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The Breeding Biology and Management of the Northern Eider (*Somateria mollissima borealis*) in the Cape Dorset Area, Northwest Territories

by F. G. Cooch

CANADIAN WILDLIFE SERVICE

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Adult male and female common eiders *(Somateria mollissima dresseri)*. This species is generally indistinguishable from the northern eider *(Somateria m. borealis)* except that the common has a shorter and more rounded frontal shield.

Issued under the authority of the
HONOURABLE ARTHUR LAING, P.C., M.P., B.S.A.,
Minister of
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CONTENTS

INTRODUCTION, 17

BIOLOGICAL RESEARCH OBJECTIVES, 18

RESEARCH PROCEDURES, 19

DESCRIPTION OF STUDY AREA, 20

LIFE HISTORY, 21

- Phenology, 1955 and 1956, 21
- Spring migration, 22
- Courtship and pairing, 23
- Nesting, 24
  - Site selection, 24
  - Site preparation, 25
  - Nesting areas, 25
  - Site tenacity, 27
  - Egg laying, 28
  - Incubation and down deposition, 29
  - Clutch size, 30
  - Nesting curve, 34
  - Renesting, 34
- Natural predation and egg loss, 35
  - Predators, 35
  - Magnitude of egg loss, 36
- Hatching and brood rearing, 42
- Post-hatch mortality, 45
- Post-nuptial moult, 46
- Autumn migration, 46

MANAGEMENT, 43

- Eiderdown collection techniques, 47
  - Time of collection, 47
  - Procedures, 47
  - Down collection, 49
- Cape Dorset eiderdown industry, 55
- Eskimo depredation, 58

SUMMARY, 59

- Life history, 59
- Management, 59

LITERATURE CITED, 60

APPENDICES, 61

- A History of eiderdown collection at Cape Dorset, 61
- B Description of study areas, 62
- C Plants collected, 64
- D Other nesting areas, 65

RÉSUMÉ, 67

LIST OF TABLES

1 Temperature and precipitation data for 1955 and 1956 from Nottingham Island, with corresponding 24-year averages, 21
2 Sex ratios and flock sizes in spring counts of northern eiders near Cape Dorset, 1955–56, 22
3 Distance of nest site from water, 26
4 Frequency of occurrence of nests containing old down only, new down only, or both, at time of laying of first egg, in 504 active nests, 1955 and 1956, 27
5 Relationship between number of eggs laid and down deposition in 180 nests with four-egg clutches, 29
6 Egg deposition and onset of incubation in 180 nests with four-egg clutches, 29
7 Frequency of occurrence of clutch sizes on July 12, 1955, and July 18, 1956, 31
8 Comparison of clutch sizes found on the study area, July 12, 1955, and July 18, 1956, with total clutch sizes including destroyed eggs and whole clutches, 31
9 Clutch sizes of *Somateria mollissima* spp. from other areas compared with those from Cape Dorset, 32
10 Comparison of complete clutch sizes of eiders nesting on the study area in the first and second halves of the nesting season, 1955 and 1956, 33
11 A comparison of clutch sizes observed between July 18 and July 23, 1956, 33
12 Clutch sizes from 12 known renesting attempts compared with those from 188 first nesting attempts, 36
13 Eggs lost on the study area through predation and other factors, 1955 and 1956, 36
14 Daily egg loss due to predation and other factors, 1955, 37
15 Daily egg loss due to predation and other factors, 1956, 38
16 Relationship between available eggs and numbers of eggs taken by predation, 1955, 40
17 Relationship between available eggs and numbers of eggs taken by predation, 1956, 41
18 Number of adult females and young recorded on lakes in study area, 1955, 43
19 Eider broods observed along 100 miles of coastline between Andrew Gordon Bay and Cape Dorset, August 19 and 20, 1956, 45
20 Percentages of nests in samples of 100 affected by fecal contamination during collecting experiments, 1955, 48
21 Weight of down collected from contaminated and uncontaminated nests, by clutch sizes, 50
22 Frequency of contamination in nests and weight of down collected on the study area compared with the remainder of the West Foxe Islands, 51
23 Correlation among amount of down collected, frequency of contamination, and nest initiation curve, study area, 1956, 53
24 Relationship between average clutch size and frequency of nest contamination, 54
25 Percentage contamination, average clutch size, and weight of down collected from groups of nests on the study area with clutches completed at various dates before the date of collection (July 18, 1956), 55
26 Total number of old nesting sites and number used in 1955, 56
27 Theoretical increase in a protected nesting population assuming a clutch average of three eggs, 57
28 Tabular description of West Foxe Islands, 63

LIST OF FIGURES

1 Map of Eastern Arctic showing location of the Cape Dorset study area, 8
2 Map showing explorations for eider nesting habitat carried out in Cape Dorset area, 1955 and 1956, 9
3 Map of West Foxe Islands, 9
4 Part of Tunitjuak Island study area showing Cliff Lake. The flat areas near the lake supported 400 eider nests. Picture taken June 20, 1955, 10
5 Typical nest site under overhanging rocks, 11
6 Typical nest, located between fallen rocks once used by Eskimos to trap nesting birds, 11
7 One-hour-old eider duckling nearly ready to leave nest, 11
8 Linear regression showing the relationship between number of eggs in the clutch and the date on which egg laying was started, 12
9 Daily egg loss expressed as a percentage of total loss, 1955 and 1956, 13
10 Map of Tunitjuak Island showing study area, 13
11 Map of Blades Island showing study area, 14
12 Map of South Island, Andrew Gordon Bay, 15
13 Map of Alareak Island, 16

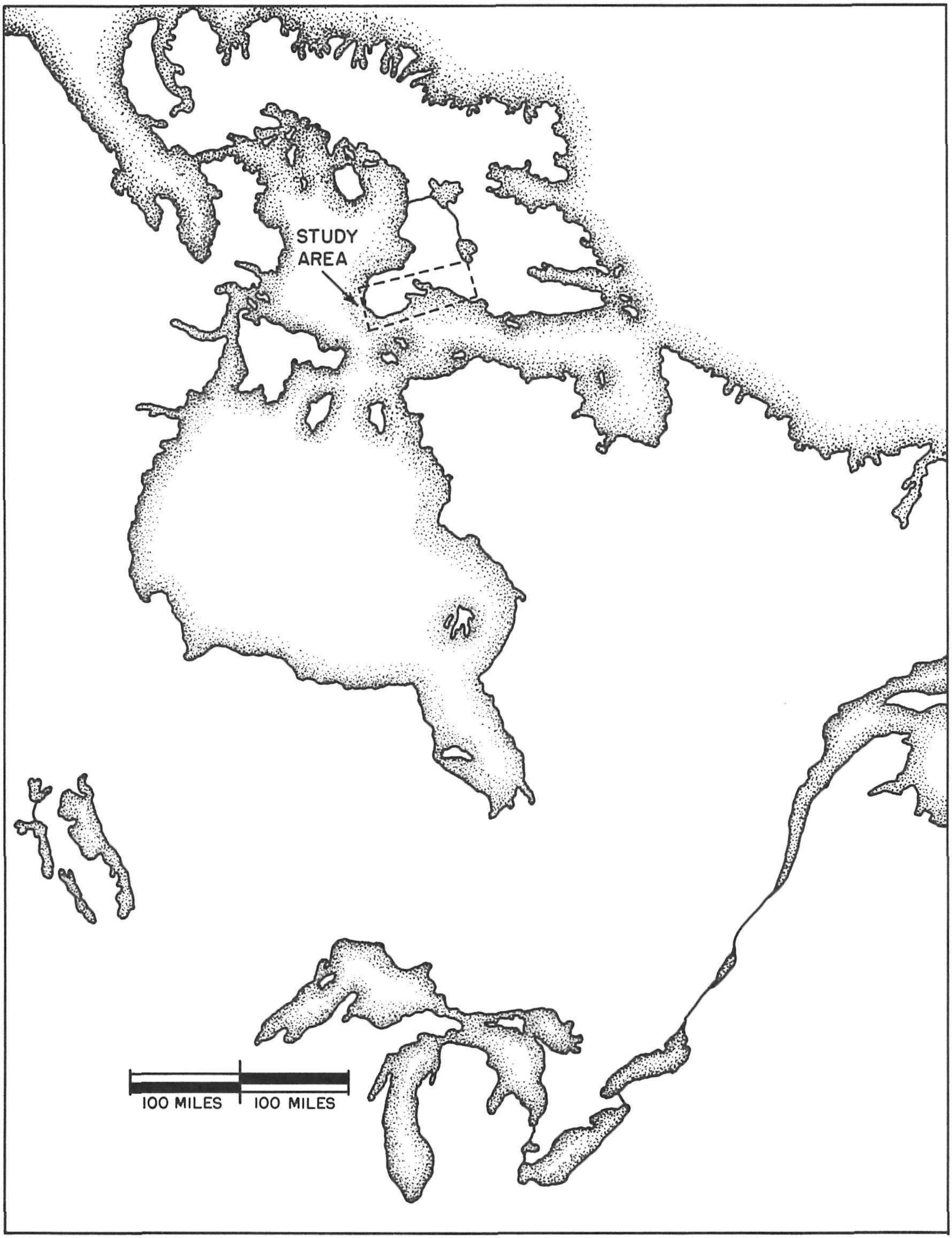

Figure 1. Map of Eastern Arctic showing location of the Cape Dorset study area.

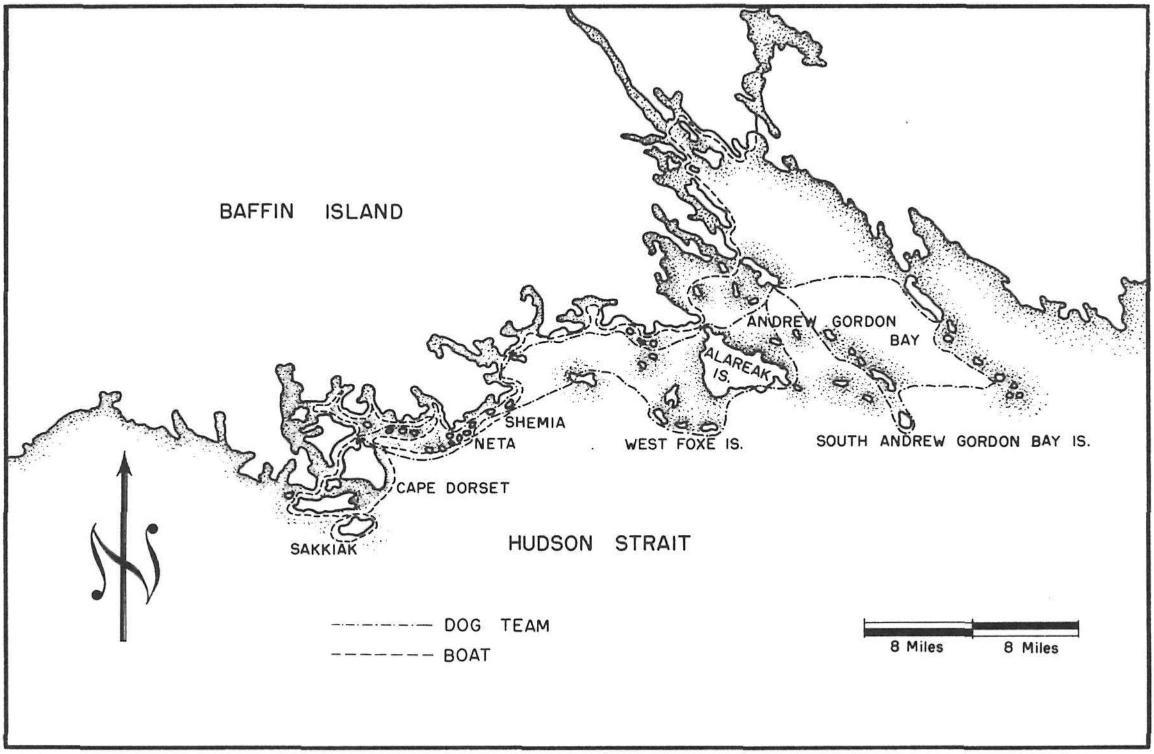

Figure 2. Map showing explorations for eider nesting habitat carried out in Cape Dorset area, 1955 and 1956.

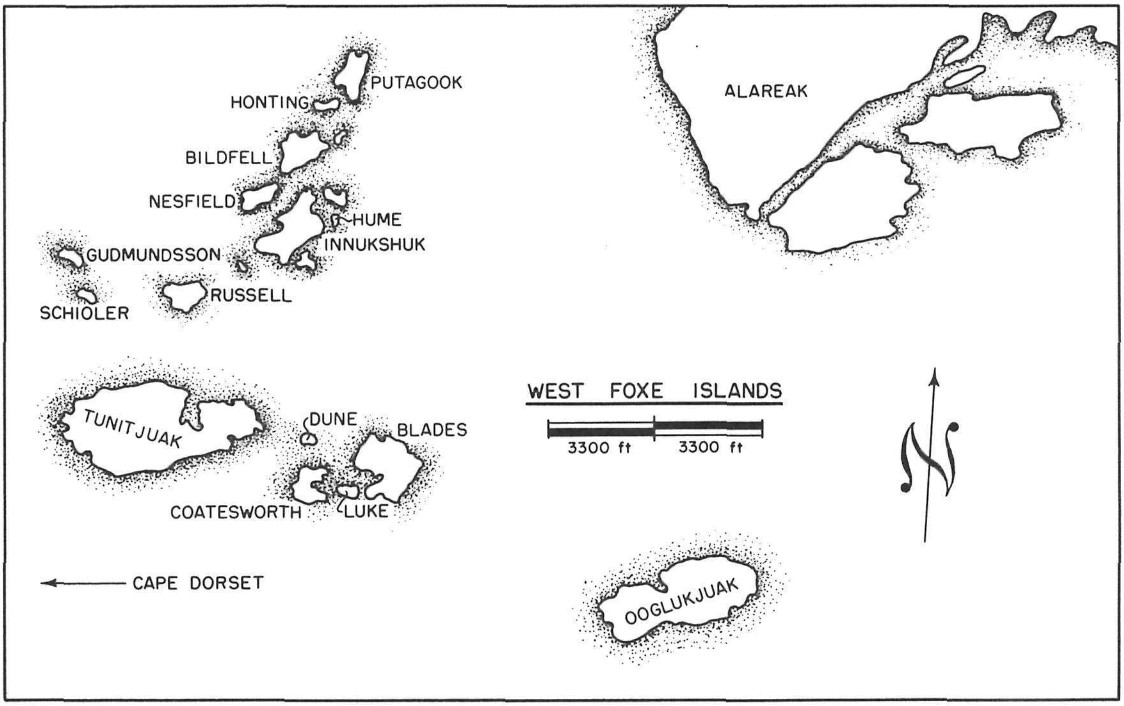

Figure 3. Map of West Foxe Islands.

Figure 4. Part of Tunitjuak Island study area showing Cliff Lake. The flat areas near the lake supported 400 eider nests. Picture taken June 20, 1955.

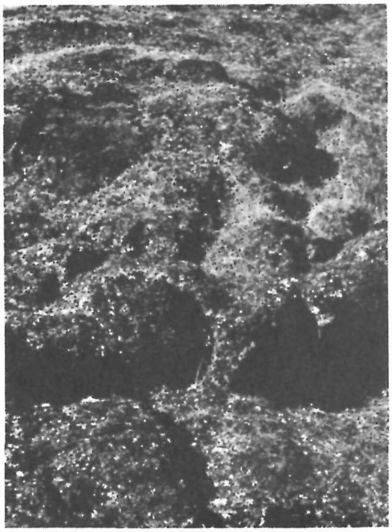

Figure 5. Typical nest site under overhanging rocks.

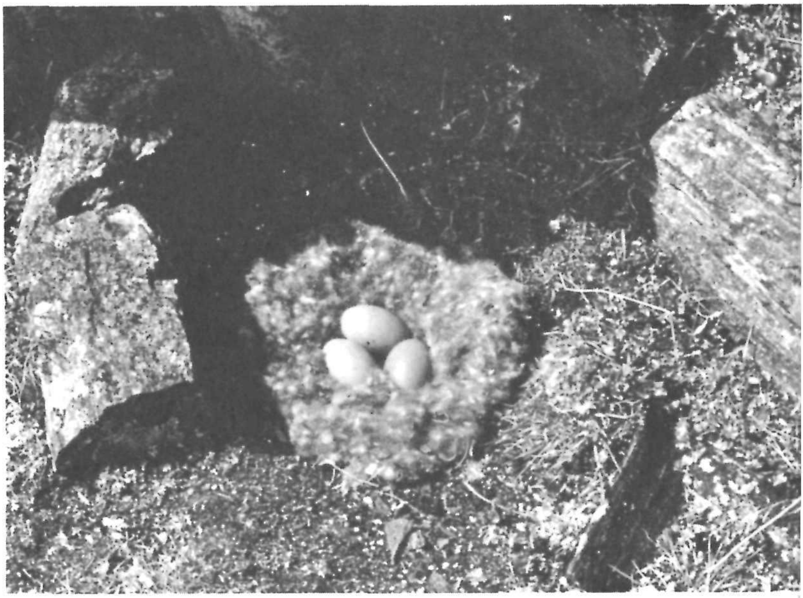

Figure 6. Typical nest, located between fallen rocks once used by Eskimos to trap nesting birds.

