THE MIGRATION, HARVEST, AND IMPORTANCE OF WATERFOWL AT BARROW, ALASKA

A

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THE MIGRATION, HARVEST, AND IMPORTANCE OF

WATERFOWL AT BARROW, ALASKA

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ABSTRACT

Daily observations were made of the spring and summer coastal migration of waterfowl at Barrow, Alaska. A sampling count of the spring migration proved impractical, and the success of the whaling season pre-empted any serious spring duck hunting. During the summer migration, between July 13 and September 7, 1970, 67,590 waterfowl were counted, consisting of 95 per cent eiders, 2.3 per cent Oldsquaws, 1.6 per cent Black Brant, and 1 per cent other and unidentified species. An estimated 842,326 waterfowl migrated past the "duck camp" near Barrow during this period. Favorable winds brought the heaviest flights and largest flocks of eiders. An estimated 8,822 ducks were harvested, 40 per cent of which were crippled or lost. The harvest consisted of 92 per cent King Eiders, 4 per cent Common Eiders, 3 per cent Black Brant, and 1 per cent other species. Although the heaviest flights of eiders occurred between midnight and 6 a.m., the greatest hunting pressure occurred from 6 p.m. to midnight. Overall hunting success averaged 1.6 birds bagged per hunter hour. The average adult duck hunter bagged 88 birds during the summer. Hunters age 12 to 24, 25 to 50, and over 50 accounted for 57 per cent, 30 per cent, and 13 per cent respectively of the hunting activity.

Waterfowl are supplementary to other more important game foods at Barrow; and, while the subsistence value of waterfowl is decreasing due to increasing Eskimo employment, recreational hunting is increasing.

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INTRODUCTION

The Migratory Bird Treaty Act of 1918 specifies that migratory game bird hunting seasons shall be closed between March 10 and September 1 of each year. Eiders and other waterfowl are not among those species specified for subsistence use by Eskimos and Indians and are, therefore, protected by the Act and by similar laws of the State of Alaska. Eskimos at Barrow, Alaska, however, have continued to hunt waterfowl during the spring and summer migrations.

The large numbers of waterfowl and especially eider ducks which are harvested annually at Barrow have been reported by several authors. Murdock (1885:121) described the harvest as plentiful, and Leffingwell (1919:64) claimed thousands were killed each year with 400 or 500 ducks per hunter not being an unusual day's bag. Remington (in Gabrielson and Lincoln, 1959:39) estimated the summer harvest alone to be 20,000 ducks, while Thompson and Person (1963) suggested a smaller summer harvest.

The harvest of eiders and other waterfowl begins in early May in the whaling camps along the open lead and continues there until the end of the whaling season in early June. A "duck camp," located where southbound migrating eiders cross the sand spit leading to Point Barrow, becomes active during the first week of July when the birds begin their return summer migration from arctic breeding grounds.

Hunting continues at the camp until mid-September.

The source of this annual harvest of eiders at Barrow is the migration described by Gabrielson and Lincoln (1959:38) as:

> ...the "Arctic Route," and superficially it may be considered, in part, as an extension of the coastal route of the Pacific Flyway. Its southern terminus is generally in the region of the Alaskan Peninsula, the Aleutians, and the islands in the Bering Sea. From this region many observers have commented upon the enormous migrations of eiders and scoters that, in the spring, move along the coast of Bering Sea, most of which have wintered in Alaskan waters.... Many of these birds continue around the coast, passing Point Barrow and along the Arctic shores to breeding grounds as far as the delta of the Mackenzie River or beyond.

Snyder (1957:88-89) suggested that the entire western Arctic population of King Eiders (Somateria spectabilis) probably migrates around the Alaskan coast and that the Common Eiders (Somateria mollissima v. nigra) also use this route between wintering and breeding grounds.

In the past, eider ducks have received relatively little attention in Alaska's game management efforts, largely because they are inaccessible to most sportsmen during the regular waterfowl season. With the influx of whites into the Arctic and the rapidly expanding oil development, however, changes will undoubtedly occur which will affect the well-being of this important wildlife resource.

This study was undertaken to determine the number of waterfowl by species migrating past Barrow, Alaska, and to monitor the annual Native harvest and evaluate its importance to local Eskimos.

METHODS

Spring Migration

During the spring migration birds make their way north along the western coast of Alaska following the open leads which are usually several miles at sea but come within a few miles of shore near Barrow.

Arrangements were made with Merle Solomen, a local Eskimo, to live with his whaling crew at the edge of the lead 4 miles north of Point Barrow, where the spring migration could be witnessed.

Sample observation periods of one half hour began at the lead on May 9 and continued until May 24, when ice conditions became unsafe. Observations were possible at all times of day since daylight persists around the clock at Barrow at this time of the year. Selection of sample periods was influenced by whaling activities, but an attempt was made to keep watch at regular intervals. Observations and identification of bird species were made with either 7x35 or 7x50 binoculars and a 20x spotting scope.

From May 27 through June 12, a series of observations were made on the shore-fast ice and inland to determine to what extent eider movements might deviate from the lead. Because transportation was limited, observations were not possible from the distant side of the lead, which was then 4 to 5 miles wide. The location of spring observation

stations is shown in Fig. 1.

Waterfowl counts were kept for each half-hour observation with estimated flock size, species composition, and direction of flight being recorded. Actual counts were made of birds within small flocks, but only estimates were possible for large flocks. The accuracy of these estimates was verified later by photographs taken with a 35mm camera and telephoto lens. Counts made from photographs served as bases for correcting estimates of flock size when no photographs were taken.

