destroyed.

Nesting within a gull's territory did not affect eider nesting success. This could have been caused by the disturbance accompanying a researcher entering the colony. Disturbance can profoundly affect breeding birds. The daily loss of Western Gull (*Larus occidentalis*) eggs was directly proportional to the frequency of disturbance of the colony; the primary cause of egg loss was gulls taking eggs (Robert and Ralph 1975). When disturbed, eiders flush and leave their clutches unprotected. Exposed eider eggs are often eaten by gulls even when the eggs are within the gulls' territory (Kistchinski and Flint 1974). Perhaps in an undisturbed situation, there is differential success between eider clutches within and outside gull territories on Cape Espenberg.

CONCLUSIONS

Andromeda polifolia, *Arctostaphylos* spp., *Empetrum nigrum*, *Ledum palustre*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Rubus chamaemorus*, *Betula* sp. (probably *B. nana*), and *Carex* spp. occurred more frequently around Common Eider nests than around Glaucous Gull nests.

Betula sp. and *Carex* spp. had higher percent ground coverage around eider nests than around gull nests. The converse was true for *Rubus chamaemorus*.

Grass spp., *Polemonium acutiflorum*, and *Stellaria* spp. covered more extensive areas near Glaucous Gull nests than near Common Eider nests.

Artemesia Tilesii, *Chrysanthemum arcticum*, *Cochlearia officinalis*, *Tripleurospermum phaeocephalum*, grass spp., *Polemonium acutiflorum*, and *Stellaria* spp. occurred more often around gull nests than around eider nests.

Eiders nested more often in dry habitat than did gulls.

Vegetation was higher around gull nests than around eider nests.

Willows (*Salix* spp.) and *Artemesia Tilesii* clumps provided most of the cover for eiders nesting on Plot 3.

The density of nesting eiders was, in descending order, greatest on shorelines, hummocks, tussocks, land, and tundra ridges.

The density of nesting gulls was greatest along shorelines, followed by hummocks. No gulls nested on land, tundra ridges, or tussocks.

At least 322 Common Eiders nested on Plot 3, yielding a density of 975 nests per hectare.

Common Eiders and Glaucous Gulls initiated egg laying earlier in 1977 than in 1976.

Hatching dates for eider clutches were the same both in 1976 and 1977.

Eider nests on peninsulas were initiated and hatched earlier than those on land, island nests contained eggs before those on hummocks, and shoreline nests hatched earlier than did land nests.

Eiders initiated clutches earlier in Plot 3 than in Plots 1 and 2, but hatching dates between Plot 3 and Mainland eider nests were the same.

The maximum number of eggs, whether incubated or not, in addition to maximum and minimum incubated clutch sizes of Common Eiders were greater in Plot 3 than in Plots 1 and 2.

Early initiated eider nests in Plot 2 during 1977 had a higher maximum incubated and minimum incubated clutch size than did those initiated later. No such difference was found in 1977 Plot 1 clutches or 1976

Plot 2 clutches.

Maximum incubated clutch size was the same for all habitats, but nests on shorelines, hummocks, and islands had a higher minimum clutch size than did nests on land.

Nests not isolated by a wide and relatively deep expanse of water suffered more partial predation and lower nesting success than did those that were isolated.

Distance between an eider nest and the nearest Glaucous Gull nest did not affect the maximum incubated clutch size, minimum incubated clutch size, or nesting success of an eider clutch.

Proximity to another nesting eider did not affect minimum eider clutch size or nesting success.

Eiders nesting close together laid more eggs than did those further apart, but also lost more eggs by partial predation.

The proportion of successful nests was greater on the eider island than on either Plot 1 or 2.

In 1977 birds initiating clutches early were more successful than were those initiating late. This was not true in 1976.

Nesting success was greater on peninsulas than on hummocks, land, sedge mounds, and tussocks. Eider nests on shorelines were more successful than were those on land.

Common Eiders and Glaucous Gulls have incompletely overlapping nesting habitat preferences on Cape Espenberg.

Appendix I. Common Eider incubated clutch size and distance from that clutch to the nearest Common Eider and Glaucous Gull nests present when the clutch was initiated in the Mainland Plot during 1977 on Cape Espenberg, Alaska. The nearest nests may or may not have been destroyed when the eider clutch was initiated.