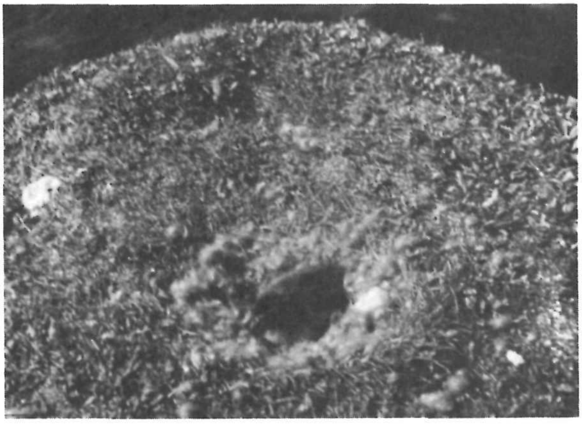

Figure 7. One-hour-old eider duckling nearly ready to leave nest.

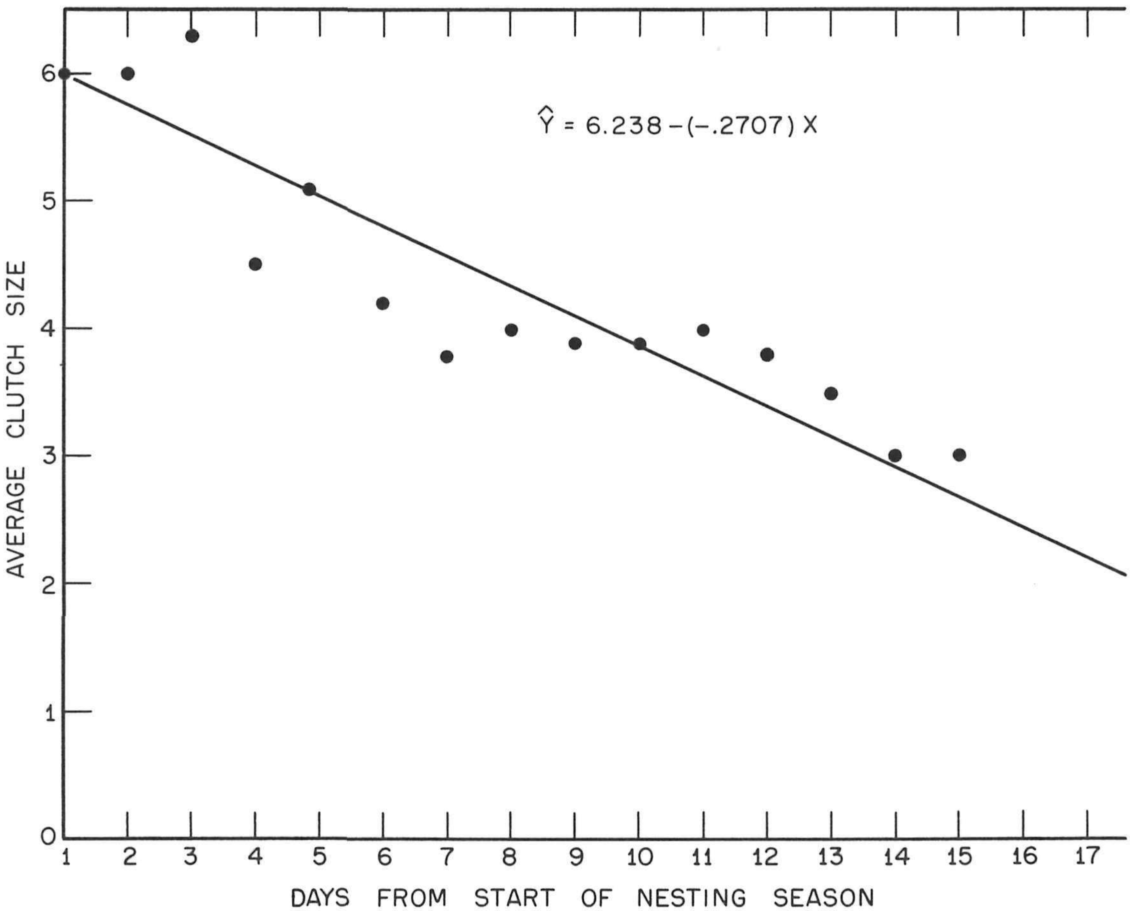

Figure 8. Linear regression showing the relationship between number of eggs in the clutch and the date on which egg laying was started.

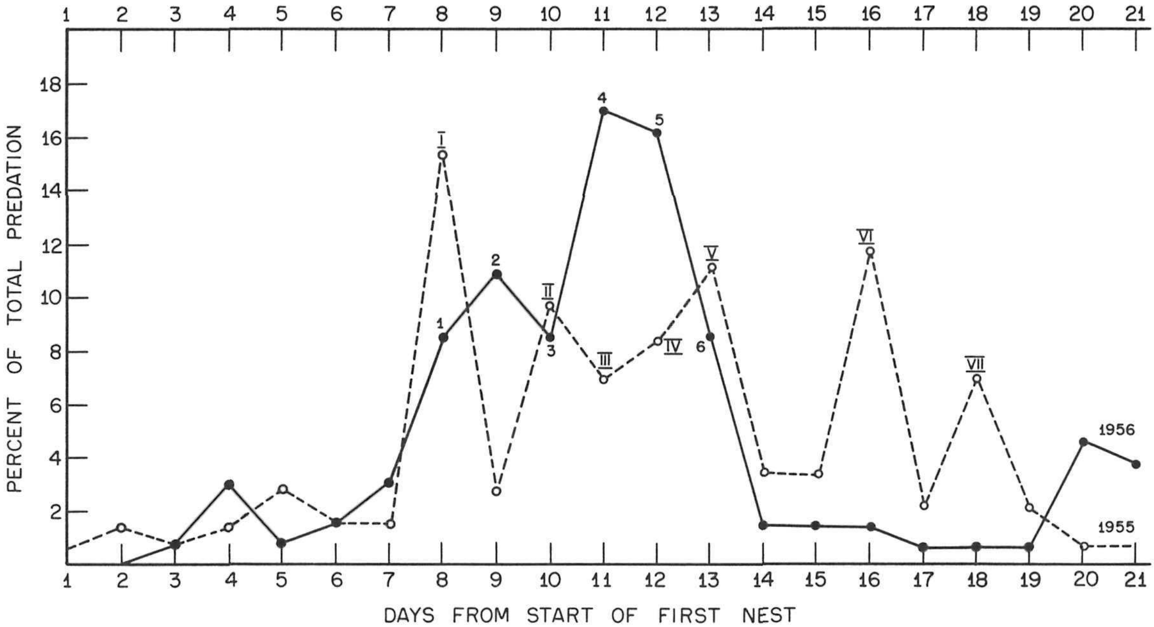

Figure 9. Daily egg loss expressed as a percentage of total loss, 1955 and 1956.

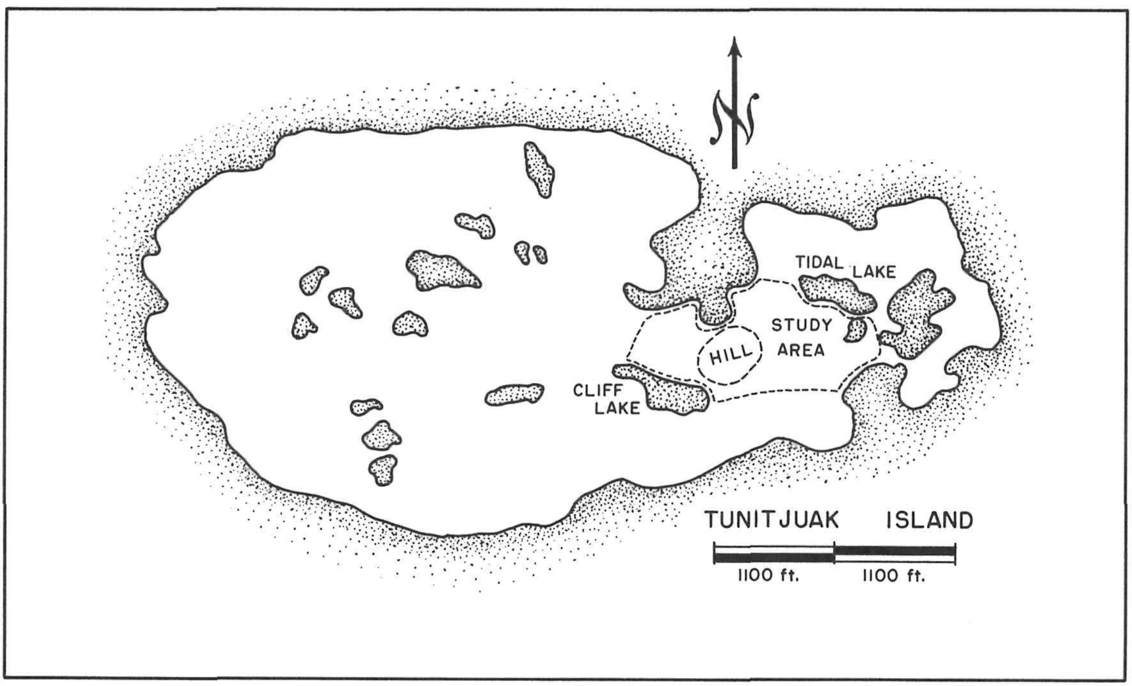

Figure 10. Map of Tunitjuak Island showing study area.

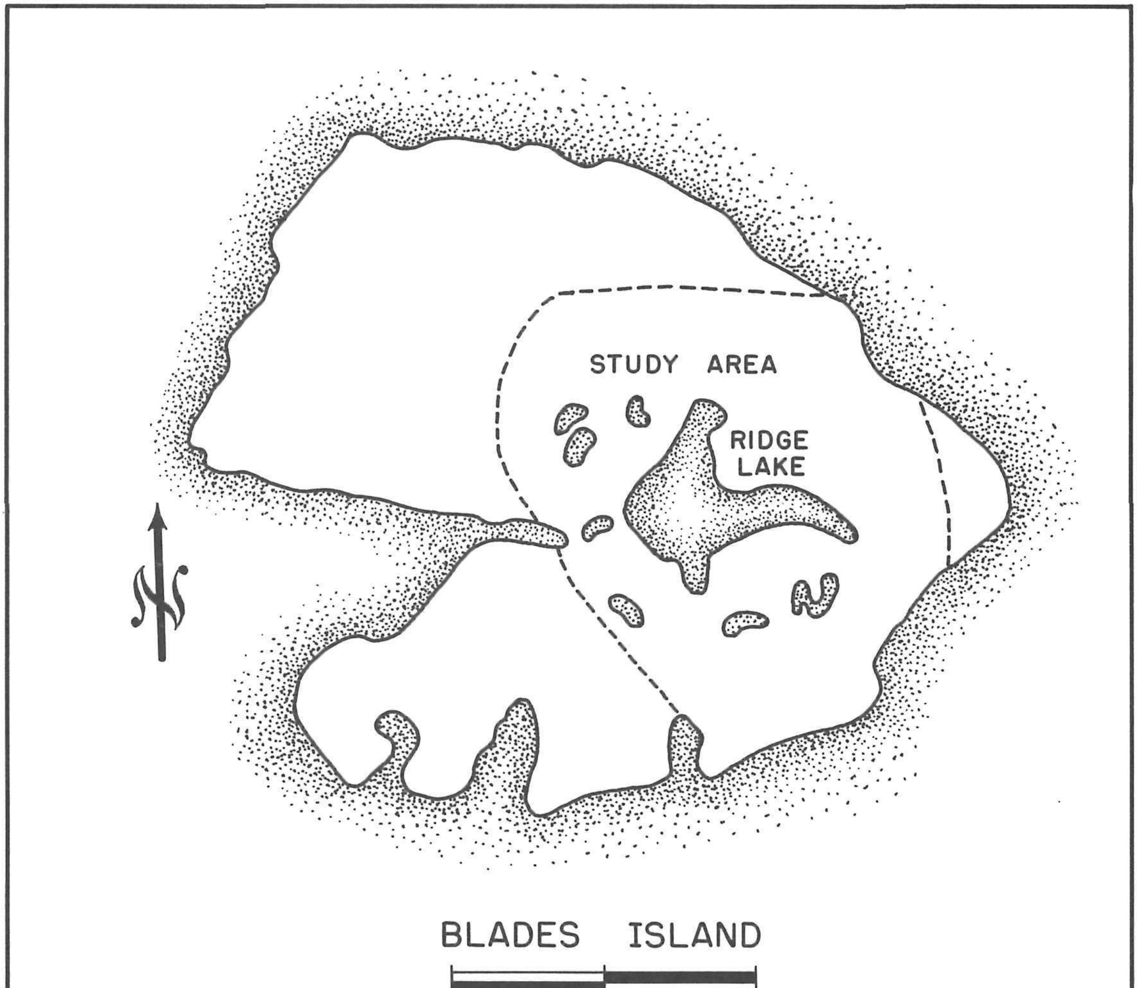

Figure 11. Map of Blades Island showing study area.

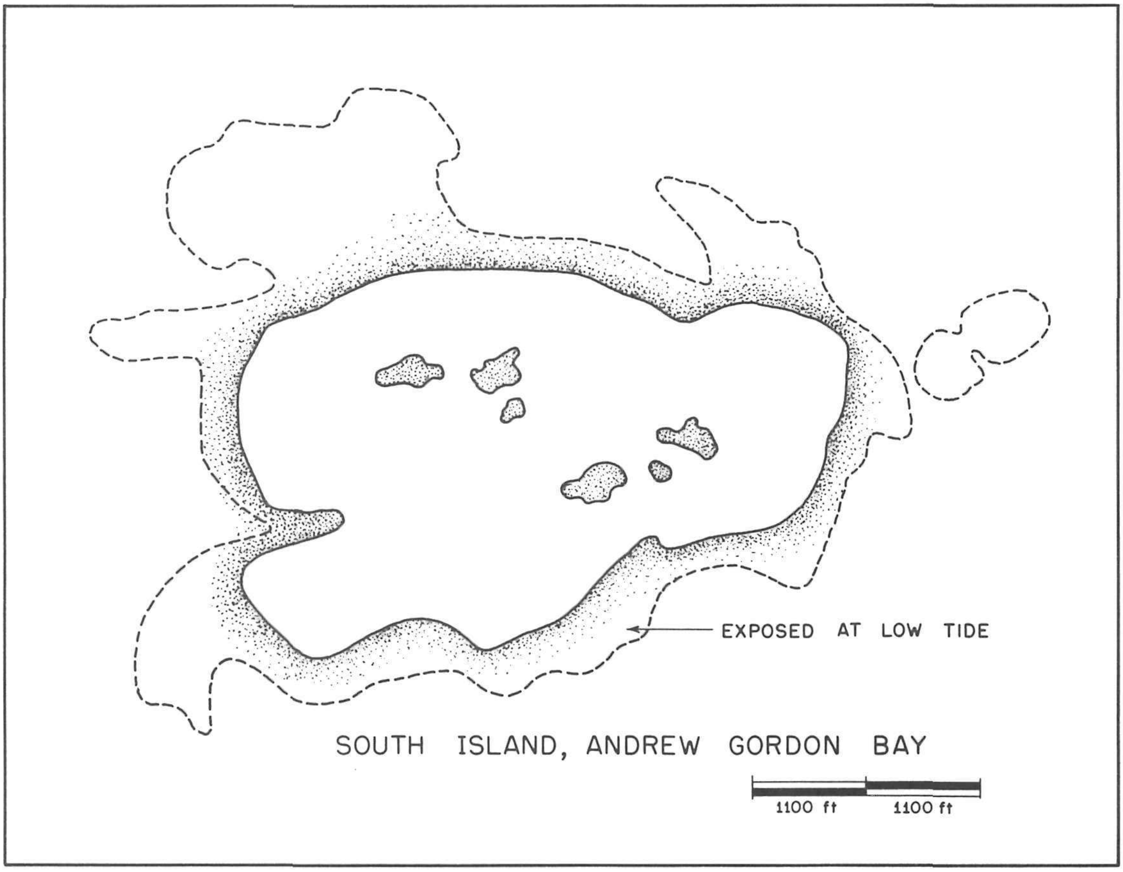

Figure 12. Map of South Island, Andrew Gordon Bay.

Figure 13. Map of Alareak Island.

INTRODUCTION

One of the most abundant waterfowl species of Arctic Canada is the northern eider duck *(Somateria mollissima borealis)*. The insulating qualities of its nesting down have been known for centuries, and a thriving eiderdown industry, utilizing "farming" methods, has long been an important factor in the economy of Iceland. Although previous attempts to establish an eiderdown industry in the Canadian Arctic have failed for one reason or another, it is hoped that eventually one can be established for Canadian Eskimos. In 1933 an eiderdown industry was organized along the north shore of the Gulf of St. Lawrence, but the amount of clean down produced seldom exceeded 150 pounds per year (Lewis, 1939). A major deterrent to success was the tedious and time-consuming cleaning procedure. After the Second World War, economic conditions favoured other activities and the industry declined. In recent years there has been renewed interest.

In 1954, active interest in the potential value of an eiderdown industry was revived, and a four-year program of research and development was implemented by the Department of Northern Affairs and National Resources. As an initial phase of the study, an investigation of the industry in Iceland was made in May, 1954, by Dr. David A. Munro, then Chief Ornithologist, Canadian Wildlife Service, and Mr. William Larmour, Arctic Division, Department of Northern Affairs and National Resources. Important developments in cleaning techniques and farming methods were seen, including a new method of cleaning. A cleaning machine was purchased in Iceland by Arctic Division and was tested in Ottawa and at Payne Bay, Quebec, in 1955, 1956, and 1957, and at Cape Dorset, Baffin Island, in 1957.