The spring whaling season usually ends by the second week of June; and, with its conclusion, many of the Barrow Eskimos shift their attention to the hunting of seals along the coast south of Barrow. To determine the extent of waterfowl harvest in the sealing camps, I traveled by snow machine to Skull Cliff on June 20-21, talking with seal hunters along the way.

Summer Migration

The male King and Common Eiders generally abandon their mates at the nest, leaving them soon after incubation begins (Delacour, 1959). They gather in large flocks at sea, begin an early autumn migration (Snyder, 1957), and by mid-July are arriving at Barrow from the east (Murdock, 1885). At the same time, many Barrow families are leaving town to set up tents for the summer at the duck camp located about 6

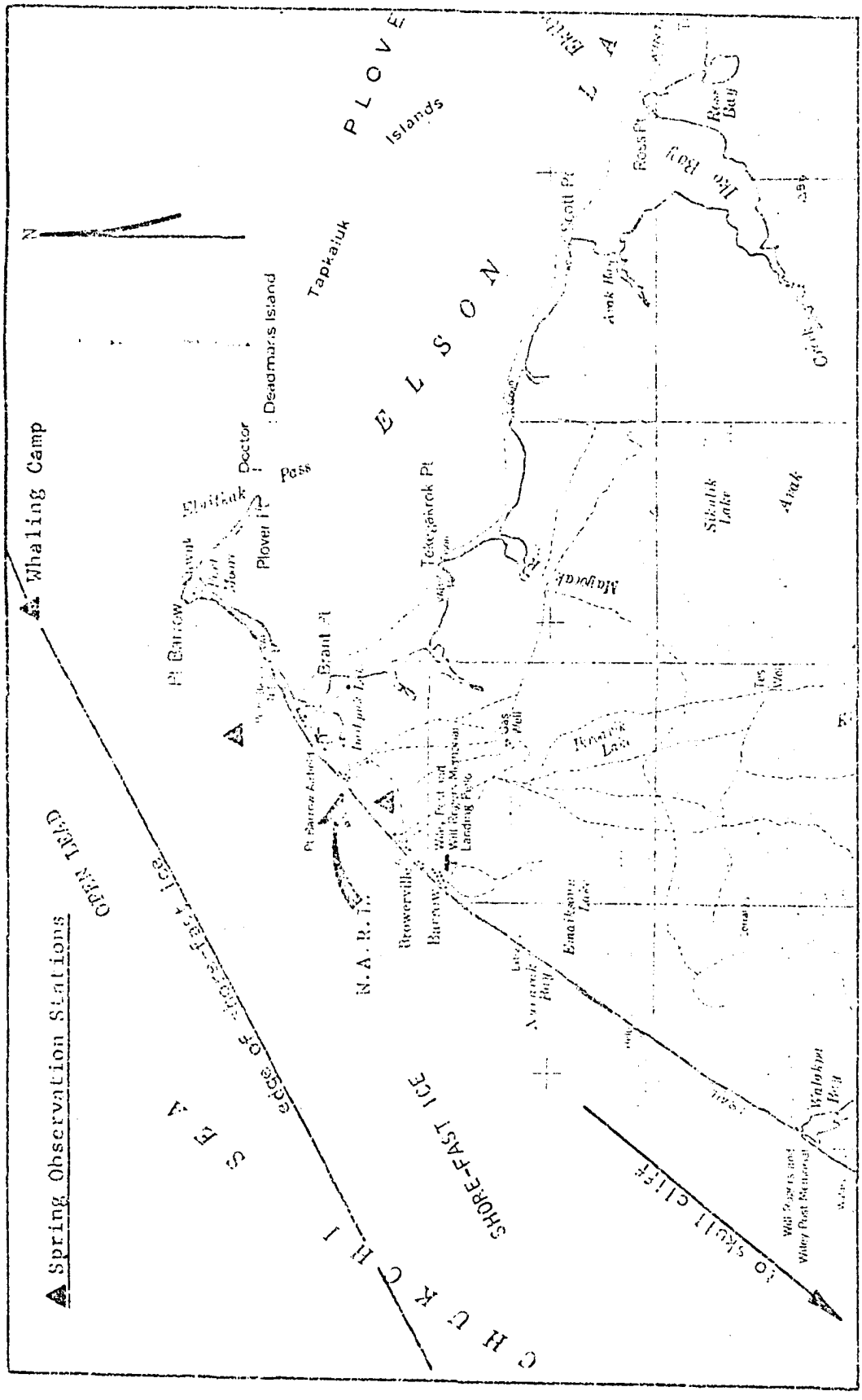


Fig. 1. Map of Barrow area showing the location of spring observation stations.

miles northeast of the village. Its location has not changed appreciably since Murdock (1885) first described it.

Observations were first made on July 13, at which time I learned that the camp had been active since the first days of the month. Many families began moving back to town in late August when school started; and by September 7, when the last observation was made, all but two or three families had left the camp.

In addition to waterfowl counts, harvest data were readily available during the summer; and for each observation period the number of hunters present, shots fired, birds bagged, and birds crippled were recorded.

Because hunters were spread out along 2 or 3 miles of coastline in localized groups, the distance was divided into three sections which were designated as "shooting stations." When more than one of the shooting stations was occupied, observations were made at the one with the most hunting activity. "Spot checks" of the other two less active stations were made whenever possible to record the number of hunters using them. Hunters' ages were estimated and each hunter was classified in one of three age groups: 12 to 24 years, 25 to 50 years, over 50 years.

The number of birds bagged per hour of hunting and species and sex composition of the bag were recorded in bag checks. On many occasions caches of ducks were found along the coast or in camps when no hunters were present to reveal

the number of hours hunted. Cached birds were not included in bag checks, but they were used in a "cache check," which also included birds from drying racks at the camp and from frost cellars in town.