Minimum Clutch Size	Maximum Clutch Size	Distance to Glaucous Gull Nest (m)	Distance to Common Eider Nest (m)
5	5	142.2	53.8
4	-	1.5	14.2
4	4	1.4	1.2
2	-	109.0	-
2	2	22.4	118.0
3	-	154.8	-
5	5	7.8	22.4
3	-	0.7	-
4	4	16.0	16.6
3	3	18.0	-
4	-	4.8	46.8
3	7	7.6	-
5	5	7.5	21.3
5	5	50.2	50.6

Appendix I (Cont'd)

Minimum Clutch Size	Maximum Clutch Size	Distance to Glaucous Gull Nest (m)	Distance to Common Eider Nest (m)
3	3	120.0	-
2	2	-	27.8
5	5	52.4	-
4	5	-	10.0
3	4	38.3	7.3
8	8	42.9	-
2	2	-	65.0
8	8	152.4	-
5	5	26.2	26.2
4	4	110.2	-
5	5	25.2	15.5
5	5	31.4	-
5	5	8.4	18.5
5	5	12.2	-
4	4	4.0	265.2
4	5	54.4	-
5	5	4.4	0.4
4	4	12.8	-
3	3	2.5	3.6
3	3	47.4	-
5	5	1.6	0.4

Appendix I (Cont'd)

Minimum Clutch Size	Maximum Clutch Size	Distance to Glaucous Gull Nest (m)	Distance to Common Eider Nest (m)
4	4	1.3	-
2	-	68.8	38.0
2	2	24.6	30.0
4	4	34.4	44.2
6	-	16.0	433.6
7	7	14.0	1.5
4	4	-	5.9
6	6	-	12.7
4	4	-	52.2
2	2	-	36.6
3	3	-	21.8
-	6	-	0.4
3	-	53.0	10.9
4	4	119.6	-
4	4	-	52.0
6	6	67.4	32.2
3	3	18.5	63.1
4	4	21.0	40.8
6	6	36.4	-
4	4	30.0	17.2
3	3	15.6	-

Appendix I (Cont'd)

Minimum Clutch Size	Maximum Clutch Size	Distance to Glaucous Gull Nest (m)	Distance to Common Eider Nest (m)
4	4	15.4	17.2
5	7	11.5	-
6	6	2.8	0.6
2	3	41.8	-
5	5	10.1	16.4
3	9	17.3	-
8	-	121.2	0.9
4	4	121.8	-
1	2	41.0	36.8
4	4	74.4	47.4
6	6	18.0	-
2	2	69.0	5.2
2	2	20.0	39.0
4	4	17.2	17.8
5	7	11.0	0.5
2	5	31.6	1.0
6	-	12.0	54.0
5	5	21.7	10.1
4	6	114.8	10.9
4	4	110.2	24.0
5	5	89.6	0.6

Appendix I (Cont'd)

Minimum Clutch Size	Maximum Clutch Size	Distance to Glaucous Gull Nest (m)	Distance to Common Eider Nest (m)
9	9	89.4	0.6
6	6	72.0	17.4
5	6	70.2	-
-	5	76.8	9.0
7	7	28.8	9.7
5	5	88.8	-
1	1	29.6	1.0
4	5	196.2	-
7	7	33.6	8.2
6	6	49.6	22.8
5	5	167.8	59.4
6	7	70.8	0.4
4	4	30.6	0.5
6	6	21.3	0.5
4	4	30.6	21.6

Appendix II. Frequency of Common Eider-Common Eider and Common Eider-Glaucous Gull internest distances in the Mainland Plot during 1977 on Cape Espenberg, Alaska. The nearest nests may or may not have been destroyed when the eider clutch was initiated.

	Glaucous Gull		Common Eider	
Distance (m)	n	%	n	%
0-10	18	17.3	34	38.6
11-20	20	19.2	18	20.5
21-30	10	9.6	10	11.4
31-40	10	9.6	7	7.9
41-50	7	6.7	7	7.9
51-60	6	5.8	6	6.8
61-70	5	4.8	3	3.4
71-80	5	4.8	0	0.0
81-90	4	3.9	0	0.0
91-100	0	0.0	0	0.0
101-110	3	2.9	0	0.0
111-120	3	2.9	1	1.1
121-130	2	1.9	0	0.0
131-140	1	1.0	0	0.0
141-150	2	1.9	0	0.0
151-160	4	3.9	0	0.0
161-170	2	1.9	0	0.0
171-180	0	0.0	0	0.0

Appendix II (Cont'd)

Distance (m)	Glaucous Gull		Common Eider	
	n	%	n	%
181-190	1	1.0	0	0.0
191-200	1	1.0	0	0.0
261-270	0	0.0	1	1.1
431-440	0	0.0	1	1.1
	104	100.1	88	99.8

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