In late June and early July, 1954, the writer made an aerial survey of eider duck populations along the east coasts of Hudson Bay and Hudson Strait (Cooch, 1954). As a result of that survey, it was decided that biological investigations would be carried out at Cape Dorset, Baffin Island, in 1955 and 1956 (Fig. 1).

This report contains the results of the two-year study of the breeding biology and management of the eider duck near Cape Dorset. Although substantial progress has been made toward the stated objectives, it is apparent that many details remain to be worked out.

BIOLOGICAL RESEARCH OBJECTIVES

A summary of the immediate research objectives follows:

1. Study the history of the eider duck on southwestern Baffin Island to aid in evaluating the applicability of published information on eider ducks in more southerly regions.
2. Study eider duck habitat requirements as an aid in selecting future sites for an eiderdown industry.
3. Study mortality and movements, by banding and otherwise marking eiders.
4. Study predation to determine whether control is necessary to ensure the success of the industry.
5. Initiate a renesting study to determine whether a second nesting attempt is made if the first is unsuccessful.
6. Study Eskimo - eider duck relationships to determine the effect of Eskimo depredations on breeding populations.
7. Develop a method of down collection appropriate to conditions at Cape Dorset.
8. Attempt by the use of local habitat improvements, such as Icelandic stone shelters, to encourage eiders to nest.

The Cape Dorset region was selected for the biological investigations because:

1. Large numbers of eiders were seen there during the 1954 aerial survey.
2. The potential habitat in the region is extensive and includes many islands more than 100 acres in area.
3. The geographical location of those islands is such that study areas on them could be set aside without interfering with normal Eskimo activity.
4. The Eskimos residing at Cape Dorset are intelligent and were reported to be interested in collecting eiderdown.
5. That area produced the greatest amount of eiderdown during the Bildfell experiment of 1939 (Appendix A).

It was considered that the study area should be a unit of two or more islands, each with an area of 100 acres or more, off main routes of Eskimo travel. It should include adequate camping facilities, be accessible throughout the year, support a large breeding eider population, and contain sufficient habitat for the development of experimental eider "farms".

The region was explored by dog team in May and early June, 1955, and the West Foxe Islands were chosen after Sakkiak, Neta, and Alareak Islands, and the islands in Andrew Gordon Bay had been examined and rejected, chiefly because there was no suitable campsite on them.

RESEARCH PROCEDURES

The following basic research procedures were used during the biological study:

1. Before the 1955 nesting season, two areas for a nesting study were marked off, one on Blades Island and the other on Tunitjuak Island.
2. Two additional areas, one on Russell Island and one on Tunitjuak Island, were chosen for use in verifying data on clutch sizes from the study areas.
3. Each study area was visited daily at low tide in order to disturb as few nesting females as possible.
4. When a nest was discovered the following data were recorded:
   - (a) number of eggs
   - (b) male present or absent
   - (c) female present or absent
   - (d) eggs covered or uncovered
   - (e) old or new down present
   - (f) nest build up or flush
   - (g) nest in exposed position or concealed by rocks
   - (h) number of feet from water.
5. A number was assigned to the nest, and a metal tag bearing that number was placed under the nesting down or in a nearby rock crevice.
6. A sketch was made of the nest site.
7. The nest number and sequence in the clutch were recorded on the ends of each egg. Each new egg when found was recorded and marked in the same manner.
8. To aid in field identification, nesting females were trapped and banded with conventional aluminum bands and with coloured plastic bands placed on the right leg.
9. To aid in following brood movements, ducklings were coloured with aniline dyes injected into the eggs just before hatching.

After a nest was found and its basic data recorded, it was checked daily until the eggs hatched. The history of each nest and egg was recorded whenever possible throughout the nesting season on individual punch cards brought up to date after each visit to the study area. Pertinent observations on behaviour, onset of incubation, predation, desertion, flooding, deposition of nesting down, hatching, and banding were also recorded for each nest.

DESCRIPTION OF STUDY AREA

The West Foxe Islands (64°17′N. 75°45′W.) are located approximately three miles southwest of Alareak Island and 25 miles east of Cape Dorset (Figs. 2 and 3). Lakes and large tidal ponds are found on five of the larger islands, and fresh water is available in rock catch basins on all the islands, except during periods of prolonged drought.

In general, the physiography of the islands is irregular. The many rock faults, crevasses, and rocky ridges provide excellent nesting habitat for eiders. Large tidal pools are found around all the larger islands and are used extensively by ducks in late June and early July. Twenty-three-foot tides create whirlpools and areas of swift-moving rip tides which remain ice-free until late in November and provide open water in early May. The areas of swift water (Eskimo = Chorbak or Ikerasik) attract many early migrant ducks and geese. Shallow, sheltered areas in the lee of the larger islands provide excellent feeding and loafing areas throughout summer.

More detailed descriptions of the West Foxe Islands are given in Appendix B.

LIFE HISTORY

Phenology, 1955 and 1956

In 1955, the weather from May 15 to July 20 was considerably warmer and drier than normal, and pack ice disappeared in late June. On July 20, 1955, the weather changed for the worse, and rain and overcast skies prevailed.

In 1956, it remained cold until May 29, and gales and snow were frequent. Large fields of pack ice remained among the islands until early August. Between June 15 and July 18 the weather was extraordinarily warm, dry, and windless; after that, conditions deteriorated, but not to the same extent as in 1955.

TABLE 1

Temperature and precipitation data for 1955 and 1956 from Nottingham Island, with corresponding 24-year averages

	Temperature in degrees Fahrenheit									Precipitation in inches of rain		
	Maximum			Minimum			Mean					
Month	1955	1956	Av.	1955	1956	Av.	1955	1956	Av.	1955	1956	Av.
May	40	32	25	2	3	19	27	19	22	0.75	0.2	1.30
June	60	61	40	25	14	30	35	37	35	0.88	0.1	0.50
July	55	62	49	30	31	36	46	43	42	1.51	0.5	1.41
August	60	60	48	30	33	36	41	44	42	2.20	0.6	1.64

Temperature and precipitation data are presented in Table 1. Unfortunately there is no weather station at Cape Dorset, and it is necessary to use data from Nottingham Island, 85 miles to the southwest, but conditions were similar at both places in 1955 and 1956.

Table 1 is perhaps misleading in that it does not indicate the almost complete change of weather after July 20, 1955, nor the concentration of rain in early August in both 1955 and 1956. In 1955 a total of 2.20 inches of rain fell during the month, but rain on August 4 and 10 accounted for nearly 2.0 inches of the total. The rain and accompanying winds caused the destruction of many black guillemot *(Cepphus grylle ultimus)* and a few late eider nests. Rain fell almost continuously in the first two weeks of August, 1956, but was not concentrated to the same extent as in 1955.

In summary, weather during both nesting seasons was exceptionally good, but deteriorated rapidly during the hatching and rearing period.

Spring migration

Two species of eiders are found in the Cape Dorset area. The first to arrive in both years of the study were king eiders *(Somateria spectabilis).* Although a few of those birds are seen in early April, the peak flight occurs late in the month. A noticeable decrease in numbers is seen after mid-May, and few remain during the breeding season. Flock counts indicated that sexes were equally represented on May 9, 1955, and May 20, 1956.

The spring migration of northern eiders occurs two weeks later than that of king eiders. Males predominated among the first arrivals and it was not until June 1, 1955, and June 5, 1956, that sex ratios approached 1:1. Data on ratios obtained in both years are presented in Table 2.

TABLE 2

Sex ratios and flock sizes in spring counts of northern eiders near Cape Dorset, 1955–56

	Ratio of male to female		No. of flocks		Average size of flocks	
Date	1955	1956	1955	1956	1955	1956
May 13	—	4.9:1	2	3	10.0	16.7
May 15	4.8:1	6.7:1	4	5	8.8	12.4
May 17	5.3:1	6.0:1	10	9	9.5	10.7
May 22	3.2:1	4.9:1	39	22	6.4	8.3
May 28	3.2:1	4.5:1	52	29	5.4	8.0
May 30	1.5:1	2.8:1	46	57	4.3	5.8
May 31	1.4:1	2.2:1	78	113	4.3	4.5
June 1	1:1	1.4:1	461	335	3.6	4.1
June 2	1:1	1.3:1	509	348	3.6	4.8
June 3*	1:1	1.2:1	757	554	2.9	3.6
June 5	—	1:1	—	703	—	3.4
June 7	—	1:1	—	635	—	3.4
June 9	—	1:1	—	909	—	3.1
June 11	—	1:1	—	965	—	2.8
June 13†	—	1:1	—	1,230	—	2.6

* After June 3, 1955, it was difficult to make adequate flock counts as pack ice reduced the amount of open water. By the time the ice moved out, eiders were nesting.

† Observations were possible until June 13, 1956, because of the late breakup of the floe edge near the study area.

The West Foxe Islands are well situated for the recording of migration data, and conditions in 1956 were especially good because the floe edge remained close to the islands until July 1.

The wintering area of Cape Dorset eiders is not completely known, but it does extend from the eastern end of Hudson Strait, north of Port Burwell, Quebec, to the Grand Banks of Newfoundland, and into the Gulf of St. Lawrence as far west as Anticosti Island. Mr. P. A. C. Nichols of the Hudson's Bay Company told me in 1955 that he saw vast flocks of eiders near Port Burwell throughout the winter months of 1922–23. Seven winter band recoveries from Newfoundland (Fogo), and one from Anticosti Island, Quebec, indicate that at least part of the population winters there.

Observations on migrating eider flocks at Lake Harbour in April, 1957, and reports by Eskimos indicate that the eiders migrate west through Hudson Strait to Cape Dorset. Secondary flights may originate from two suspected wintering areas: (1) south of Flaherty Island (one of the Belcher Islands), and (2) Roes Welcome Sound, Southampton Island. There is, however, no evidence to support that premise.

The route most commonly used by all species of birds during spring migration is from east to west through Hudson Strait. An exception is the snow goose *(Anser c. caerulescens),* which migrates up the east coast of Hudson Bay and crosses the strait to Baffin Island along a narrow front extending from Ivugivik to Sugluk, Quebec. Willow ptarmigan *(Lagopus lagopus)* cross the strait between Cape Hope's Advance, Quebec, and Lake Harbour, Baffin Island. They then migrate west into the Dorset area. A similar route is followed by American brant *(Branta bernicla hrota)* (Lewis, 1937).

Courtship and pairing

Many early eider migrants arrive at Cape Dorset in sex-segregated flocks. Large flocks of females are never abundant. It may be that non-breeding males arrive first, depart, and are gradually replaced by paired birds. Non-breeding females may arrive at about the same time as the breeding pairs and thus not be noticed. Although concrete evidence is not available, I feel that many breeding birds are paired before their arrival in the Cape Dorset area. Observations made at Lake Harbour (250 miles east of Cape Dorset) in April and May, 1957, indicate that more courtship and pairing occurs there than at Cape Dorset. That would seem to indicate that pairing occurs during migration as well as on the breeding grounds.

Little courtship or vocalization is noted among the first arrivals, but a marked change occurs during the last week of May, when the mournful "Ah-hoo's" of the males are heard constantly. Little antagonistic behaviour among the males is noted. Eiders spend much time sitting quietly along the floe edge or feeding in the placid ice-sheltered water. They carry on most of their courtship while swimming. Aggressive behaviour by males appears to be limited to jostling for favourable positions near responsive females.

A typical "courting party" consists of a single female accompanied by two or three interested males. Such parties spend considerable time swimming in single file, the female in the lead. At the beginning of the season they are usually silent, but gradually the intensity and frequency of their calls increase. Observed activity on the part of the male appears to be confined to two acts: (a) rearing up in the water, exposing the velvet-black belly, at the same time flapping the wings a few times; and (b) giving a restrained head "toss" with the bill pointing vertically upward. During moments of more intense display the head is jerked backwards rigidly from the vertical position, then returned to its normal position. Vocalization occurs as part of the visible display. The long-drawn-out "ah-hoo" is thought to be a preliminary courtship note. It is uttered while the bill of the male is in a vertical position or when it is brought forward from the more extreme head toss. A different call is heard when courtship reaches a point of greater intensity, or possibly when the male senses he is obtaining more response from the female. This note, "doo" or "k'doo", appears to be emitted while the bill is pointed directly downward and held tightly against the breast.

Throughout most of those male antics the female maintains an attitude of studied unawareness and swims about placidly. Mating is observed soon after, when, accompanied by one male, the female quietly moves away from the party.

Copulation occurs soon after the apparent formation of the pair bond. The female indicates responsiveness by stretching her head and neck forward, and lying low on the water, her body forming a straight line. As she does so, the drake becomes quite excited, swims in a circle around her, and repeatedly raises himself in the water, exposing his velvet-black belly and flapping his wings. Finally he swims behind the female, who is now lying nearly prone on the water, mounts, and copulates. The act requires but a few seconds. More detailed ethological studies on the behaviour of eiders have been published since this report was written, notably those of McKinney (1961) and Johnsgard (1964).

The newly mated pair immediately wash themselves by vigorous splashing accomplished by a fore-and-aft rocking motion. This is followed by preening. The birds then return to the flock and join other pairs sitting along the floe edge.

Nesting

After mating has been consummated, the paired birds spend hours sitting motionless along the floe edge. With the rising tide they move to feed in the open water between the islands. During May and early June they seem to avoid flying over land, apparently preferring to skirt along the floe edge. In early June, however, first flocks, then pairs, are regularly seen flying low over islands.

The lakes on Blades and Tunitjuak Islands thawed on June 12, 1955, and on June 14 the first birds were recorded there. A similar situation was observed in 1956, when thawing occurred on June 16, and birds were noted on the lakes on June 19. The number of birds using the lakes increases daily, reaching a peak approximately 14 days after the first birds are seen there. After that date some males desert their females and spend an increasing amount of time in the waters around the islands.

Site selection

An increase in the number of birds using the lakes, or flying in pairs low over the islands is the first hint of the onset of nesting. Scouting forays and visits to the lakes are made on the incoming tide, whereas at low tide marine feeding areas are more accessible, and the birds seem to concentrate there.

During the scouting forays the male always accompanies the female. The male is usually silent, but the female keeps up an incessant croaking or moaning throughout the flight. The pairs fly low over the land, the female slightly in the lead. Desirable areas are circled many times, but no obvious attention is paid to any particular spot. At the termination of the search flight, the birds land on the water near the potential nesting areas. There they move about cautiously and, if the way seems clear, swim to land. The female leaves the water, followed by the more timorous male, and walks toward the selected nesting area. Throughout the expedition the male keeps watch constantly and takes flight at the first sign of trouble, whereas the female is engrossed in inspecting possible nest sites. In 1955, 92 per cent of the females selected sites which had been used in previous years, and in 1956, 87 per cent of the sites had been used previously. The final preparation of a site is not normally made during the first tour of inspection. No eggs are laid during that inspection trip except late in the season or when new nests are constructed. When the birds complete their inspection, they walk back to the water, the male in the lead. The male is thus the last to leave the water and the first to return. The pair often preen and wash on the lakes before returning to the sea.

Site preparation

Prospective nest sites are normally scouted two or three days before the deposition of the first egg. Since old nest sites are most frequently chosen, much detritus from previous seasons is accumulated. During the spring runoff that material often forms a sodden mass and must be aired before the first egg can be laid. On her first visit to the site, the female churns up the material with her bill, permitting air to circulate and dry out the site. Nests with the contents thus churned up were first noted on June 15, 1955, and on June 20, 1956.

New nests (constituting 8.4 per cent of the 1955 sample, and 12.8 per cent of the 1956 sample) are usually constructed on the same day as the deposition of the first egg. It takes several seasons before they are fully built up. A new nest is recognizable by the relatively large amount of newly dug-up plant material in it, the general looseness of construction, and the absence of old down.

Nesting areas

Areas selected by eiders for nest sites are of biological interest and have implications for management. Approximately 5,700 old nest sites were observed during a survey made in May and June, 1955. At that time, much low-lying habitat was snow-covered and was not sampled. During the 1955 survey less than 10 per cent of the old nests seen were in flat, open, grassy areas; the rest (90 per cent) were sheltered by rocks. Only two of 219 active nests located on the study areas in 1955, and 15 of 275 in 1956, were in exposed locations. Edwards (1957) noted that eiders in the Payne Bay district definitely favoured broken terrain and avoided islands where the physiography was regular.

Most eider ducks in the Cape Dorset area select sites surrounded by rocks, or under an overhang, or, preferably, both (Figs. 4, 5 and 6). Many appear to use man-made rock shelters somewhat similar to those used in Iceland. Whether they were constructed during the Bildfell experiment of 1939 (Appendix A), or during attempts by the Eskimos to snare nesting females is not known. Most of them appear to have been constructed by Eskimos. Edwards (1957) and Houston (1957) report that eiders at Payne Bay and Cape Dorset responded well to the erection of Icelandic stone shelters. By that means they were able to increase the number of birds nesting on any given area.

Favoured sites, provided that shelter or concealment is available, are along the ridges facing south and southwest that run across most nesting islands in the Cape Dorset area. Those ridges are normally snow-free early in the season and are well drained. Pockets of soil supporting luxuriant growth occur at the bases of the ridges. One such ridge (eight acres in area) on Blades Island supported more than 100 nests.