Between scheduled observations, supplemental data on shooting success were recorded.

With the aid of a local Eskimo, Native hunters were given a questionnaire relating to spring and summer duck hunting and the utilization of harvested birds.

RESULTS AND DISCUSSION

Spring Migration

Migration Estimate

From the edge of the shore-fast ice, it was possible to see the flocks of migrating eiders flying low over the water at a distance of 500 yards or more. King Eiders, the earliest arrivals, usually begin to arrive at Barrow in late April or early May (Murdock, 1885:120).

The sampling scheme for estimating the number of waterfowl passing Barrow was based upon two assumptions. The first, that wind direction has a major influence on eider migrations, has been described by Murdock (1885), Myres (1958), and Thompson and Person (1963). It was assumed that more flocks of larger size would pass the observation point on days with southwesterly tail winds than with northeasterly winds. The second assumption was based upon Thompson and Person's (1963) work. In making a count of eiders during the summer migration at Barrow, they found that eider flights were increased on days with favorable tail winds and decreased on days with head winds; but they also showed that wind direction was not important when the wind speed was less than 9 miles per hour. These two assumptions led to a stratified sampling design with three strata: periods of favorable winds, periods of unfavorable winds, and periods of winds with neutral effect. For the spring migration, the optimum wind direction is

southwest, and winds blowing from all directions within 89° of it were also considered favorable. All other winds were considered head winds and unfavorable except those of less than 9 miles per hour, which were considered neutral in effect. Since the winds were never predictable from one day to the next, an effort to get as large a sample as possible under all conditions was made and the data were stratified after sampling.

Although wind direction and speed were recorded for each observation, Barrow's U. S. Weather Bureau records were more reliable and were, therefore, used for all calculations.

Although the data are not sufficient to make a valid estimate of spring migration size, some characteristics of spring eider movements can be determined from them. King and Common Eiders and Oldsquaws (Clangula hyemalis) were observed on the open lead from May 9 to 24 under all wind conditions and averaged 468 (n=69) per half hour. Between May 27 and June 12 these birds averaged 141 (n=61) per half hour during observations made on shore-fast ice. A t test shows these two means to differ significantly ($p<0.05$). Only 17 observations on five different days in late May and early June were made inland. Seven of these observations were made in a single day; and it was on this day, May 29, that all of the eiders seen inland were counted. These consisted of seven flocks, averaging 22 birds per flock. Winds were unusually favorable that day, being recorded as southwesterly at every Distant Early Warning (DEW) station from Cape Lisburne

to Barrow. The sample of inland observations was too small to be conclusive about the number of eiders crossing overland but did confirm the reports of Murdock (1885), Leffingwell (1919), Bailey (1948), and Myres (1958) that not all eiders in the spring migration use the open lead as a lane of traffic when nearing Barrow. Because the observations were not made concurrently among the three possible routes, the data are not conclusive; but they do indicate that the lead is the principal migration route.

During the month of May when the majority of birds were migrating past Barrow, U. S. Weather Bureau records showed that the only days with favorable winds were May 8, 9, and 26 through 31. Since observations could be made on only one of these days, May 9, the data on the influence of wind on spring migration are incomplete and, therefore, inconclusive. On days when the winds were neutral, the mean number of ducks observed per half hour at the lead was 357 (n=27). The heaviest flights observed were on days with unfavorable winds, when the mean per half hour was 566 (n=39). The standard deviations about these two means, 489 and 1,271 respectively, show very high variability.

The heaviest flights observed arrived on May 24 with unfavorable winds. The DEW line stations southwest of Barrow, however, reported winds of neutral and favorable effect at this time. Since wind conditions vary along the coast south of Barrow, an overall view of the wind conditions along this

portion of the migration route may be necessary to show this relationship between spring flights and wind. My data do not support Myres' (1958:4) statement that "...eiders migrate in spring almost exclusively before, and during, periods of southerly and southwesterly winds," but do support Nelson's (1969) and Dorst's (1962) more realistic view that, while eiders prefer a tail wind, they fly with and without one.

Problems in Estimation

An estimate of the spring migration is complicated by many factors. The most serious is that of the dispersed nature of the migration. Murdock (1885) reported large numbers of eiders passing Barrow over the ice and along the lead. Leffingwell (1919) commented on the difficulty in counting eiders over the shore-fast ice from the whaling camp. Myres (1958) reported eiders migrating across the arctic coastal plain south of Barrow and 30 miles north of Point Barrow in May, 1958. Daniel Q. Thompson (pers. comm.) is of the opinion that the extent of the northbound flight is nearly impossible to calculate because of its dispersed nature. The lead's position and shape may change daily with shifting winds and thawing temperatures; and, as a result, lanes of eider movement are unpredictable.

When southwesterly or westerly winds blew drifting sea ice against the shore-fast ice, whaling crews moved their camps from the lead edge for safety. Since these same winds

are assumed to bring the largest flights of eiders, it is likely that an observer at the whaling camp will not be at the lead's edge when the heaviest flights arrive.

Visibility at the lead was reduced by either heat radiation off the water, or fog, thereby making conditions poor for counting and photographing eiders, which generally fly low over the water. When visibility was good, only male King and Common Eiders could be distinguished, since females are too similar to be distinguished except at very close range. Numerous large, mixed flocks of King and Common Eiders of both sexes made it impossible to gather species proportions. Murdock (1885:120) reported the first flocks of eiders, which were exclusively males, arriving on April 27, 1882, and May 5, 1883; but Bailey, Brower, and Bishop (in Gabrielson and Lincoln, 1959:223) reported the male eiders arriving at Barrow by April 3 and the females by May 1. Observations first made on May 9, 1970, consisted of nearly equal proportions of males and females and, therefore, suggested that the migration was well under way by this date.

Duck Hunting Activity During Whaling

During the 1970 spring eider migration, I saw duck hunting activity at the whaling camp on only one occasion. During a lull in whaling activity on May 23, three boats were observed positioned in the lead waiting for eiders to pass. Although each boat contained three or four hunters and several

shots were heard, the boats were too far away for me to see if any birds were killed. Lack of transportation prevented a visit to the hunters' camp.

The location of the individual whaling camps depends on the configuration of the lead edge (Sonnenfeld, 1957). Camps were located in coves along the edge of the ice, and eiders tended to fly up the lead coming near the edge of the shore-fast ice only at extended points. Whalers, therefore, were always several hundred yards out of shooting range. To get within range, the hunters had to position their boats in the lead; and they would not do this when whales were in the vicinity.

Early in the season, when whaling activity was high, no duck hunting occurred. As whaling diminished at the end of the season, however, an increasing amount of time was spent in hunting other game. This inverse relationship between supplementary hunting and whaling activity was also described by Murdock (1885), Sonnenfeld (1957), Myres (1958), Chance (1966), and Nelson (1969). Klein (1966) reported a similar relationship between seal hunting and eider hunting among the Eskimos of the Yukon-Kuskokwim Delta in Alaska.

Although the inaccessibility of hunters prevented the collection of harvest data, I have little doubt that eiders are taken every year during the spring migration, regardless of the whaling success. However, Barry's (1968) speculation that the annual spring harvest is probably as large as the

summer harvest could only be valid at Barrow if the whaling success were poor. Spring is the most important time for eider hunting at Wainwright (Nelson, 1969), but at Barrow only 55 per cent of the hunters questioned had shot ducks during the 1970 spring migration. Furthermore, the average total bag per man was only 26 birds (Table 5, Questions 10 and 11).

The apparent reason for this small harvest is the exceptionally high whaling success in the spring of 1970. Seventeen whales were taken, while an average year might yield only seven or eight (Durham, viva voce).

Duck Hunting Activity During Sealing

The sealing camps along the coast from Barrow south to Skull Cliff had a more relaxed air about them than did the whaling camps. Hunting success did not seem to be taken quite as seriously. The entire family took part in the outing, and some were as interested in camping as they were in hunting. The absence of shotguns in some whaling camps indicated that there was no intention to hunt ducks; but sealers obviously had other plans, for each sealing camp I visited had at least one shotgun.

Sealing camps were visited where hunters had taken not only bearded seals (Erignathus barbatus) and ringed seals (Phoca hispida) but also King Eiders, Common Eiders, Spectacled Eiders (Lampronetta fischeri), Steller's Eiders

(Polysticta stelleri), Black Brant (Branta nigricans), Arctic Loons (Gavia arctica), Oldsquaws, and Crested Auklets (Aethia cristatella).

As in whaling, however, duck hunting at sealing camps was of secondary importance. On June 21 all of the 12 sealing camps along the coast from Barrow to Skull Cliff were visited. Eiders were common in the camps but in small numbers (an estimated four or five per family). The majority of the ducks appeared to be consumed within a few days. Only one family was observed taking ducks, 45 in number, back to Barrow for storage.

Summer Migration

Migration Estimate

Wind conditions were recorded daily from July 13 to September 7 at Lonely, Ooliktok, Flaxman Island, and Barter Island, the DEW stations east of Barrow. This record indicated that the prevailing polar easterly winds were fairly consistent in direction and speed along 300 miles of coastline east of Barrow. The wind conditions recorded at Barrow during the summer migration, unlike those of the spring migration, were, therefore, generally representative of wind conditions affecting eider movements along this portion of the coastline.

The sampling scheme and counting technique for the summer migration followed the basic format described for the

spring migration. A few changes, however, were necessary. The direction of the returning migration made it necessary to re-define favorable and unfavorable winds. The birds were now flying in a slightly northwesterly direction along the Alaskan Arctic coast, so favorable winds were designated to be from east-southeast (112°) and from all directions within 89° of east-southeast. All other winds were classified unfavorable except those of less than 9 miles per hour, which were considered neutral. Good visibility and the close range of passing birds made counting and identification of species possible in most cases. The conditions were also good for photographing flocks of ducks and, thus, verifying estimated flock sizes. The proximity of passing birds allowed the use of a 35mm camera with a standard 55mm lens. An orange filter used with black-and-white film increased contrast so that individual ducks could be more readily counted from the film. While both color film (ASA 160) and black-and-white film (ASA 400) were used, black-and-white film negatives projected on a screen for counting gave the best results.

All flock size estimates were adjusted according to the correction factors listed in Table 1, and corrected flock sizes were used for all calculations. Included in the 67,590 waterfowl recorded between July 13 and September 7 were 64,389 (95%) eiders, 1,545 (2.3%) Oldsquaws, 1,103 (1.6%) Black Brant, 59 (0.1%) Pintails (Anas acuta), and 494 (0.7%) unidentified ducks.

Table 1. Correction factors for estimated flock sizes as determined by actual counts from photographs.

Estimated Flock Size	No. Flocks Photographed	Total Estimated	Total Actual Count	Correction Factor
20 or 25	9	215	272	1.26
30 or 35	20	645	1,056	1.63
40 or 45	33	1,380	2,437	1.76
50 or 55	21	1,080	1,797	1.66
60 or 65	21	1,290	2,230	1.72
70 or 75	10	735	1,576	2.14
80 or 85	6	490	1,015	2.07
90 or 95	9	824	1,554	1.88
100 or more	20	2,595	5,010	1.93

The assumption that prevailing wind conditions influence eider movements was substantiated. The mean number of eiders passing Barrow during favorable half hours was 346, while during neutral and unfavorable periods, it was 299 and 41 respectively. An analysis of variance indicates that the effect of wind on flight intensity is very significant ($p<0.01$).