TABLE 3

Distance of nest site from water

Distance in feet	Frequency		Per cent		Cumulative per cent	
	1955	1956	1955	1956	1955	1956
1– 50	46	54	21.9	19.6	21.9	19.6
51– 100	38	58	18.1	21.0	40.0	40.6
101– 200	28	40	13.3	14.5	53.3	55.1
201– 300	20	20	9.5	7.2	62.8	62.3
301– 400	4	16	1.9	5.8	64.7	68.1
401– 500	8	8	3.8	2.9	68.5	71.0
501– 600	8	16	3.8	5.8	72.3	76.8
601– 700	14	14	6.7	5.1	79.0	81.9
701– 800	16	10	7.6	3.6	86.6	85.5
801– 900	8	4	3.8	1.4	90.4	86.9
901–1000	8	17	3.8	6.2	94.2	93.1
1001 +	12	19	5.7	6.9	99.9	100.0
Totals	210	276	99.9	100.0	99.9	100.0

Data presented in Table 3 show that about 40 per cent of all eiders nested within 100 feet of water, while at least 10 per cent nested more than 900 feet from water. Thus, if suitable sites are available, habitat within 1,000 feet of any body of water might eventually be utilized for eider farming. The experiments of Edwards and Houston (op. cit.) are therefore of great potential importance in increasing the amount of available nesting habitat.

Site tenacity

Site tenacity may be defined as the tendency of adult females to return to their first nest site in subsequent seasons. Sowls (1955) demonstrated site tenacity in dabbling ducks in Manitoba, and Cooch (1958) showed that female blue geese return to the same nesting sites in successive years.

At the end of the 1955 field season, data on the presence or absence of old and new down had been collected which seemed to indicate that eiders also return to the same nest sites. The data, with additional data of the same kind collected in 1956, are presented in Table 4.

TABLE 4

Frequency of occurrence of nests containing old down only, new down only, or both, at time of laying of first egg, in 504 active nests, 1955 and 1956

		Built-up			Flush		
	Old down	New down	New and old down	Old down	New down	New and old down	Total
Old site 1955	61	36	12	59	9	24	201
1956	96	40	30	56	11	33	266
New site 1955	—	—	—	—	17	1	18
1956	—	—	—	—	19	—	19
Total	157	76	42	115	56	58	504

A study of the phenomenon of site tenacity usually requires observation of marked birds for several years. An experiment of that kind was initiated in 1955, when 26 nesting female eiders were trapped and banded. In addition to regular 7B aluminum bands of the U.S. Fish and Wildlife Service, each bird was marked with a red, green, or yellow plastic band placed on the left leg. In 1956, 23 of the females banded in 1955 (88.5 per cent) were successfully retrapped on the study area and records were obtained on two others. One of the two had shifted its nesting site from Russell Island to Tunitjuak Island. The other, banded on Tunitjuak Island, nested there in 1956, but not on the study area. Thus, information was obtained on 25 of the 26 birds banded.

All 23 birds recaptured in 1956 were taken on the same island on which they were first trapped. Eighteen (78.3 per cent) nested within 50 feet of their 1955 sites, and two (8.7 per cent) nested within 200 feet of their former sites. Those birds that shifted nesting sites all nested on their original nesting ridges or beside the same ponds. Unusually large and long-lasting snowdrifts which covered some sites until early July, 1956, are thought to be the reason for some of the minor shifts. The successful retrapping of the small sample of banded females in 1956 is regarded as proof that eiders do nest on the same sites in successive years.

An unknown proportion of birds nesting for the first time may utilize abandoned, incompletely built-up sites, thus accounting for the high proportion of "flush" or incomplete nests containing old down. Since the flush nests had apparently been built on before, it is assumed that they were occupied in 1954 or 1955, and that the down was deposited then, whereas some built-up nests may have been constructed and abandoned many years ago and lost their original deposit of down.

There is additional evidence to support the theory that female eiders return in succeeding years to their old nesting sites:

1. Pairs were often seen inspecting old nests containing down, even within 100 feet of the camp.
2. Renesting attempts are normally made in the same nest (if the down is not removed) or within a few feet of the first nest (if the down is removed).
3. Very grey females (assumed by Gudmundsson (1932) to be old birds) were observed driving brown females (assumed to be young) away from old nest sites which the latter had occupied.

Egg laying

When the nest site is selected and prepared, the female lays the first egg. Under normal conditions she deposits one egg per day until the clutch is completed, but during inclement weather, egg laying virtually ceases. Interrupted egg laying is the rule for many Arctic species, such as the lesser snow goose. However, in that species the phenomenon is not regulated by weather and occurs even under ideal nesting conditions. Lesser snow geese commonly skip a day in egg laying after the deposition of the third or fourth egg. The physiological basis for the interruption in egg laying observed in eider ducks is not known, but weather conditions are undoubtedly important. In 1955, adverse weather on June 26 and 30, and July 2 and 4, apparently caused some interruption in the sequence of egg deposition and nest initiation. In 1956, when the weather during the nesting period was almost uniformly excellent, no marked irregularities in egg laying or nest initiation were noted.

It has been shown that the tidal rhythm has a marked influence on the nest initiation behaviour of eiders. Its influence is again apparent during the laying period. Even though many pairs spend all their time on island lakes at a distance from tidal areas, their daily movements are seemingly co-ordinated with the ebb and flow of the sea, although they may be influenced to some extent by the influx of birds coming from the sea at high tide. Throughout the egg laying period, most females visit their nests only at high tide.

The male continues to accompany the female on every trip to land and sits or stands a few feet away while the egg is being laid. When egg laying starts the birds fly instead of walk to and from the nest site. After an egg is laid and covered, they usually return to the water where the female washes herself.

Few females are observed sitting on nests which contain only one egg. The length of time spent at the nest during egg laying varies. Generally, the duration of the visit increases each day, until finally the female spends all her time at the nest. Before incubation commences, the pair spend much time sleeping on communal loafing areas. No reaction involving the defence of the female by the male was observed there.

Incubation and down deposition

The deposition of down varies in different nests as egg laying progresses. Some nests receive their first nesting down with the deposition of the first egg; in other cases no down is deposited until the clutch has been completed. That is demonstrated in Table 5 where, to facilitate comparison, only data from nests where clutches of four eggs were eventually completed are used.

TABLE 5

Relationship between number of eggs laid and down deposition in 180 nests with four-egg clutches

No. of eggs laid	1	2	3	4
With new down	21	66	142	175
Without new down	159	114	38	5

TABLE 6

Egg deposition and onset of incubation in 180 nests with four-egg clutches

No. of eggs laid	1	2	3	4
Incubating	3	23	130	175
Not incubating	177	157	50	5

It should not be inferred from Table 5 that some eggs are left exposed to the elements until the clutch is completed. It has been calculated from Table 4 that in 1955, 71.7 per cent of the nests contained old down, moss, grass, or willow cover and that in 1956, 75.4 per cent of the nests contained old down or other nesting cover at the time of the laying of the first egg.

It is generally agreed that female eiders do not normally pluck their nesting down, but shed it gradually throughout the nesting period. Female eiders have been observed plucking down during displacement display; and some contour feathers are plucked during renesting attempts, or when the first nesting down has been collected by man. The plucked down is not the same as the shed down, being shorter and less cohesive. It is actually normal body down. Its potential commercial value is considerably less than that of down produced during first nesting attempts.

The onset of incubation, like the deposition of down, varied from individual to individual. A few females remained on the nest almost continuously after the first egg had been laid. However, as previously stated, the length of time most of the females remained at the nest gradually increased with the number of eggs laid. The data are presented in Table 5.

It will be noted from Table 6 that most females began to incubate after the deposition of the third egg. Criteria used for determining if the bird was incubating were (a) the presence or absence of the female at the nest during low tide, and (b) whether or not the eggs were warm to the touch. Although the latter criterion is not precise, an egg is not usually warm under Arctic conditions unless it has been incubated. Before incubation, egg temperatures seldom differ from air temperatures.

During the first week of incubation the females made short visits to the ponds, where they bathed and drank. Apparently they consumed little or no food during the incubation period, as their body weight appeared to decrease greatly. Water is the only essential requirement of incubating females. If ponds are not available, a certain amount of water is obtained from fleshy plants. Some water is available during rainstorms, when water droplets collect in the depression between the scapulars.

About the time the females began sitting continuously, a marked change was noted in their behaviour when they were disturbed. Instead of flying directly from the area and silently circling back, or remaining away from the nest for an extended period, they remained on the nests as long as possible before taking flight. They would not fly far, but would land within a few feet of the nest and utter a harsh grating croak, a sound unlike any made at other times. If water was near they flew to it and performed displacement activities, i.e., sham eating, washing, and broken wing.

A female suddenly frightened from her nest left a trail of watery, greenish or blackish, ill-smelling excreta behind. The dropping of excreta is apparently a reflex action and is less likely to happen if the approach of the observer is slow and methodical. This is discussed in greater detail in the section on down collection.

The length of the incubation period is not known, but is thought to be 28 to 30 days.

Clutch size

The system of marking eggs for the determination of clutch size is described in the section on research procedures. Since the nest number and sequence in the clutch were marked on each egg, it was apparent on inspection when an egg had been removed by predation or otherwise lost. Data on clutch sizes were obtained in that manner from two study areas only. For comparison, data from two otherwise undisturbed areas were gathered on July 12, 1955, and July 18, 1956. These include an unknown number of clutches which resulted from renesting, but do not include completely destroyed nests. Clutch sizes from the study area obtained on those days were recorded in the same manner as those obtained from the undisturbed areas. The data are presented in Table 7.

The data suggest to me that in 1955 frequent flushing of the birds in the study area and subsequent exposure of eggs to predators resulted in heavier than normal egg loss. Although the average from undisturbed area "B" is not quite as low as from the study area, it is considerably lower than from undisturbed area "A". This may have been caused by the proximity of the former to the study area. As far as possible, ecologically similar areas

TABLE 7
Frequency of occurrence of clutch sizes on July 12, 1955, and July 18, 1956

	1955				1956				Total
Clutch size	Study area	Area "A"	Area "B"	Total	Study area	Area "A"	Area "B"	Total	nests both years
1	10	—	24	34	4	—	10	14	48
2	19	2	72	93	14	10	94	118	211
3	36	8	188	232	48	14	226	288	520
4	34	30	226	290	101	19	259	379	669
5	7	2	30	39	26	5	48	79	118
6	2	—	8	10	6	2	6	14	24
7	2	—	2	4	2	1	1	4	8
Total nests	110	42	550	702	201	51	644	896	1,598
Total eggs	353	158	1,848	2,359	760	182	2,195	3,137	5,496
Clutch av.	3.21	3.76	3.36	3.36	3.78	3.57	3.41	3.50	3.44

TABLE 8
Comparison of clutch sizes found on the study area, July 12, 1955, and July 18, 1956, with total clutch sizes including destroyed eggs and whole clutches

	1955		1956	
Clutch size	Survey	Corrected	Survey	Corrected
1	10	10	4	5
2	19	24	14	16
3	36	48	48	72
4	34	62	101	118
5	7	22	26	40
6	2	8	6	12
7	2	4	3	3
Total nests	110	178	201	266
Total eggs	353	636	760	1,018
Clutch av.	3.21	3.57	3.78	3.83

were involved in these comparisons. Adverse weather during some trips to the study areas in 1955 may have caused some additional desertion and predation. A complete reversal recorded in 1956 is attributed to a delay in nest initiation caused by snowdrifts on area "B" and long-lingering sea ice which surrounded area "A".

Clutch sizes obtained on the study area on July 12, 1955, and July 18, 1956, and clutch sizes from the same area, corrected to include eggs known to have been destroyed, are presented in Table 8. Clutch size data from other areas compared with data from Cape Dorset are summarized in Table 9.

A comparison between early and late clutches may be made from the data in Table 10. In both years of the study, clutch size data from the study area were gathered over a 24-day nest initiation period. In Table 10 those

TABLE 9

Clutch sizes of *Somateria mollissima* spp. from other areas compared with those from Cape Dorset

Location	Reference	Clutch size 1	2	3	4	5	6	7	8	9	10	Mean clutch	No. of nests	Total eggs
Iceland	Gudmundsson (1932)	6	14	7	15	—	—	—	—	—	—	2.74	42	115
Payne Bay, Que.	Edwards (1957)	4	13	31	19	6	—	—	—	—	—	3.13	73	229
North shore St. Lawrence	Lewis (1939)	27	79	215	405	337	55	6	6	—	1	4.04	1,131	4,565
Green Island, Que.	Lemieux (1954)	2	37	114	254	248	57	19	3	—	—	4.32	734	3,173
Lower Razades, Que.	Lemieux (1954)	1	21	38	48	35	15	8	6	1	1	4.24	174	737
Cape Dorset	Cooch (1955, 1956)	48	211	520	669	118	24	8	—	—	—	3.44	1,598	5,496

TABLE 10

Comparison of complete clutch sizes of eiders nesting on the study area in the first and second halves of the nesting season, 1955 and 1956

Clutch size	1955		1956	
	First half	Second half	First half	Second half
1	1	9	2	3
2	6	18	6	10
3	38	10	36	36
4	59	3	94	24
5	20	2	36	4
6	8	—	12	—
7	4	—	2	—
Total	136	42	188	77
Average	3.96	2.31	4.06	3.21

TABLE 11

A comparison of clutch sizes observed between July 18 and July 23, 1956

Island	Clutch size 1	2	3	4	5	6	7	Total no. of nests	Av.
Bildfell	1	3	11	19	2	—	—	36	3.50
Gudmundsson	4	4	6	10	2	—	—	26	3.08
Innukshuk	—	20	28	30	10	4	2	94	3.53
Hume	1	4	6	6	—	—	—	17	3.00
Ooglukjuak	6	15	32	29	3	1	—	86	3.13
Nesfield	1	1	5	8	4	2	—	21	3.90
Blades	3	11	31	48	6	3	—	102	3.51
Dune	1	4	9	7	1	—	—	22	3.14
Honting	1	4	6	5	—	—	—	16	2.94
Russell	—	10	14	15	5	2	1	47	3.53
Schioler	—	4	12	16	4	—	—	36	3.56
Putaguk	1	5	6	12	2	—	—	26	3.35
Tunitjuak	12	101	250	316	61	14	1	755	3.48
Summary	31	186	416	521	100	26	4	1,284	3.44

data are arbitrarily divided into two sections at the 12th day. The first half probably includes few data from renesting attempts, while the second may be assumed to include many more such data. A similar division is not possible from the undisturbed areas since only one survey was made there.

The observed differences might be much greater if the two types of nesting activities could be completely segregated. That would be impossible unless all females were individually marked and complete nest histories were known. In 1955, predation and nest desertion apparently caused many birds to renest, but that did not occur to such a marked degree in 1956.

One striking aspect of the study of clutch sizes was that nests initiated on the first day of nesting averaged more eggs than those initiated later in the season. The decline in clutch size was examined by linear regression and correlation (Fig. 8). A negative correlation of minus 0.9975 ($P = .05$) was obtained for the 1955 data and indicates that a real relationship exists between clutch size and date of nest initiation. Similar regressions and correlations have been derived from studies of lesser snow geese and Hutchin's geese *(Branta canadensis hutchinsi)* (Cooch, 1958). That point is discussed in greater detail under the section on natural predation and egg loss. Variation in clutch sizes on the various islands in the West Foxe group in 1956 is demonstrated by the data in Table 11. The observed range in clutch averages presented in the table is 0.96, from 2.94 eggs found per clutch on Honting Island, to 3.90 eggs per clutch on Nesfield Island. The difference between the two extremes is significant at $P = 0.05$. If those two clutch averages had been found on widely separated islands and were associated with even slight plumage differences, subspecific status might be suspected. However, the low clutch average of 2.94 eggs on Honting Island may have been due to snow remaining there until late June, and a consequent delay in nest initiation; and the higher average of 3.90 on Nesfield Island to the fact that water leads were open there and habitat available before June 19, 1956. Another possibility is that birds nesting on Nesfield Island were older than those on Honting Island. Such an age-dependent relationship has not been demonstrated for eiders, however.

Nesting curve

In 1955, more than 75 per cent of all nests, and in 1956, more than 70 per cent, were initiated in the first half of the 24-day nesting period.

Pair relationships change after the nesting and egg laying period. Throughout that period and for a few days after, the male remains in close association with the female. For the first few days after the completion of the clutch, the female continues to make short visits to the water and loafing areas at high tide. The male spends more and more time with other males at favoured loafing areas, and joins the female only when she comes to the lake. Visits to the water by the female cease at the end of the first week of incubation.

If the nest is destroyed more than a few days after the completion of the clutch, it is doubtful whether successful renesting can occur. By July 5, 1955, and by July 14, 1956, the only males still in constant association with females were in pairs attempting to renest. On the same dates, several flocks of 10 to 20 males each were seen on the sea nearly three miles from breeding habitat. Such flocks gradually increased in size as the season progressed. It is assumed that the pair bond in the males had terminated.

Renesting

Renesting by waterfowl that breed in the Arctic is uncommon. It has long been suspected that the eider duck is one of the few species capable of renesting under Arctic conditions. Eiders have a comparatively long nest initiation period, a maritime habitat, an apparent excess of males over females, and a temporary pair bond. The following evidence that eiders renest was gathered in the 1955 field season:

1. Clutch sizes in the second half of the nesting period averaged approximately half those started in the first half (Table 11).

2. Nests initiated late in the breeding season contained little down and many small contour feathers, evidence that the female might previously have shed all her nesting down.

3. Some nests in which the clutches were destroyed, but where the nesting down remained relatively intact, were noted to have new eggs added within two or three days. That happened only in nests where incubation had just started.

In 1956, a renesting study using females banded in 1955 gave further evidence that eiders renest. Three nests were destroyed by gulls or ravens. In each case the female laid additional eggs two days later. Nest number 902 was destroyed twice, once by a raven *(Corvus corax)* and later by a herring gull *(Larus argentatus smithsonianus)*. Each time, the nesting down was left in the nest, and the female laid additional eggs. The nest was started on June 23, and the four eggs were destroyed June 27. A second clutch was started on June 29, and the three eggs destroyed on July 1. The third and last clutch (four eggs) was started on July 3, and hatched successfully.