The summer field season consisted of 2,736 half-hour periods, of which 1,907 had favorable winds, 569 had neutral winds, and 260 had unfavorable winds. A total of 220 half hours were sampled, consisting of 151 during favorable periods, 50 during neutral periods, and 19 during unfavorable periods.

Based upon the mean waterfowl per half hour in the three strata (favorable, neutral, and unfavorable wind periods), an estimated 842,326 waterfowl passed Barrow between July 13 and September 7. Table 2 summarizes the estimation procedure. This estimate is nearly identical to Thompson and Person's (1963) estimate of 800,000 for a similar time span (July 14 - September 1) in 1953. Barry (1968) estimated that 1,108,000 eiders used the Beaufort Sea migration route; and this is a reasonable approximation of this study's and Thompson and Person's estimates, since both excluded all juveniles as well as some adult males and females. Although a much earlier estimate by Leffingwell (1919) was made with rather questionable estimating procedures, the 700,000 to 1,000,000 eiders

Table 2. A summary of the estimation procedure used for the summer migration.

Wind Effect	Stratum Size (N)	Sample Size (n)	Mean Waterfowl Per Half Hour	S.E. of Mean	Stratum Estimate ($\hat{y}$)	Total Estimate ($\hat{Y}$)
Favorable	1907	151	365	32	696,703	
Neutral	569	50	235	43	133,692	842,326*
Unfavorable	260	19	46	15	11,931	

* Standard deviation of the estimate = 63,639

he estimated is surprisingly similar. His estimate was made in the spring and also did not include juveniles.

The heaviest eider movements observed occurred during the last week of July (Fig. 2). During this period an average of 536 waterfowl per half hour were counted. In addition to the effect of wind, flight intensity was also affected by the time of day (Fig. 3). Eider movements were greatest between midnight and 6 a.m., while the smallest number of eiders flew between noon and 6 p.m. Nelson (1969) also indicated that more eiders fly at night when the sun is low than during the warm part of the day.

The average flock sizes for favorable, neutral, and unfavorable periods were 91, 82, and 43 respectively. Although flock sizes for favorable winds did not differ significantly from those for neutral winds, they did differ significantly ($p<0.01$) from flock sizes for unfavorable winds. The sizes of 736 flocks of eiders counted near the duck camp are shown in Fig. 4. While 70 per cent of the flocks consisted of 100 birds or less, only 2.6 per cent of the flocks contained over 300 birds. The largest flock observed, 640 eiders, was seen on August 31. Although the average flock size in the Thompson and Person (1963) study was somewhat larger (105 birds), the percentages of flocks under 100 birds and over 300 birds were nearly identical.

The sample of observations was possibly biased by reduced visibility and a lack of uniform sampling throughout all hours

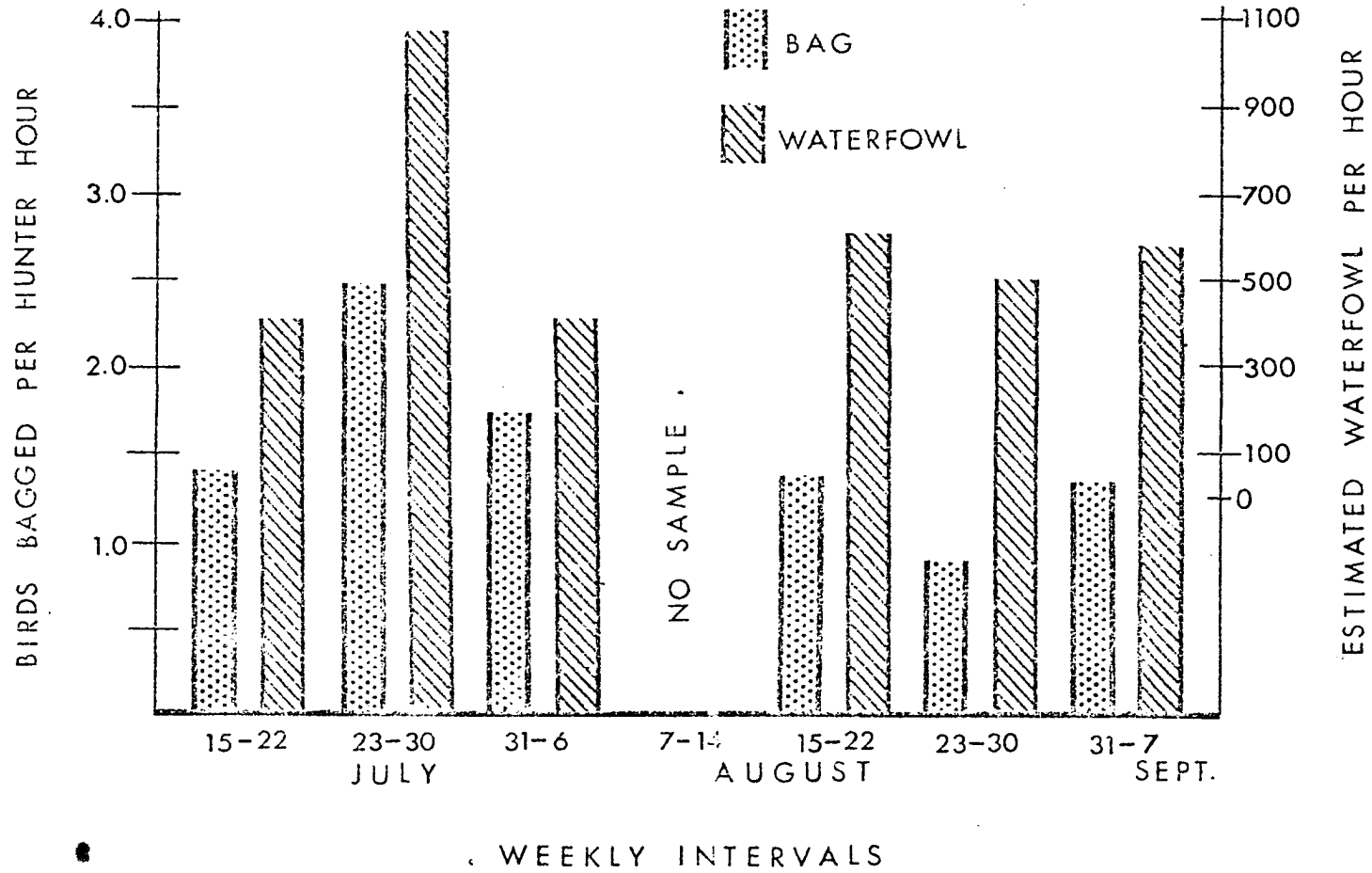


Fig. 2. Weekly fluctuations in hunter success and eider flight intensity at Barrow, Alaska, 1970.

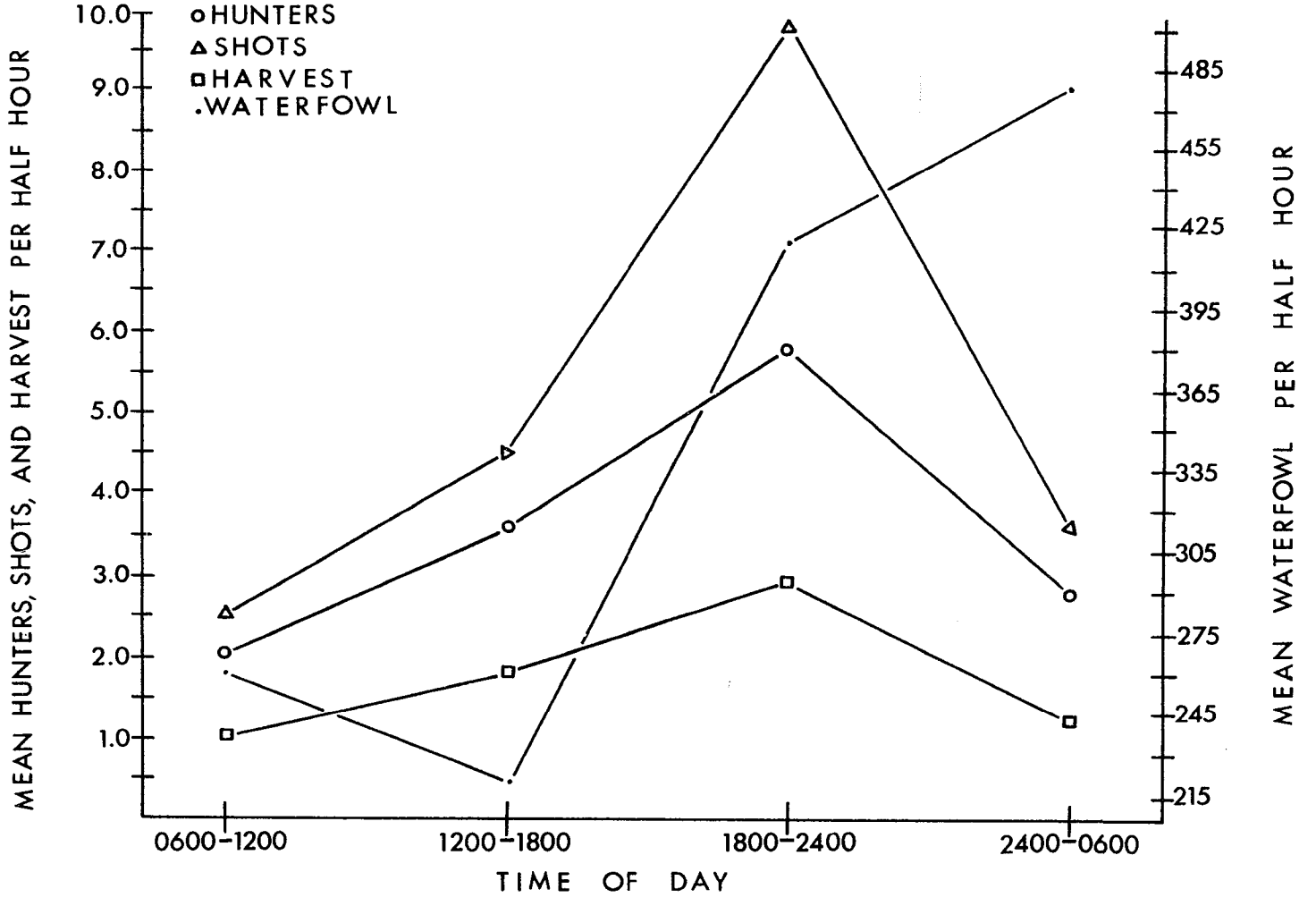


Fig. 3. Hunting and flight intensity for four daily time intervals at Station 1.