A total of 12 nests was used in the renesting experiments. Renesting was successful in 11 of them. It was discovered that if the down as well as the eggs were removed from the nest, the female constructed an entirely new nest, usually within a few feet of the original site.

The sample was not large enough to permit the construction of a linear regression showing the decrease in clutch size in renesting attempts.

Clutch sizes in nests initiated during the second half of the 1956 breeding season averaged 3.21 eggs, whereas in the 12 known renesting attempts they averaged 2.33 eggs (Table 12). The lower clutch-size average observed in renesting attempts is compatible with results obtained by Sowls (1955).

The ability of eiders to renest is an important factor in compensating for eggs taken by predation or collected by Eskimos.

Natural predation and egg loss

The effect of predation on any breeding population of birds is ill defined and difficult to analyze. Its importance is variable; in a static population which maintains itself at carrying capacity, the effect is negligible. If, on the other hand, the population is depressed, predation may be an important factor in maintaining low numbers. The term "natural predation" is used to distinguish animal predation from Eskimo depredation.

Predators

Three avian predators, the raven, the herring gull, and the parasitic jaeger *(Stercorarius parasiticus)*, used the West Foxe Islands as hunting areas in

TABLE 12

Clutch sizes from 12 known renesting attempts compared with those from 188 first nesting attempts

Clutch sizes	1	2	3	4	5	6	7	Av.	No. of nests
First attempt	2	6	36	94	36	12	2	4.06	188
Renesting	2	5	4	1	—	—	—	2.33	12

both 1955 and 1956. Only the herring gull nested locally. The ravens nested on mainland cliffs some miles away.

In both years, 14 pairs of herring gulls nested on the West Foxe Islands. Four of the nests were on the study area. They did not start to nest until June 14, 1955, and June 25, 1956. The eggs in all herring gull nests found in the area were shaken and the embryo killed. The adults continued to defend their nesting territories and succeeded in driving off many would-be predators. A small number of non-breeding gulls also preyed in the area.

Kumlien's gulls *(Larus glaucoides kumlieni)* nested abundantly on Ooglukjuak Island, but no evidence of predation by them was obtained, nor were their nests disturbed.

Predation by ravens remained relatively constant throughout June and July, with birds of the year joining the adults in search of food.

Parasitic jaegers are not known to nest in the Cape Dorset area. Only two observations were recorded in 1955, but more than 100 in 1956. There was no evidence that jaegers took eggs from the study area, and egg loss caused by them elsewhere on the islands is thought to have been negligible.

Magnitude of egg loss

Comparable data on the egg loss on the study area in 1955 and 1956 are given in Table 13. The relative percentage loss in 1955 was slightly more than 50 per cent greater than that in 1956.

Preliminary examination of Table 13 suggests that loss by predation was considerably lower in 1956 than in 1955. However, the number of eggs taken by predators was not much less. The total number of predators seen

TABLE 13

Eggs lost on the study area through predation and other factors, 1955 and 1956

Year	No. of eggs laid	Source of loss		Total loss	Net production
		Predation	Other factors		
1955	736	142 (19.3%)	30 (4.1%)	172 (23.4%)	564
1956	1,022	129 (12.6%)	19 (1.9%)	148 (14.5%)	874
Total	1,758	271 (15.4%)	49 (2.8%)	320 (18.2%)	1,438

TABLE 14

Daily egg loss due to predation and other factors, 1955

Date	Nests started	No. of eggs laid	Cumulative total laid	Daily loss	Eggs available for destruction	Desertion	Predation	Flooding	% of total predation occurring	% of total loss occurring
June										
19	6	6	6	1	6	Nil	1	Nil	.70	.58
20	2	4	10	4	9	2	2	Nil	1.40	2.32
21	6	10	20	1	15	Nil	1	Nil	.70	.58
22	14	24	44	2	38	Nil	2	Nil	1.40	1.16
23	8	32	76	4	68	Nil	4	Nil	2.82	2.32
24	20	54	130	2	118	Nil	2	Nil	1.40	1.16
25	24	72	202	2	188	Nil	2	Nil	1.40	1.16
26	14	60	262	29	246	7	22	Nil	15.49	16.80
27	36	96	358	4	313	7	4	Nil	2.82	2.32
28	18	82	440	17	391	3	14	Nil	9.86	9.88
29	14	64	504	12	438	2	10	Nil	7.04	6.98
30	8	48	552	16	474	4	12	Nil	8.45	9.30
Sub total	170	552	552	94	474	18	76	Nil	53.48	54.72
July										
1	18	46	598	18	504	2	16	Nil	11.26	10.46
2	6	36	634	5	522	Nil	5	Nil	3.52	2.90
3	8	30	664	6	547	1	5	Nil	3.52	3.48
4	5	23	687	24	564	4	17	3	11.97	13.95
5	3	14	701	3	554	Nil	3	Nil	2.11	1.74
6	2	9	710	12	560	2	8	Nil	5.63	5.81
7	1	6	716	4	556	Nil	3	Nil	2.11	1.74
8	1	2	718	1	554	Nil	1	Nil	.70	.58
9	2	3	721	1	556	Nil	1	Nil	.70	.58
10	1	4	725	1	559	Nil	1	Nil	.70	.58
11	1	3	728	Nil	561	Nil	Nil	Nil	—	—
12	1	3	731	1	563	Nil	1	Nil	.70	.58
13	Nil	3	734	1	564	Nil	1	Nil	.70	.58
14	Nil	1	735	1	565	Nil	1	Nil	.70	.58
15	Nil	1	736	1	565	Nil	1	Nil	.70	.58
16	Nil	Nil	—	1	564	Nil	1	Nil	.70	.58
17	Nil	1	—	1	563	Nil	1	Nil	.70	.58
Sub total	49	184	736	79	90	9	66	3	46.42	45.30
Total	219	736	736	173	563	27	142	3	99.90	100.02

in the area appeared to be about the same in both field seasons, although some changes were noted in species composition. A possible explanation why the number of eggs taken did not increase even though more were available is that individual predators were taking their maximum toll in 1955. Unfortunately, weather conditions and other factors were not identical in the two years. That point is discussed in greater detail later in this section.

TABLE 15

Daily egg loss due to predation and other factors, 1956

Date	Nests started	No. of eggs laid	Cumulative total laid	Daily loss	Eggs available for destruction	Desertion	Predation	Flooding	% of total predation occurring	% of total loss occurring
June										
23	2	2	2	Nil	2	Nil	Nil	Nil	—	—
24	2	4	6	2	6	2	Nil	Nil	—	1.35
25	4	6	12	3	10	2	1	Nil	0.78	2.03
26	5	10	22	4	17	Nil	4	Nil	3.10	2.70
27	12	22	44	1	35	Nil	1	Nil	0.78	0.68
28	16	36	80	2	70	Nil	2	Nil	1.55	1.35
29	26	60	140	6	128	2	4	Nil	3.10	4.05
30	30	88	228	11	210	Nil	11	Nil	8.53	7.43
July										
1	36	112	340	18	311	4	14	Nil	10.85	12.16
2	28	118	458	15	411	4	11	Nil	8.53	10.14
3	20	104	562	25	500	3	22	Nil	17.05	16.89
4	16	96	658	23	571	2	21	Nil	16.28	15.54
Sub total	197	658	658	110	571	19	91	Nil	70.55	74.32
July										
5	14	82	740	11	630	Nil	11	Nil	8.53	7.43
6	10	52	792	2	671	Nil	2	Nil	1.55	1.35
7	8	50	842	2	719	Nil	2	Nil	1.55	1.35
8	8	38	880	2	755	Nil	2	Nil	1.55	1.35
9	6	32	912	1	785	Nil	1	Nil	0.78	0.68
10	6	20	932	1	804	Nil	1	Nil	0.78	0.68
11	8	22	954	1	825	Nil	1	Nil	0.78	0.68
12	6	20	974	6	844	Nil	6	Nil	4.65	4.05
13	2	10	984	5	848	Nil	5	Nil	3.88	3.38
14	2	10	994	1	853	Nil	1	Nil	0.78	0.68
15	6	10	1,004	2	862	Nil	2	Nil	1.55	1.35
16	2	10	1,014	Nil	870	Nil	Nil	Nil	—	—
17	—	8	1,022	4	878	Nil	4	Nil	3.10	2.70
Sub total	78	364	1,022	38	874	—	38	—	29.48	25.68
Total	375	1,022	1,022	148	874	19	129	—	100.03	100.00

Tables 14 and 15 give the daily numbers of nests started, eggs laid, and losses for 1955 and 1956 respectively, as well as cumulative totals of eggs laid, eggs available, daily predation, and total losses expressed as percentages of total predation and loss. The tables are interrupted at the end of the 12th day to demonstrate different rates of loss before and after incubation had commenced in most of the nests.

The egg laying period lasted for 29 days in 1955 and 25 days in 1956. The average total daily loss was identical in both years: 5.92 eggs per day in 1955 and 5.93 eggs per day in 1956. Average daily loss from predation alone was 4.9 eggs in 1955 and 5.1 eggs in 1956. The similarity in those averages, despite a 39.0 per cent increase in egg production in 1956 and a relatively constant number of predators, supports the contention that the number of eggs taken per predator was at a maximum in 1955. It also demonstrates that predators have a relatively greater effect on a small population than on a large one.

Daily egg losses have been plotted and are shown in Figure 9. The peaks are apparently caused by the interaction of two factors: (a) weather conditions, and (b) egg availability.

In 1955, all seven peaks (accounting for 74 per cent of total loss by predation) coincided with periods of adverse weather. Conditions throughout the 1956 egg laying period were almost uniformly excellent, and of the six peaks (accounting for 70 per cent of total loss by predation) only one, on July 12, coincided with adverse weather.

It has been mentioned that egg laying and nest initiation are interrupted during periods of adverse weather. During those periods the female eider may stay away from her nest site for one or more days at a time, and thus the opportunity for predation is increased. In addition, down and other nesting cover may be blown out of the nest, exposing the eggs. Unfortunately, it is impossible to state definitely how many nests are temporarily abandoned, leaving the eggs exposed and subsequently taken by predators, since such data are impossible to obtain unless constant watch is kept at each nest.

Adverse weather did not coincide with all peaks in predation and therefore cannot be regarded as the sole factor producing them. Apparently adverse weather tends to increase the opportunity for predation, but is not the primary agent. The only factor common to all peaks is egg availability, i.e., the number of eggs on the area not being incubated. The relationship between magnitude of egg loss and the number of available eggs is presented in Tables 16 and 17. It is hoped that the tables demonstrate clearly the importance of egg availability in the formation of predation peaks. The peaks have been somewhat flattened by relating the number of eggs taken to egg availability, expressed as the number of unincubated eggs. What the curves would have been if all temporarily abandoned eggs had been recorded is not known, but it is assumed that they would have been flattened even more.

Table 16 (1955) shows that the total number of eggs present on the area has little relationship to the number of eggs available for predation, e.g., at Peak I, 86 out of 246 eggs were being incubated, but at Peak VII, 498 out of 570 were being incubated. That was perhaps more strikingly apparent after July 8 (20 days after the start of nesting), when the total number of eggs present levelled off at a peak, but predation almost ceased. At that time 97 per cent of all eggs were being incubated. Conversely, the peak of predator activity, measured by the number of eggs taken, occurred between June 26 and July 1, 1955, inclusive, when the total number of eggs present

TABLE 16

Relationship between available eggs and numbers of eggs taken by predation, 1955

Peaks	1	2	3	4	5	6	7
% of total destruction	16.8	9.86	7.04	9.2	10.46	13.95	5.63
% of total predation	15.48	9.88	6.99	8.45	11.26	11.97	5.81
Total no. of eggs present	246	391	438	474	504	564	570
No. of eggs being incubated	86	252	334	352	384	436	438
No. of eggs still exposed	160	139	104	122	120	128	72
Desertion	7	3	2	4	2	2	2
Predation	22	14	10	12	16	19	10
Flooding	—	—	—	—	—	3	—
No. of eggs destroyed	29	17	12	16	18	24	12
% of unincubated eggs taken by predation	13.75	10.07	9.61	9.84	13.33	14.84	13.89
% of unincubated eggs lost	18.13	12.23	11.54	13.11	15.00	18.75	16.66

on the study area was lower than after July 8, but the number not being incubated was many times greater. The total number of eggs taken by predators decreased through July, partly as a result of a smaller number of eggs per new nest then available. The destruction of a complete nest started during July resulted in an average loss of only 2.21 eggs, whereas nests initiated in June averaged 4.02 eggs per complete clutch. The 1956 data may be similarly interpreted.

A further examination of the data shows a marked similarity between the 1955 and 1956 curves. The curve obtained by plotting the 1956 data included, at most, relatively few eggs which were deserted, then taken by predators. If only eggs taken by predators were included in the data from both years, it may be that the curves would have been even more similar.

An intangible factor remains to be discussed. All personnel participating in the investigations agreed that the birds on the study area seemed to be tamer in 1956 than in 1955. There is a possibility that because of greater tameness the birds returned to their nests more quickly or were less prone to desert after being disturbed, thus reducing predation. Increased tameness was also reported by Houston (1957) during the collection of down at Cape Dorset in 1957. Some birds trapped and noted as being wild in 1955 were

TABLE 17

Relationship between available eggs and numbers of eggs taken by predation, 1956

Peaks	1	2	3	4	5	6
% of total destruction	7.43	12.16	10.13	16.89	15.54	7.43
% of total predation	8.52	10.82	8.52	17.05	16.27	8.52
Total no. of eggs present	210	311	411	500	571	630
No. of eggs being incubated	18	61	129	196	257	376
No. of eggs still exposed	192	250	282	304	314	254
Desertion	—	4	4	3	2	—
Predation	11	14	11	22	21	11
Flooding	—	—	—	—	—	—
No. of eggs destroyed	11	18	15	25	23	11
% of unincubated eggs taken by predation	5.73	5.60	3.90	7.24	6.68	4.33
% of unincubated eggs lost	5.73	7.20	5.32	8.22	7.32	4.33

handled easily in 1956.

Egg loss resulting from nest desertion and flooding follows no set pattern, but some association with predation peaks is observed in Tables 14, 15, 16, and 17. Apparently weather influences greatly the number of nests and eggs deserted. Nests classed as deserted on June 27, 1955, were all rain soaked, and all nest cover had blown out of most of them. Possibly other eggs were deserted and destroyed before the daily inspection of the area. Undoubtedly some desertion can be attributed to the presence of people in the nesting area. Care was taken, however, to visit the islands at low tide when the only birds at the nests were incubating females, which could be expected to return to their nests as quickly as possible.

In summary, it is believed that three factors act together to produce fluctuations in the frequency and magnitude of egg loss:

1. The number of eggs available because of increase or decrease in the number of pairs nesting for the first time or attempting to renest. Peak I is attributed to an increase in new nests, Peaks VI and VII to increased renesting.

2. Adverse weather conditions — rain, sleet, or snow accompanied by winds of up to gale force and low temperatures.

3. Variation in the number of predators hunting.

Hatching and brood rearing

In 1955, the first brood hatched on the study area on July 19, 31 days after the discovery of the first egg, and the last eggs hatched on August 13. Thus the 1955 nesting season lasted 57 days. The 1956 nesting season started on June 23, and the last duckling hatched on August 16. The nesting season in that year was therefore 55 days.

Late stages of incubation and hatching were subjected to unfavourable weather in both years. In 1955, rain fell on 14 of the 29 days from the laying of the last egg until hatching was completed. On three separate occasions (July 25, August 4, and August 10), rainfall exceeded one inch in a 24-hour period, and strong winds, exceeding 25 miles per hour, occurred on 10 of the last 18 days of the hatching period. (A possible role of winds in brood mortality is discussed later in this section.) The 1956 nesting season was much drier and the weather more favourable for successful incubation and hatching.

The time required for a clutch to hatch is variable. It depends on three factors:

1. The number of eggs in the clutch, especially if a skip in egg production occurs.
2. The stage of clutch completion when the female starts to incubate.
3. Inclement weather sometimes delays the emergence of a duckling from the shell.

Invariably the first egg laid was the first to hatch. In one seven-egg clutch, hatching required 24 hours, while two- or three-egg clutches were recorded hatching within four hours. In the seven-egg clutch, the female started setting after laying egg number four. Whether or not that should be considered true incubation is uncertain since recording equipment was not available and incubation temperatures are lacking.

The length of the brooding period is definitely related to humidity, rain, and wind. Under warm, dry conditions accompanied by a slight breeze, ducklings are completely dry and ready to leave the nest within 24 hours, whereas during periods of excessive rain and strong wind, drying takes nearly two days.

When the brood is dry, it is led to water by the female. Some broods have difficult obstacles to overcome before reaching the water, and mortality may occur en route. The ducklings are led to shallow tidal pools or preferably to lakes of the type existing on the study area. There they are convoyed about in great flotillas by the adult females. Table 18 gives some indication of the concentration of ducklings on lakes in the study area in 1955. The three lakes referred to in Table 18 are small: they average only three acres each. It is believed that broods move from Tidal Lake quite rapidly, as tidal pools extend to within 50 feet of the lake shore. Ridge Lake (Blades Island) retains the broods a little longer, as they have to pass through a narrow passage in the rocks on their 300-foot journey to the sea. Cliff Lake (Tunitjuak Island) retains the largest number of birds for the longest time. Broods

TABLE 18

Number of adult females and young recorded on lakes in study area, 1955

Date	Ridge Lake		Tidal Lake		Cliff Lake		Total	
	Adult	Young	Adult	Young	Adult	Young	Adult	Young
July 20	—	—	1	3	—	—	1	3
July 22	1	3	2	6	1	2	4	11
July 23	9	28	11	42	9	21	29	91
July 25	15	70	16	51	28	168	59	289
July 27	32	98	21	72	42	261	95	431
July 29	14	52	1	3	41	230	56	285
Aug. 1	2	18	1	2	21	142	24	162
Aug. 3	2	10	—	—	14	90	16	100
Aug. 5	1	5	1	1	10	35	12	41
Aug. 7	1	3	3	1	2	9	6	13
Aug. 9	1	2	—	—	1	3	2	5

migrating to the sea from that lake are forced to walk 1,000 feet over difficult and hazardous footing.