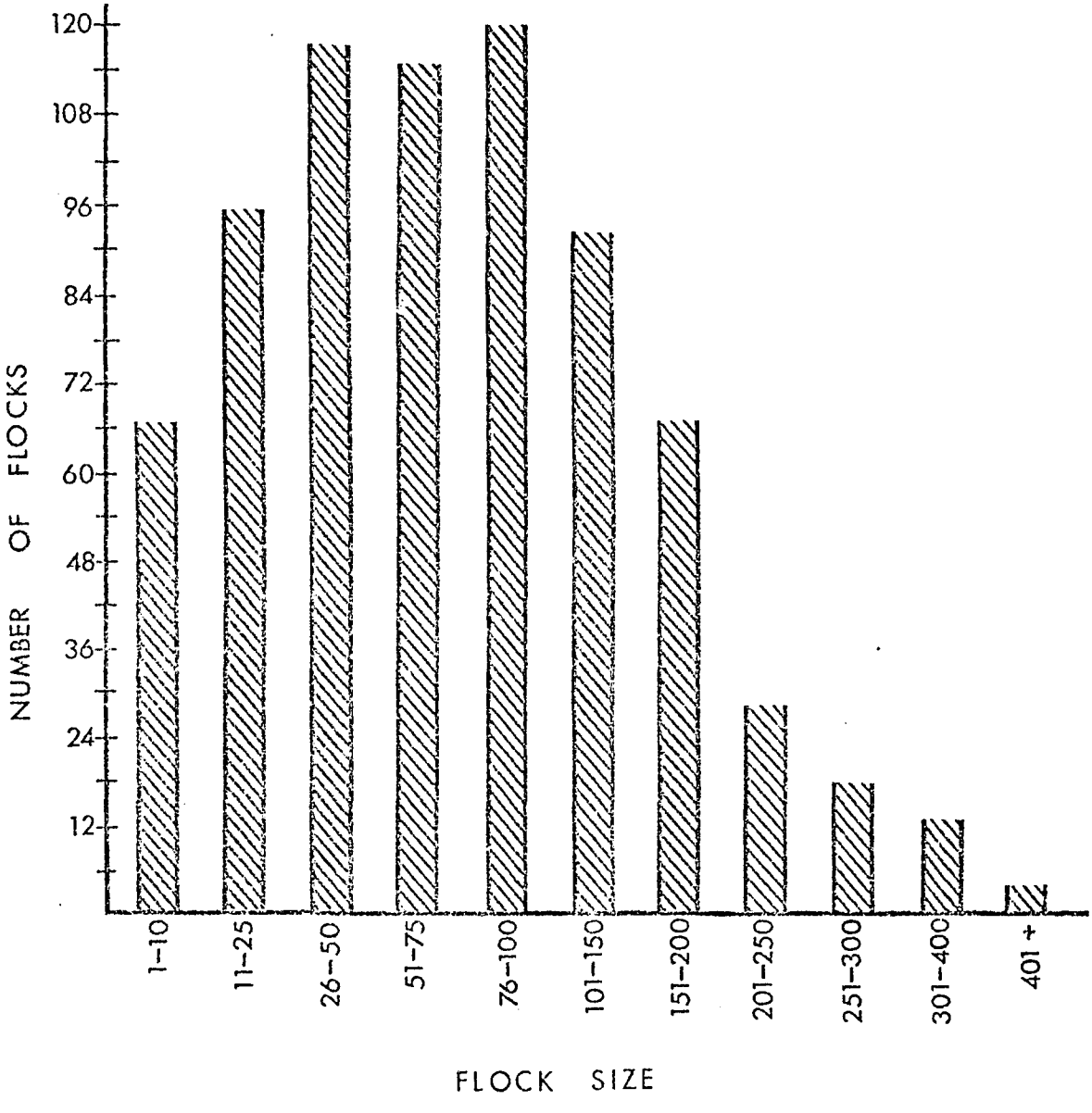


Fig. 4. Distribution of eider duck flock sizes at Barrow, Alaska, July 13 to September 7, 1970.

of the day. Heavy fog during the month of August often prevented waterfowl counts, but observations during foggy periods indicated that eider flight intensity was not reduced. Eskimo hunting continued with what seemed to be at least equal success as on clear days. In fact, the hunting success may have improved slightly during foggy periods. During such periods the birds seemed to follow the coastline more closely and, therefore, were closer to the hunters. I attempted to schedule observation periods so that each part of the 24-hour arctic daylight would be sampled but was unable to sample during the very early morning hours as often as during regular daytime and evening hours. By mid-August the sun was again setting and several hours of darkness each night could not be sampled. Observations at dusk and dawn in late August and early September indicated that eiders continued to fly in the darkness, although Eskimos generally did not hunt at that time.

Species Composition

Waterfowl identification during the summer migration was much easier than during the spring migration, simply because the birds could be seen at closer range. The male King and Common Eiders became more difficult to distinguish in late July when the breeding plumage began to molt but could still be identified by the differing amounts of white remaining on their backs and wings. Female King and Common

Eiders were nearly impossible to distinguish except at very close range when the long, sloped bill of the Common could be seen. In large flocks of mixed females, it was impossible to estimate the proportions of each species. Because the females could not usually be distinguished and because some flocks were too far away to be identified by species, many flocks were simply classifed as "unidentified eiders." Since eiders do have a characteristic flight pattern which distinguishes them from all other waterfowl passing Barrow, even flocks in excess of a mile away could be identified as eiders.

Authors reviewed were in agreement that the King Eider was the most abundant migrant past the duck camp. This becomes obvious to anyone observing the migration. Of more than 842,000 waterfowl estimated to pass Barrow from July 13 to September 7, nearly 800,000 (95 per cent) were eiders. Of over 31,000 eiders identified in flight, 95 per cent were King Eiders and 5 per cent were Common Eiders. These percentages were closely approached in the hunter bags and caches where Kings and Commons combined accounted for 99.5 per cent of all eiders (Table 3). No Steller's or Spectacled Eiders were recognized in flight; and only four and five of them, respectively, appeared in the hunter bags and caches.