During a survey of the West Foxe Islands made on August 15, 1955, only four females and 28 young were recorded; the rest had disappeared. At that time the cause of the reduction in population was unknown, and it was feared that gales in late July and early August had destroyed many ducklings. It is now known that females and their broods leave the outer islands at that time and move to large tidal pools along the mainland coast. They stay there until the end of August (four to five weeks) and are then seen again in large groups in the water near the West Foxe Islands.

The post-hatch migration of broods which occurs at Cape Dorset was first recorded in 1955. In 1956, 100 ducklings were coloured while still in the egg with aniline dyes. The technique originally worked out by Evans (1951) was modified: instead of drilling a hole through the egg, injecting the dye, then sealing the hole with colloidin, the dye was injected through the "pipping" hole at the time of hatching. It had been noted in previous investigations (Cooch, 1958) that dye injected in that manner before the ducklings had dried out gave nearly as good results as the more laborious Evans technique. The modification has several advantages:

1. Boiled water can be used instead of distilled water, which is hard to obtain in the Arctic.

2. Mortality is reduced since there is little danger of injecting the dye into the body of the bird.

3. Injection of the dye requires very little time and so causes little disturbance in the study area.

4. Large numbers of ducklings can be coloured in a single day.

The main disadvantage of the modified technique is that the dyes do not last quite so long, nor is colouring as complete.

The experiment was not very successful. Only two coloured young were seen after the broods left the West Foxe Islands. Both were seen along the coast of Alareak Island on August 20, 1956, one within six miles of Blades Island and the other 11 miles away. Since the dyeing experiments took place between July 30 and August 6, the two ducklings had retained their colouration for a maximum of 21 days and a minimum of 15 days.

A banded female eider whose brood had not been marked was shot September 18, 1956, by an Eskimo at the head of Pudla Inlet, 20 miles northwest of Tunitjuak Island. That bird had hatched a brood of six young on August 6, 1956. When shot, she was accompanied by five ducklings. If it was her original brood, she had travelled at least 20 miles with it.

A major withdrawal of females and broods from the West Foxe Islands occurred on August 5, 1956. A brief survey along the south coast of Alareak Island on August 7 disclosed a major concentration of females and broods in sheltered tidal pools. The pools there are very extensive — up to 100 acres in area — and, although connected with the sea at high tide, are completely landlocked at low tide. Conditions were not good for making observations, but 119 adult females and an estimated 700 ducklings were recorded on one pool. Alareak Island is very heavily egged and has little nesting habitat. It seems unlikely that the large number of females and broods seen on August 7 could have been produced there. The West Foxe Islands are the most likely source. The recovery of coloured young in the area indicate definitely that at least some broods from the West Foxe Islands go to the large tidal pools on Alareak.

Apparently the ducklings do not require food during the first 48 hours after hatching. Nourishment is provided by the remnant of the yolk sac, which is gradually resorbed and finally disappears when the duckling is 72 hours old. They feed a little during the third day after hatching. Apparently the first food consists mainly of mosquito larvae *(Culicidae* sp.).

Although the ducklings can swim easily upon first contact with water, their ability to dive increases with age. Their first dives are very short. Until they have attained diving proficiency, ducklings are limited to surface feeding. Their ability to dive appears to be in some way correlated with their withdrawal from the lakes. It seems reasonable to assume that shallow, fresh-water or brackish ponds have relatively more food accessible to surface-feeding ducklings than do deeper maritime pools.

The food consumed by the ducklings after their emigration from the ponds consists largely of invertebrates. Fish lice *(Argulus* sp.) appear to make up a large part of their food. The date when the ducklings begin feeding on mussels *(Mytilus truncatus)* and small fish is not known. Although they are able to dive with great ease within a week of hatching, it is doubtful whether they are large enough then to cope successfully with molluscs. Undoubtedly they are capable of handling smaller molluscs within five weeks of hatching.

When the hens have led their broods to water, an ever-increasing tendency to share rearing duties is apparent. Table 18 shows that the ratio of adults to juveniles was 1:6.75 on the study area on August 1, 1955, whereas the adult to egg ratio had been 1:3.54. It may be inferred that half of the females had left their young broods. On August 2, 1955, flocks of 10 to

26 adult females without young were seen near the West Foxe Islands. The number of non-breeding birds in those flocks is not known, but it is assumed that most of them were hens which had deserted their broods. Someone must eventually mark adult females and see whether the crêche mothers are the same birds or whether there is a sharing of duties.

A brood survey was made on August 19 and 20, 1956, along 100 miles of coast between the head of Andrew Gordon Bay and Cape Dorset. The results of the survey are presented in Table 19.

TABLE 19

Eider broods observed along 100 miles of coastline between Andrew Gordon Bay and Cape Dorset, August 19 and 20, 1956

Class	Frequency		Ratio of female to young
	Female	Young	
I	136	826	1:6.07
II	74	408	1:5.51
III	46	178	1:3.87
Total	256	1,412	1:5.52

Many broods may have been missed during the survey, as much of it was conducted at high tide, and broods were able to hide at the head of long bays. It was noted that Class I broods were normally found close to the mainland and, in general, the older the brood, the farther from the mainland it would be. Almost all Class III broods in Andrew Gordon Bay were recorded among small islands and reefs 10 miles from the mainland.

The preflight period lasts at least eight weeks. The first flying young were seen on September 10, 1955. By extrapolation it may be deduced that most young reached the flying stage by October 7. Because broods dispersed from the study area soon after hatching, it was not possible to determine accurately the length of time required before they were able to fly.

Post-hatch mortality

The number of young eiders lost in the preflight period and the relative importance of the various agents causing loss at that time are unknown. Post-hatch mortality may be caused by several factors:

1. predation by gulls, jaegers, ravens, Arctic fox, red fox, and possibly seals and short-tailed weasels;
2. adverse weather;
3. disease.

In a species whose young do not remain in discrete broods and which undertakes a post-hatch migration of several miles, data on numbers lost and causes of the loss are difficult to obtain.

Herring gulls and glaucous gulls were observed harrying eider broods on 34 occasions. The greatest loss from gulls occurs during the first week after hatching, before the ducklings are fully able to dive. That may be another reason why the ducklings are retained on the lakes, where the greater concentration of adult females may afford more protection than at sea.

Herring gulls and ravens were observed attacking ducklings during the journey from the lake to the sea. At such times the ducklings show a sometimes fatal tendency to straggle. Some also fall between rocks and eventually die. One freshly killed duckling was found near Cliff Lake, August 2, 1956. Foxes, weasels, and seals also prey upon eider ducklings, but no case of predation by those species was observed.

The toll taken by gales during emigration from the nesting grounds is not known. Week-old ducklings may not be strong enough to resist the battering of gale-force winds. Undoubtedly some ducklings become separated from the broods. They may join other broods of similar age or be destroyed by predators.

Because of the mobility of the broods which are spread out along hundreds of miles of coastline and because of their gregarious nature, it is impossible to keep track of losses during that period.

Post-nuptial moult

Little was learned about the post-nuptial moult of eiders in the Cape Dorset area.

When the breeding males desert the nesting females early in the incubation period, many of them migrate far out to sea and probably do not return to the breeding area until the following year. Others seek shelter among rocky islets and on deep channels, as among the Neta Islands. A few small flocks were observed between Cape Dorset and the West Foxe Islands.

Observations of male flocks were made between July 5 and September 1, 1955, mostly among the Neta and Shemia Islands. Small flocks of 5 to 20 birds each were seen on July 5, 10, and 16. Those flocks consisted almost entirely of males, although a few females were noted. At no time were flocks seen which consisted largely of moulting birds. Peak numbers of birds were seen in the area on July 16 and 30 and August 13, 1955. At those times several flocks of 200 to 300 birds were noted. Only a few were flightless.

Breeding females apparently begin to moult when their broods reach a certain stage of development, so that both young and females start flying at about the same time. The duration of the post-nuptial moult in breeding females is not known.

Autumn migration

Little firsthand knowledge of the autumn migration of eiders is available from the Cape Dorset region. Local Eskimos said that nearly all eiders leave the area by freeze-up, although some are seen in mid-November among the loose ice well away from the coast.

Apparently there is no massive autumn migration, but a gradual withdrawal along routes followed in spring migration. The males and subadults of both sexes appear to leave first, followed later by the adult females with their broods. This is the reverse of the order of arrival in spring, when the males are the first to arrive.

MANAGEMENT

Eiderdown collection techniques

The techniques of eiderdown collection are well known. Unfortunately, most of them were designed to fit sociological conditions different from those at Cape Dorset. The techniques described below were designed to fit local conditions there.

Time of collection

Eiderdown can be collected twice during each nesting season. The best quality down is that taken midway through the incubation period when the maximum amount of new down is present and has not been in the nest long enough to become matted and soiled by rain and fecal material. Since the nest bowl in old nests is quite firm, nesting down can be easily removed without gathering very much detritus. Not all the down is taken at that time because some must be left to protect the incubating eggs. Additional down and feathers are plucked by the females and added to that which is left.

A second down collection can be made after all the eggs have hatched. That down is not as suitable for commercial use. It contains, in addition to bits of shell and fecal matter from the ducklings, a great many small contour feathers. The collection experiments conducted during the investigation were concerned primarily with the first collection.

Procedures

Several down collecting procedures were tested in 1955 in an effort to reduce soiling by excretion. The type of clothing worn and the speed and manner of approach were found important. Before the start of the tests it was noted that a white parka produced more violent escape reactions than did one of a darker colour. With that in mind the tests were run in duplicate on alternate days, using white and navy blue parkas and varying the manner of approach. In the direct approach, the observer left the boat, and proceeded at a fast walk into the duck colony. That method gives the birds little opportunity to cover their nests and many are forced to flush directly from the eggs. In slower approaches — 15 to 30 minutes — the observer circled the study area, stood on hilltops, talked quietly, and gradually worked his way toward the nests.

Results of the tests are presented in Table 20 and are expressed in

TABLE 20

Percentages of nests in samples of 100 affected by fecal contamination during collecting experiments, 1955

Type of approach	Colour of parka	No. of nests sampled	Nests contaminated, %	Amount of down per 100 nests, gms.	
				Contaminated	Collected
Direct	White	100	91	1,549	151
Direct	Blue	100	82	1,394	306
15 min.	White	70	53	901	799
15 min.	Blue	64	35	595	1,105
30 min.	White	59	21	357	1,343
30 min.	Blue	69	9	153	1,547

terms of amounts of down collected or contaminated under varying conditions of collection, per sample of 100 nests.

The usefulness of a slow, cautious approach, giving the birds ample time to cover the eggs and leave their nests, is shown clearly. The colour of the parka also seems to make a surprising difference. A possible explanation is that during incubation many female eiders doze for long periods. The sudden appearance of a bulky object apparently startles them more when the colour is white than when it is less striking.

It was noted that they appeared to leave their nests in waves; a chain reaction seemed to start from every female that first noticed our presence. Her actions in covering her eggs and her alarm calls apparently warned other females, until eventually 90 per cent of the birds in the area left their nests. Only those completely isolated from other females or well advanced in incubation were actually flushed directly from the nest.

We tried to devise some method of collecting eiderdown that did not require the collector to remain in the nesting area from mid-June to mid-August. A study of the nesting curve (Tables 14 and 15) indicated that down collection could best be begun 25 days after the laying of the first egg. At that time 95 per cent of the eiders have been incubating for at least nine days. The 25-day interval was calculated in the following manner:

1. The median date of nest commencement was eight days after the first nest was begun.

2. Clutches started on the eighth day averaged three eggs, usually laid at a rate of one per day.

3. Midpoint of incubation, from the median number of eggs, was 14 days after commencement of incubation.

Thus, the midpoint of incubation for most nests was 25 days after the laying of the first egg.

The 25-day interval need not be precisely adhered to. Unfavourable weather may prevent collection on the day selected. A delay of two or three days would not greatly reduce the amount of down collected.

The advantages of following the 25-day method of down collection are twofold:

1. There is little likelihood of disturbing ducks that have just commenced nesting. That is especially important while attempts are being made to increase the size of the breeding population.

2. Eskimos are left free to carry on their normal activities until down collection commences.

For the first few years it is not deemed wise to make a second collection. Predation and desertion rates are high at the time the second collection is usually made. Females often leave the nest, taking only the dry young, and may abandon one or more ducklings or eggs.

Down must be collected when dry. Wet, dirty down mats and when dried forms hard nut-like clusters and is impossible to clean. If there is only a small amount of free moisture in the down, it can be dried over a primus stove or, even better, in the sun and wind. Down gathered in 1955 and 1956 was dried in burlap bags suspended from the ridge pole of the tent.

Down collection

The 25-day down collection procedure first used on July 12 and 13, 1955, was tested during the period July 18 through July 23, 1956. In 1955, 5,765 grams of down were collected from 272 nests. The scope of collection was widened in 1956, and 22,719.5 grams were collected from 784 nests. The average yield per nest was 21.2 grams in 1955 and 28.9 grams in 1956. The latter figure compares favourably with yields obtained in Iceland (34.1 grams per nest in two collections). The low yield per nest in 1955 was attributed to the inexperience of the collectors, the frequency of nest contamination, and the large number of renesting birds.

The following procedures were used in all collections in 1956:

1. The eggs were removed from the nest and placed on the ground.

2. The inner layer (next to the eggs) was removed entirely and collected.

3. The outer layer, containing most of the detritus, was loosened up; enough to cover the eggs was replaced in the nest; and the remainder was collected.

4. The collected down was placed in small paper bags on which were recorded the number of eggs in the clutch, whether or not the down was contaminated, the name of the locality, and the nest number.

Data on the amount of down collected in 1956 from contaminated and uncontaminated nests of various clutch sizes are presented separately in Table 21. The data reveal that contaminated nests yield on the average 17.5 grams of dirty down, in comparison with 34.1 grams of cleaner down from uncontaminated ones. This optimum figure for clean nests is as high as the average obtained in Iceland for all nests. Actually, the loss by contamination is probably greater than the data indicate, since the inner layer of down is usually most contaminated, while the dirty outer layer escapes. It is the dirty, outer layer that is usually collected from the contaminated nests. As a result, the weight of clean down eventually reclaimed from such nests is considerably reduced by the weight of the dirt cleaned out of it.

TABLE 21

Weight of down collected from contaminated and uncontaminated nests, by clutch sizes

	Contaminated			Uncontaminated			Summary		
Clutch size	No. of nests	Wt. of down, gms.	Av. per nest, gms.	No. of nests	Wt. of down, gms.	Av. per nest, gms.	No. of nests	Wt. of down, gms.	Av. per nest, gms.
1	7	81.0	11.6	14	404.0	28.8	21	485.0	23.1
2	34	554.0	16.3	55	1,789.0	32.5	89	2,343.0	26.3
3	75	1,263.5	16.8	153	5,047.5	33.0	228	6,311.0	27.7
4	110	1,989.0	18.1	236	8,302.0	35.2	346	10,291.0	29.8
5	18	392.0	21.8	64	2,185.0	34.1	82	2,577.0	31.4
6	—	—	—	18	712.5	39.6	18	712.5	39.6
Totals	244	4,279.5	17.5	540	18,440.0	34.1	784	22,719.5	28.9

TABLE 22

Frequency of contamination in nests and weight of down collected on the study area compared with the remainder of the West Foxe Islands

		Contaminated			Uncontaminated			Summary		
Area	Clutch size	No. of nests	Wt. of down, gms.	Av. wt., gms.	No. of nests	Wt. of down, gms.	Av. wt., gms.	No. of nests	Wt. of down, gms.	Av. wt., gms.
Study	1	4	46.0	11.5	4	99.0	24.7	8	145.0	18.1
Other	1	3	35.0	11.7	10	305.0	30.5	13	340.0	26.2
Study	2	14	56.0	14.0	14	467.0	33.4	18	523.0	29.1
Other	2	30	488.0	16.3	41	1,322.0	32.2	71	1,810.0	25.5
Study	3	16	254.0	15.9	44	1,375.0	31.3	60	1,629.0	27.2
Other	3	59	1,009.5	17.1	109	3,672.0	33.7	168	4,681.5	27.9
Study	4	24	365.0	15.2	84	3,059.0	36.4	108	3,424.0	31.7
Other	4	86	1,624.0	18.9	152	5,243.0	34.5	238	6,867.0	28.8
Study	5	6	139.0	23.2	28	1,000.0	35.7	34	1,139.0	33.5
Other	5	12	253.0	21.1	36	1,182.0	32.8	48	1,435.0	29.9
Study	6	0	—	—	12	470.0	39.2	12	470.0	39.2
Other	6	0	—	—	6	242.0	40.3	6	242.0	40.4
Study total		54	870.0	16.1	186	6,570.0	35.3	240	7,330.0	30.5
Other total		190	3,409.5	17.9	354	11,966.0	33.8	544	15,375.5	28.3

The 244 contaminated nests yielded 4,279.5 grams of dirty down, but based on the clean nest average of 34.1 grams of clean down per nest, the contaminated nests should have yielded 8,320.4 grams, a difference of 4,040.0 grams or 17.8 per cent of the amount collected from all nests (22,719.5 grams). That represents the theoretical minimum loss for contamination by faeces and urine.

The data in Table 21 were gathered throughout the West Foxe Islands and include information from areas seldom visited except during collection as well as from the study area. The frequency of contamination on the study area is compared with that on nearby islands in Table 22. It may be calculated from the table that contamination occurred in 22.5 per cent of the study area nests and in 34.9 per cent of nests in other areas.

In Table 23 data are arranged to show how date of nest initiation affects the amount of down collected and the frequency of contamination. The data in that table are from the study area only, as comparable data from other areas were not available. It is apparent that the later the date of initiation, the more frequently are nests contaminated. This may be the result of two factors:

1. The females that are renesting may tend to be more nervous as a result of having their first nests destroyed.

2. The period is short between the laying of the last egg and the collection of down.

Nests started during the last 10 days of nest initiation constituted only 22.5 per cent of the sample, but made up 55.5 per cent of the number of nests contaminated.

The amount of down collected from uncontaminated nests did not decrease markedly until the last four days of the nest initiation period. Most of the very late nests were renesting attempts begun when the female had little down remaining.

The problem is to reduce the frequency of nest contamination, which, on the study area, caused a total reduction of approximately 1,010 grams (13.8 per cent) in the amount of down collected. Comparable data from other areas show a reduction of approximately 3,025 grams or 19.5 per cent. It would be pleasant to assume that human activity on the study area resulted in the birds becoming tamer and thus not so prone to contaminate their nests. If that is the case, then, in two years the amount of down lost could have decreased from 19.5 per cent to 13.8 per cent, a net gain of 5.7 per cent of the total amount of down collected.

It has been pointed out previously that clutch sizes decrease significantly as the nest initiation period progresses, that nests with small clutches yield less than the average weight of down, and that small clutch sizes occur most frequently in nests initiated in the last 10 days of the nest initiation period. The variation in clutch sizes on different areas (Table 9) may reflect a variation in the date of first nest initiation. Some islands remained snow-covered and others surrounded by ice until considerably later than the start of the nesting season. Thus the low average clutch sizes of 2.93 on Honting Island

TABLE 23

Correlation among amount of down collected, frequency of contamination, and nest initiation curve, study area, 1956

	Contaminated				Uncontaminated				Total down collected			
Nests	No. of nests	Amount of down	Av.	Per cent	No. of nests	Amount of down	Av.	Per cent	No. of nests	Amount of down	Av.	Per cent of total
June 25	0	0	0	0	2	64.0	32.0	100.0	2	64.0	32.0	0.87
26	0	0	0	0	6	192.0	32.0	100.0	6	192.0	32.0	2.62
27	2	34.0	17.0	20.0	8	263.0	32.9	80.0	10	297.0	29.7	4.06
28	2	40.0	20.0	12.5	14	417.0	29.8	87.5	16	457.0	28.6	6.24
29	0	0	0	0	18	702.0	39.0	100.0	18	702.0	39.0	9.59
30	4	68.0	17.0	14.3	24	820.0	34.2	85.7	28	888.0	31.7	12.13
July 1	8	148.0	18.5	28.6	20	744.0	37.2	71.4	28	892.0	31.9	12.18
2	4	67.0	16.7	15.4	22	839.0	38.1	84.6	26	906.0	34.8	12.37
3	2	57.0	28.5	11.1	16	529.0	33.1	88.9	18	586.0	32.6	8.00
4	2	51.0	25.5	16.7	10	331.0	33.1	83.3	12	382.0	31.8	5.22
5	0	0	0	0	14	481.0	34.4	100.0	14	481.0	34.4	6.57
6	0	0	0	0	8	250.0	31.2	100.0	8	250.0	31.2	3.42
7	4	92.0	23.0	66.7	2	100.0	50.0	33.3	6	192.0	32.0	2.62
8	4	56.0	14.0	50.0	4	117.0	29.2	50.0	8	173.0	21.6	2.36
9	0	0	0	0	6	229.0	38.2	100.0	6	229.0	38.2	3.12
10	2	27.0	13.5	50.0	2	56.0	28.0	50.0	4	83.0	20.7	1.13
11	4	62.0	15.5	50.0	4	134.0	33.5	50.0	8	196.0	24.5	2.67
12	2	20.0	10.0	33.3	4	140.0	35.0	66.7	6	160.0	26.7	2.18
13	2	34.0	17.0	100.0	0	0	0	00.0	2	34.0	17.0	0.04
14	6	64.0	10.7	100.0	0	0	0	00.0	6	64.0	10.6	0.87
15	4	30.0	7.5	66.7	2	42.0	21.0	33.3	6	72.0	12.0	0.98
16	2	20.0	10.0	100.0	0	0	0	00.0	2	20.0	10.0	0.03
Total	54	870.0	16.1	22.5	186	6,450.0	34.8	77.5	240	7,320.0	30.5	100.0

may have been due to snow remaining there until late in June, and the high average of 3.9 on Nesfield Island to the fact that water leads were open there and habitat available before June 19.

TABLE 24

Relationship between average clutch size and frequency of nest contamination

Area	Clutch size	Per cent contaminated	Av. wt. of down per nest, gms.	Av. wt. of down per uncontaminated nest, gms.
Honting	2.93	42.8	19.9	21.9
Hume	3.00	36.5	27.1	33.6
Ooglukjuak	3.10	32.1	25.3	29.4
Dune	3.13	31.5	26.0	31.9
Study area	3.42	22.5	30.5	34.8
Bildfell	3.50	26.6	23.6	28.1
Putaguk	3.56	21.7	27.5	30.1
Nesfield	3.91	12.5	28.6	30.5

Table 24 shows the relationship between average clutch size and frequency of contamination. If it is true that the smaller the average clutch size, the later the date of first nesting, it is not surprising that 42.8 per cent of nests on Honting Island were contaminated, whereas only 12.5 per cent were contaminated on Nesfield Island. The cause of high frequency of contamination on Honting Island may be that a relatively large number of nests there were started in the second half of the nest initiation period, leaving less than the desirable minimum of nine days before the down was collected.

It also appears that the frequency of nest contamination decreases as the eiders become more accustomed to human activity in the nesting area. That may be one of the main advantages of the Icelandic method of continuous farming.

Table 25 gives the number of days from completion of clutch to down collection, the percentage contamination, the average clutch size, and the average weight of down collected from nests on the study area. It is apparent that most of the contamination is in nests initiated late in the season. It also appears that the weight of down collected and frequency of contamination do not vary greatly in nests that have been incubated more than eight days. It is calculated that 516.6 grams of down were lost by not collecting from each nest when it reached the midpoint of incubation. That amount would yield less than half a pound after cleaning, with a value of about $4.00 or 6.6 per cent of the total value of the down collected on the study area.

In 1955, it was demonstrated that a slow cautious approach in dark clothing tended to reduce the frequency of nest contamination. It was apparent in 1956 that this may be true for large areas but not necessarily for smaller islets, where the collectors have little opportunity to give the birds quiet warning of their presence. In several attempts to do so, the

TABLE 25

Percentage contamination, average clutch size, and weight of down collected from groups of nests on the study area with clutches completed at various dates before the date of collection (July 18, 1956)

Date clutch complete	No. of days to collection	No. of nests	Per cent con-taminated	Av. clutch size	Av. wt. of down per nest, gms.
June 29	20	4	0.00	5.00	29.5
30	19	12	16.00	3.66	26.3
July 1	18	16	0.00	4.50	35.2
2	17	22	0.00	3.54	35.7
3	16	22	18.10	3.91	32.5
4	15	24	33.30	4.00	32.4
5	14	36	16.60	4.33	34.7
6	13	18	22.20	3.44	32.5
7	12	18	0.00	3.66	30.1
8	11	6	0.00	4.66	32.8
9	10	16	25.00	3.62	31.3
10	9	4	0.00	3.50	32.0
11	8	10	40.00	3.00	25.3
12	7	10	40.00	2.60	27.3
13	6	6	33.33	2.52	20.0
14	5	4	50.00	3.50	17.0
15	4	2	100.00	4.00	10.0
16	3	2	100.00	4.00	17.0
17	2	8	100.00	2.75	11.0

islands were circled in a canoe, using either a paddle or an outboard motor. If a paddle was used, the birds were not alarmed sufficiently to move from their nests. The noise of the motor startled them into leaving the nest suddenly, usually with disastrous results. Even on the study area where birds were most accustomed to humans, a certain number of birds contaminated their nests even at the midpoint of incubation. That happened at perfectly concealed nests where the female could not be given any warning. Contamination in such cases can probably never be eliminated completely.

In summary, the down collecting experiments conducted in 1955 and 1956 have produced a method of collection suitable for local conditions at Cape Dorset. The use of that method instead of collecting at the midpoint of incubation of a particular nest should result in a loss of less than seven per cent of the potential weight of down. It should also reduce substantially the number of ducklings abandoned when down collection is carried on at the time of hatching.

A second collection of down can be made at the end of the hatching period. However, in both years of the study, heavy rains after hatching rendered the remaining down useless for commercial purposes.

Cape Dorset eiderdown industry

The eiderdown industry in Iceland is well known to be successful, but cannot be used without modification as a model for the Canadian Arctic. The Icelandic farmer is sedentary and can cultivate his various "crops" intensively. Eiderdown collection is part of his normal way of life, and he devotes a good deal of time to it. Eiderdown collection is not usually his only occupation, and if his crop of down fails, he may have other sources of income.

The Cape Dorset Eskimos, on the other hand, are still somewhat nomadic, and some families change campsites as many as seven times a year to camp near areas of good hunting. They are relatively well off compared with some other Eskimos. Food is abundant for most of the year, especially in the camps at Andrew Gordon Bay. At present (1956) their income comes mostly from the sale of stone handicrafts, fox fur, and seal skins. It would seem undesirable to create an eiderdown industry at the expense of present sources of income. It is also important to remember that during the summer, Eskimos have to prepare caches of dog food for winter travel. Interference with that aspect of their way of life would be unfortunate.

Surveys in May and August, 1955, indicated that there were four potential eider farming areas — the West Foxe Islands, Alareak Island, Sakkiak Island, and the islands in Andrew Gordon Bay. (The three last named areas are described in detail in Appendix D.) In 1955 and 1956 all were used intensively by Eskimos as sources of eggs, down, and birds killed for food. Apparently as a result of continuing utilization some excellent habitats are underpopulated by eiders, and most of the habitats are believed to support less than 20 per cent of carrying capacity.

TABLE 26

Total number of old nesting sites and number used in 1955

	Area in acres	Old sites	No. of active sites	Per cent
Ooglukjuak	200	324	18	5.5
Blades	95	692	92	13.3
Tunitjuak	302	2,163	667	30.8
Dune	5	65	18	27.7
Coatesworth	30	74	11	14.9
Luke	5	15	5	33.3
Russell	25	78	42	53.8
Innukshuk	95	275	29	10.5
Sakkiak	1,400	1,630	378	23.2
Andrew Gordon Bay	190	560	98	17.5
Total	2,347	5,876	1,358	23.1

Data supporting that belief are presented in Table 26, which gives the number of old sites counted on various islands before nesting commenced in 1955, and the number occupied that summer. Unfortunately, many of the counts of old nest sites were made when much of the low-lying land was covered with snow. As a result, counts were too low. However, the data demonstrate the present low level of the eider population. If an eiderdown industry is to be established at Cape Dorset it will be necessary to increase the number of breeding eiders. That may best be accomplished in three ways:

1. By complete protection of "farm" areas from hunting.
2. By controlling predators — herring gulls, glaucous gulls, ravens, and in some seasons possibly Arctic foxes.
3. By habitat improvement.

The necessity of giving the eiders complete protection is obvious. Predator control would allow more eggs and ducklings to survive to breeding age. At least 25 per cent of all eggs and ducklings were destroyed by predation in 1955 and perhaps 15 per cent in 1956. Loss by predation could never be entirely eliminated, but its reduction is possible.

If complete protection from man were provided, the breeding population might double within five years. The manner in which that might take place is shown in Table 27.

TABLE 27

Theoretical increase in a protected nesting population assuming a clutch average of three eggs

	1961		1962		1963		1964		1965		1966	
	*S	A	S	A	S	A	S	A	S	A	S	A
No. of adults†	200	190	180	170	162	153	300	285	394	374	489	464
No. of young‡	—	225	—	180	—	170	—	360	—	420	—	522
No. of first year subadults†	—	—	203	190	171	162	161	153	342	324	398	378
No. of second year subadults‡	—	—	—	—	180	162	154	146	145	138	·308	292
Total	200	415	383	540	513	647	615	944	881	1,256	1,195	1,656

* S = Spring. A = Autumn.
† Seasonal reduction of about 10 per cent (guess).
‡ Seasonal reduction of 25 per cent (guess).

Table 27 is theoretical and is included only to show the probable effect of protection. It does seem likely, though, that the most important factor in building up the population is protection from human interference. If predation was also reduced, the increase might be even more rapid.

On February 7, 1957, all key eider nesting habitat in the Cape Dorset area received protection, when a migratory bird sanctuary was established there. The Cape Dorset Migratory Bird Sanctuary includes Sakkiak Island, West Foxe Islands, and the islands in Andrew Gordon Bay, containing approximately 13 square miles, 55 square miles, and 32 square miles, respectively. The sanctuary units are patrolled by two Eskimo wardens hired by Arctic Division, Department of Northern Affairs and National Resources.

It is still too early for significant results to be obtained from protection from Eskimo depredation, but a start has been made. Most significant is the realization by some Cape Dorset Eskimos that such protection is worthwhile.

Habitat improvement would be most important after the eider population had reached the carrying capacity of the unimproved habitat. It would consist mainly of the erection of stone shelters and the digging of nest site forms in otherwise barren areas.

The problem of selecting a group of Eskimos to collect eiderdown lies outside the scope of this investigation. Unfortunately, the more progressive Eskimos in the area are those already earning a fair living. The impoverished Eskimos at Cape Dorset own no boats and have little energy, yet they are the people who could benefit most by a thriving eiderdown industry.

Finally, the eventual success of the proposed eiderdown industry depends on the manner in which the scheme is presented to the Eskimo. He must undertake the work of his own will and must not be forced by the administrator. If that can be accomplished and a large, continuing supply of eiderdown becomes available, the future of the industry will be bright.

Eskimo depredation

The total number of eider eggs and birds taken annually by the Eskimos is not known. Most of their hunting is done during the nesting season. Organized collecting trips are made to favoured nesting areas and all the eggs may be taken from some islands. In addition, many female eiders are taken by shooting and trapping. Some females are shot with .22 rifles while they are sitting on the nests, but most are taken while they walk to water. Some Eskimo camps leave parties of women and children on the islands for one or two days. Those parties trap nesting females by means of snares suspended from rocks and caribou antlers. Nearly every colony visited had 20 or more snare sites still operational. That method is more than 90 per cent effective. Fortunately, no attempt is made to snare more than 30 or 40 birds at a time, or the eider population could conceivably be eliminated. As a rule only one visit is made during the nesting season. Most of the visits are made early in the season, allowing many eiders to partially recoup their losses by renesting. Islands near the large settlements (The Netas, Sakkiak) are visited more frequently, and the annual eider production on them is very low. The Neta Islands were once considered an important source of eggs, but today fewer than 50 pairs nest there. On Sakkiak, because of its large size and relative isolation, the eider population has fared slightly better, but depletion elsewhere has led to an increase in the egging there.

Some moulting females and young are taken each year but no organized effort is made to take those birds.

More than 1,200 eggs are known to have been collected in 1955 and more than 1,600 in 1956. The actual figures may be twice as great. Many of the eggs are replaced by renesting, but late clutches are only half as large as first nesting ones. The most important loss is that of breeding females.

SUMMARY

Life history

The 1955 and 1956 breeding seasons can be divided into two parts. In each year the first half was warm and pleasant, but after mid-July rain and high winds were common.

The first northern eiders arrived in early May, with the peak of migration occurring in late May and early June. The first migrants were males, but sex ratios were equalized in early June.

Little courtship was noted at first, but it became fairly common in early June. Pre-nesting flights started in mid-June, and egg laying on June 19, 1955, and on June 23, 1956. Most nest sites were inspected and prepared at least two days before the laying of the first egg. More than 90 per cent of the sites contained old down. Site tenacity is shown to occur in northern eiders.

The average clutch size on the study area in 1955 was 3.7 eggs and in 1956, 3.83 eggs. Predation and other losses accounted for 25 per cent of all eggs laid in 1955 and 15 per cent in 1956. Renesting reduced the effect of complete nest destruction. However, second clutches were approximately half as large as first ones.

Nearly all nesting down is deposited before the laying of the last egg. Incubation frequently starts before the last egg is laid, and lasts 28 to 29 days. Males desert nesting females soon after the laying of the last egg. The female rarely leaves the nest after the midpoint of incubation.

Ducklings are able to leave the nest soon after hatching. On the West Foxe Islands, most ducklings remain on the lakes for two or three days; elsewhere they proceed directly to the sea. A post-hatch migration to mainland tidal pools occurs within a week of hatching. Ducklings, escorted by relatively few females, stay in those areas for nearly a month. The fledging period is thought to be 60 days.

Autumn migration from Cape Dorset area is gradual. Some birds remain in the area throughout the winter.

Management

At least four potential eider "farm" areas exist in the Cape Dorset area. At present all are underpopulated. A procedure for collecting nesting down 25 days after the onset of nesting is recommended. This method would yield approximately 95 per cent of the potential amount of down. It has the advantage of keeping disturbances on the nesting area at a minimum. A slow, indirect approach on visits to the nests is advocated. That and the wearing of dark clothing reduce the number of nests fouled by reflex defecation. Complete protection of nesting eider ducks is essential if the eider industry is to succeed. Protection should be given the existing eider populations before further reduction occurs.

LITERATURE CITED

Cooch, F. G. Typed reports in files of Can. Wildl. Serv., Dept. Northern Affairs Natl. Resources.

Cooch, F. G. 1954. Eider duck survey, Eastern Arctic 1954. 19 p.

Cooch, F. G. 1955. A preliminary study of the life history and management of the northern eider *(Somateria mollissima borealis)*, Cape Dorset, N.W.T. 90 p.

Cooch, F. G. 1956. A report on the biology and management of the northern eider *(Somateria mollissima borealis)*, Cape Dorset area, N.W.T. 112 p.

Cooch, F. G. 1958. The breeding biology and management of the blue goose *(Chen caerulescens)*. Ph. D. Thesis, unpublished. Cornell University, Ithaca, N.Y. 235 p.

Edwards, W. A. 1957. Report on eider duck project, Payne Bay, P.Q. Typed report. Dept. Northern Affairs Natl. Resources, Arctic Div. 12 p.

Evans, C. D. 1951. A method of colour marking young waterfowl. J. Wildl. Mgmt. 15(1):101–103.

Gudmundsson, F. 1932. Observations made on Icelandic eider ducks. Beiträge zur Fortpflanzungsbiologie der Vögel, May–June 1932. No. 3/4.

Houston, J. A. 1957. Report on the eiderdown project, Cape Dorset, N.W.T. Typed report. Can. Dept. Northern Affairs Natl. Resources, Arctic Div. 10 p.

Johnsgard, P. A. 1964. Comparative behaviour and relationships of the eiders. Condor 66(2):113–129.

Lemieux, L. 1954. Eider survey 1954, Apple Island. Typed ms. in files of Can. Wildl. Serv., Dept. Northern Affairs Natl. Resources. 3 p.

Lewis, H. F. 1937. Migrations of the American brant *(Branta bernicla hrots)*. Auk 54(1):73–95.

Lewis, H. F. 1939. Canadian eider ducks and production of eiderdown. Ms. in files of Can. Wildl. Serv., Dept. Northern Affairs Natl. Resources.

McKinney, F. 1961. An analysis of the displays of the European eider *Somateria mollissima mollissima* (Linnaeus) and the Pacific eider *Somateria mollissima* v. *nigra* Bonaparte. Behaviour, Suppl. 7:vii, 1–124.

Sowls, L. K. 1955. Prairie ducks, a study of their behaviour, ecology and management. Stackpole Co., Harrisburg, Pa. 193 p.

APPENDICES

Appendix A

History of eiderdown collection at Cape Dorset

The résumé presented below was abstracted from the files of the Northern Administration and Lands Branch, Department of Northern Affairs and National Resources.

From 1939 through 1943 the Hudson's Bay Company attempted to collect eiderdown on a large scale. That effort was carried out under the supervision of Dr. Bildfell.

The experiment was conducted at Cape Dorset, Lake Harbour, and Frobisher Bay. A total of 3,792 pounds of uncleaned down was collected by the Eskimos, including 1,713 pounds from the Cape Dorset area.

Unfortunately, much of the down was collected by unsupervised Eskimos, and the destruction of great numbers of eider nests is believed by many to have caused the reduced populations of today.

The experiment was terminated after the 1942 season when a loss of $919.86 was realized by the company. At that time Dr. H. F. Lewis, Parks Branch, pointed out that much of the down was sold uncleaned and thus commanded a very low price. An additional expense was incurred when Dr. Bildfell received $1,120 for cleaning the down himself, Eskimo labour being then available at a much lower rate. It is generally agreed that the 1939–43 experiment failed primarily from a lack of adequate cleaning facilities and failure to give close supervision to the Eskimos.

That was the outstanding attempt to establish the industry on Baffin Island, although the Eskimos at Pangnirtung had been taught crude cleaning methods by whalers as early as 1890.

The writer saw several of the cord cleaning frames still in use at Cape Dorset in 1955 and 1956. A few Eskimos still collect one or two pounds of down per year for use in sleeping bags and mitt lining. The techniques are crude and destructive, but it must be remembered that the Eskimos have been taught the potential value of eiderdown.

Appendix B

Description of study areas

Some islands and reefs of the West Foxe Islands have been named by Eskimos. Many of the names aptly describe an island itself, its relation to other islands, or its historical past. To those not accustomed to the Eskimo language, it is perhaps more practical to utilize English names when referring to the islands.

Tunitjuak Island (from Tunit — so-called because of the old ruins and graves)
This is the largest island in the group, having an area of 302 acres. It is roughly oval, with large bays on the north and southeast coasts that are nearly dry at low tide. A 180-foot hill located near the eastern end of the island is the most striking topographical feature of the West Foxe Islands. It falls away abruptly on the seaward side in a jagged cliff. Eighteen fresh-water ponds are found in parallel fault lines, running east–west along the long axis of the island. In common with most other large islands in the group the highest land is found around the outer rim. Only at the eastern end does the land slope gently to the sea. The shores of the lakes are generally low, with loafing areas for ducks along them. The ponds do not exceed four feet in depth. Only one pond is not detritus-filled at the bottom; the rest have from two to three feet of partially decomposed muck near the shoreline.

The 32-acre study area on Tunitjuak Island (Fig. 10) was selected because of the varied nature of the habitat found there.

Ooglukjuak Island (from Eskimo = walrus hauling-out ground)
This is the second largest island in the group, covering 200 acres. It is the most isolated of the West Foxe Islands and shows few similarities to the other islands in the group. Nearly half (90 acres) of the island consists of a large, exposed, granite crest which terminates in an excellent gull cliff along the northeast coast. The physiography is generally quite flat and regular. This island received little attention during the 1955 investigations. Some excellent habitat capable of supporting 200 to 300 pairs of eider ducks was discovered there in 1956.

Coatesworth Island
This 30-acre island lies midway between Tunitjuak Island and Blades Island. At low tide, exposed reefs almost form a land bridge connecting all three islands. The island actually consists of three separate islands joined together by a gravel beach. The rock on the island is badly fractured and large granite boulders cover much of the surface. Talus slopes provide excellent nesting habitat for Mandt's guillemots. At best, the island provides only marginal habitat for eider ducks.

Innukshuk Island (from Eskimo = stone beacons)
This 95-acre island follows the same general pattern as Blades and Tunitjuak Islands, but its elevation does not exceed 75 feet and the physiography is much flatter. A large lake in the central part provides excellent habitat similar to that of Ridge Lake on Blades Island.

Russell Island

This 25-acre island has no permanent body of fresh water. The height of land runs along the south and west coasts, dropping abruptly to the sea. The rock there is badly fractured and provides excellent habitat for guillemots. The north coast is low and sandy.

Dune Island

This island, five acres in area, consists of disintegrating black sandstone and sulphates rising 50 feet at the point of maximum elevation. Very little plant life was noted in the nearly sterile soil. Despite that, considerable eider habitat is available.

Luke Island

This island is connected to Coatesworth Island at low tide but a 20-fathom channel exists between Luke and Blades Islands. The island is a many-fractured block of granite, and vegetation is not found except at the bottom of the fractures.

The eight brief descriptions presented above are representative of all 20 islands of the West Foxe group. A summary of the data is presented in Table 28.

Blades Island

This 95-acre, doughnut-shaped island is of the usual physiographic type, with the height of land running around the outer rim. Its most notable feature is the four-acre Ridge Lake, found in the centre of the island. The southern and northern coasts are barren and nearly devoid of vegetation. The central portion is carpeted with a luxuriant growth of plants (Appendix C). Park-like valleys finger out from Ridge Lake and provide excellent eider duck habitat (Fig. 11).

TABLE 28

Tabular description of West Foxe Islands

Name	Area in acres	Number of lakes	Net land area	Habitat rating in acres		
				Excellent	Good	Poor
Tunitjuak	300	18	270	100	80	90
Ooglukjuak	200	3	195	10	40	145
Blades	95	4	85	30	20	25
Coatesworth	30	—	30	2	15	13
Innukshuk	95	3	90	30	40	20
Luke	5	—	5	—	1	4
Dune	5	—	5	—	—	5
Russell	25	—	25	5	5	15
Miscellaneous	145	2	135	45	50	35
Total	900	30	840	222	251	352

Appendix C

Plants collected

Plants collected on the West Foxe Islands 64°17′ N., 75°45′ W. (Identified by the National Herbarium of Canada.)

1. *Saxifraga oppositifolia* L.
2. *Salix arctica* Pall.
3. *Potentilla crantzii* (Cr.) Beck
4. *Draba alpina* L.
5. *Draba fladnizensis* Wilfen var. *heterotricha* (Lindbl.) Ball
6. *Ranunculus nivalis* L.
7. *Alopecurus alpinus* Sm.
8. *Saxifraga caespitosa* L.
9. *Ranunculus hyperboreus* Rottb.
10. *Cochlearia officinalis* L.
11. *Oxytropis arctobia* Bunge
12. *Pedicularis hirsuta* L.
13. *Cerastium alpinum* L.
14. *Stellaria ? laeta* Rich.
15. *Papaver radicatum* Rottb.
16. Moss
17. *Silene acaulis* L. var. *exscapa* (All.) DC.
18. *Eutrema edwardsii* R. Br.
19. *Campanula uniflora* L.
20. *Polygonum viviparum* L.
21. *Eutrema* sp.? R. Br.
22. *Saxifraga cernua* L.
23. *Epilobium latifolium* L.
24. *Cardamine pratensis* L.
25. *Oxytropis maydelliana* Trautv.
26. *Taraxacum ? lacerum* Greene
27. *Lazula confusa* Lindebl.
28. *Eriophorum scheuchzeri* Hoppe
29. *Lychnis apetala* L. var. *arctica* (Fried) Cody
30. *Erigeron eriocephalus* Vahl.
31. *Trisetum spicatum* (L.) Richt. var. *naidenii*
32. *Poa arctica* R. Br.
33. *Saxifraga hirculus* L.
34. *Festuca baffinensis* Polunin
35. *Puccinellia phryganodes* (Trin.) Scribn. & Merr.

Appendix D

Other nesting areas

A summary of surveys made on potential "farm" areas other than those already described is presented below. Since the first report of the investigation was submitted, part or all of the islands listed below have been included in a migratory bird sanctuary.

Andrew Gordon Bay

The southern islands of Andrew Gordon Bay have long been regarded by local Eskimos as optimum eider duck breeding areas. During the survey flight of July 1, 1954, several hundred birds were seen in the water around them. A ground survey was made on May 20, June 30, and August 29, 1955.

South Island, the best area in the bay (Fig. 12), is 190 acres in size. It closely resembles Blades Island in physiography, vegetation, and resident eider population. The first ground surveys yielded 560 nests, of which 98 were occupied during the 1955 season.

Eskimos visited the island on June 19, 1955, and collected 300 eggs and 20 female eiders. An Eskimo expedition in 1956 obtained a similar number of eggs and birds.

At least 10 pairs of herring gulls nested on small islets in the central lake. The island is grossly underpopulated and could support many times the present number of eiders.

Alareak Island

This large island (Fig. 13) is joined to the mainland at low tide by a gravel bar. It is large enough to support its own resident population of Arctic foxes and weasels. Several fox dens were found on August 4, 1956, none occupied. The island is roughly triangular, with the apex extending toward the mainland (Fig. 13). The height of land follows the northeast coast and reaches elevations in excess of 500 feet. The southern and northwest coasts are low and dotted with myriads of lakes and ponds. Smaller islands are found along the southern coast of the main island. The area supports few nesting eiders because of a lack of suitable habitat and because of heavy egging. Due to pressure of other work, it was not surveyed in detail in either 1955 or 1956.

Three large camps of 20, 25, and 50 Eskimos respectively, utilize eiders on the island. The number of eggs and birds taken is not known but is assumed to be large.

It will be difficult to control predators on Alareak Island proper but control is feasible on the smaller coastal islands.

The large tidal pools along the south coast provide excellent rearing areas for ducklings. As previously mentioned, many broods hatched on the West Foxe Islands migrate to that area.

Like other breeding areas in the region, Alareak and adjacent islands are underpopulated by eiders.

Sakkiak Island

This is the most southerly island in the Cape Dorset area. It is roughly oval, and the height of land runs along the eastern coast. Barren hills and cliffs more than 500 feet high are found there. The south and west coasts are considerably lower, and a chain of lakes 10 acres or more in area follows the flat land near the coast. A second chain of lakes extends inland along the north–south axis of the island. All these areas provide some eider habitat.

An incomplete ground survey of the area was made on August 16, 1955. A total of 1,630 nest sites, of which 378 had been used during 1955, was observed. Many more eiders than were recorded are known to use the area.

Eskimo use of the area has started in recent years. During the 1955 season an estimated 1,000 eggs were taken. Increased pressure was exerted on the area because of an abnormally large concentration of Eskimos at Cape Dorset. The area was not visited by the writer in 1956, but is known to have been heavily egged. It is expected that increasing depredation pressure will be exerted on Sakkiak in the next few years. The area has been included in a sanctuary to prevent severe reduction of the population.

RÉSUMÉ

En 1955 et 1956, l'auteur s'est rendu à Cape Dorset, dans l'île Baffin (T. du N.-O.), pour y recueillir des données sur la vie et les moyens de protéger une sous-espèce de l'Eider commun *(Somateria mollissima borealis),* en vue de l'établissement projeté d'une industrie de l'édredon. L'étude de base s'est faite aux îles Foxe-Ouest, situées à 25 milles, environ, à l'est de Cape Dorset.

Le rapport se divise en deux parties: la première traite de la vie de l'Eider commun, et la deuxième envisage la question de la protection de cet oiseau.

Vie de l'Eider commun

Au cours des deux années à l'étude, la température s'est montrée clémente et agréable durant la première moitié de la couvaison, mais les pluies et les vents violents sont devenus fréquents après la mi-juillet.

La migration a débuté dans les premiers jours de mai par l'arrivée de quelques Eiders communs, pour atteindre son intensité maximum à la fin de mai et au commencement de juin. Les premiers arrivants étaient des mâles, mais les deux sexes étaient en nombre égal au début de juin.

De rare qu'elle était dans les premiers temps, la pariade est devenue assez fréquente aux premiers jours de juin. La recherche de lieux de nidification s'est faite à la mi-juin, et la ponte des premiers oeufs s'est produite le 19 juin 1955 et le 23 juin 1956. La plupart des lieux de nidification avaient été visités puis préparés au moins deux jours avant la ponte du premier oeuf. Plus de 90 p. 100 de ces nids contenaient du vieux duvet; on sait que l'Eider a une tendance marquée à nicher dans le nid qu'il a occupé les années précédentes.

Dans la région à l'étude, la couvée moyenne comprenait 3.7 oeufs en 1955 et 3.83 oeufs en 1956. Les prédateurs, ainsi que d'autres éléments, ont entraîné la perte de 25 p. 100 des oeufs pondus en 1955, et en 1956, une perte de 15 p. 100. L'établissement du nid à un autre endroit a permis d'éviter la perte totale de la couvée; toutefois, le nombre d'oeufs était à peu près deux fois moins élevé qu'à la première couvée.

L'Eider dépose presque tout le duvet de revêtement du nid avant la ponte du dernier oeuf. L'incubation est souvent amorcée avant la fin de la ponte et dure 28 ou 29 jours. Le mâle quitte la femelle couveuse peu après la ponte du dernier oeuf; par contre, la femelle déserte rarement le nid durant la seconde moitié de la période d'incubation.

Les canetons sont en mesure de quitter le nid peu de temps après l'éclosion. Dans les îles Foxe-Ouest, la plupart d'entre eux demeurent sur les lacs encore deux ou trois jours; ailleurs, ils se dirigent immédiatement vers la mer. Dans la semaine qui suit l'éclosion, le gros des canetons, accompagnés d'un petit nombre de femelles, émigrent vers les étangs salés du littoral, où ils demeurent près d'un mois. Les canetons, semble-t-il, mettent une soixantaine de jours à acquérir le plumage nécessaire au vol.

A l'automne, les Eiders émigrent peu à peu de Cape Dorset vers le sud; cependant, il arrive que certains d'entre eux hivernent dans la région.

Protection de l'Eider commun

Il se trouve au moins quatre régions possibles d'"élevage" des Eiders, dans les environs de Cape Dorset. Ces quatre régions sont actuellement sous-peuplées, mais on pourrait espérer une augmentation de la population d'Eiders, si les nids étaient convenablement protégés contre les prédateurs.

L'auteur propose un moyen pratique de récolter le duvet d'Eider 25 jours après le début de la nidification. Cette méthode permettrait de recueillir environ 95 p. 100 du duvet accumulé dans le nid, et elle a le mérite de minimiser les occasions de dérangement dans les lieux de nidification. On conseille d'approcher des nids lentement et de façon détournée, ainsi que de porter des vêtements de couleur foncée, pour éviter que les Eiders effrayés ne salissent le duvet de leur nid par un réflexe de défécation. Le succès de l'industrie de l'édredon repose sur la protection absolue qui sera accordée aux Eiders à l'époque de la nidification. Dès maintenant, il faut veiller à la protection des colonies actuelles d'Eiders, avant que leur nombre n'accuse une nouvelle diminution.

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