The abundance of Steller's and Spectacled Eiders on the Alaskan arctic coast has not been clearly established. Murdock (1885:119) found them to be far less abundant than Kings and Commons. He reported the Spectacled Eider to be "regular

Table 3. Species composition of bag checks and caches at the Barrow duck camp, July 15 to September 7, 1970.

Bag Checks for the Week of:	Species	No.	Per Cent
July 15 - 22	King Eider	341	92
	Common Eider	26	7
	Oldsquaw	3	1
	loon	2	
July 23 - 30	King Eider	361	94
	Common Eider	21	5
	Spectacled Eider	2	1
	loon	1	
July 31 - August 6	King Eider	115	97
	Common Eider	2	2
	Spectacled Eider	1	1
August 7 - 14	no sample		
August 15 - 22	King Eider	220	95
	Common Eider	6	3
	Black Brant	5	2
August 23 - 30	King Eider	46	96
	Common Eider	2	4
August 31 - September 7	King Eider	76	90
	Common Eider	3	4
	Black Brant	5	6
All Bag Checks	King Eider	1,159	93
	Common Eider	60	5
	Black Brant	10	1
	Spectacled Eider	3	1
	Oldsquaw	3	
	loon	3	
All Caches	King Eider	921	89
	Common Eider	42	4
	Black Brant	56	6
	Spectacled Eider	2	1
	Steller's Eider	4	
	Pintail	3	
	Oldsquaw	1	
	loon	1	
Bag Checks and Caches Combined	King Eider	2,080	92
	Common Eider	102	4
	Black Brant	66	3
	other	20	1

though rather rare..." and observed none in the summer migrations of 1882 and 1883. Anderson (1913) considered the Steller's Eider a rare straggler east of Barrow, but Bailey (1948:171) found them fairly common at Wainwright. Bent (1962) pointed out that the breeding grounds of both Steller's and Spectacled Eiders extended east at least to Barrow, and Bartonek (1969) and Gavin (1970) found both species to be fairly common along the Alaskan arctic coast east of Barrow. In addition, Bailey (1948:175) considered Spectacled Eiders fairly common near the Colville River delta and stated, "Many [Spectacled Eiders] are killed for food by the natives at Barrow...." Thompson and Person (1963), however, saw no Spectacled Eiders but recorded seeing 21 Steller's Eiders at the duck camp in 1953. More recently, Bartonek (1969) counted 87 Steller's Eiders during a 4-hour stay at the duck camp.

Male King and Common Eiders make up the major portion of the summer migration until the middle of August. When observations were temporarily suspended on August 7, the flocks consisted almost entirely of male eiders with only a few females present; but, when observations were resumed on August 17, the situation was completely reversed, with males constituting only a small percentage of each flock. This transition was observed by Thompson and Person (1963) during approximately the same time span (August 4 to 22) in 1953.

This segregation of sexes by time might be used to roughly estimate the adult sex ratio of the King and Common

Eiders passing Barrow. An estimate of the male eiders passing Barrow from July 13 to August 6 and the females passing from August 17 to September 7 suggests a 60:40, male-female ratio. However, taking into consideration the relatively few males which passed Barrow before July 13 compared to the number of females which probably passed after September 7, the ratio would approach 50:50.

Neither the immature eiders of one and two years of age nor the juveniles which are only a few months old have been included in any estimation or discussion thus far. Immature eiders were reported not to flock with or migrate as far north as adults (Bent, 1962); this is supported by the fact that only three of them appeared among 2,182 eiders in my bag and cache checks. The report of two hunters bagging one juvenile eider each on September 4 led me to believe that the young of the year had not arrived at Barrow, except as scattered individuals, when observations were concluded September 7.

Among the other waterfowl observed using the coastal migration route were Oldsquaw ducks and Black Brant. Oldsquaws commonly nest in the area and were seen throughout the study. However, they migrate later than the eiders (Kortright, 1942) and appeared to begin flying with the migrating eiders on August 31. During observation periods from August 31 through September 7, 1,545 Oldsquaws were counted crossing the spit heading southwest over the Chukchi Sea, a figure which extrapolates to nearly 21,000 Oldsquaws for the eight-day period.

Black Brant first appeared in a bag check on August 18. Between August 18 and September 7, 1,103 Black Brant were counted and 14,000 were estimated for this 21-day period, based upon the expansion of data.

Thompson and Person (1963) counted only 80 Oldsquaws and 47 Black Brant. During the 1970 summer migration, the Black Brant usually crossed overland south of the duck camp flying at an altitude of several hundred feet.

On many occasions during the summer, loons (Gavia spp.) nesting in the area were observed flying to and from the sea to feed but were not counted. On September 3, however, flocks of loons and jaegers (Stercorarius spp.) began arriving from the east, crossing the spit and heading southwest. In the following five days, 83 loons and 153 jaegers were counted crossing the spit. Thompson and Person (1963) reported seeing only two loons.

Hunting Methods

The duck camp is strategically located where the returning eiders cross the spit which extends to Point Barrow. As the birds migrate west along the northern coast, they seem to hug the coastline, flying from point to point. Shooting seems to have little effect on dispersing an approaching flock or changing its general direction. Flocks flying up Elson Lagoon may veer off temporarily as a result of shooting but soon redirect themselves toward one of several crossing

points to the Chukchi Sea in the general area of the duck camp.

The Natives take full advantage of this situation by setting up crude blinds where the eiders are known to cross most often, a technique Nelson (1969) also observed at Wainwright. The result is that hunter groups and, hence, shooting activity is restricted to three general areas which were designated as Shooting Stations 1, 2, and 3 (Fig. 5).

Shooting Station 1 (Fig. 6) had the heaviest hunting activity. It was the closest to the duck camp and was used most consistently by eiders as a crossing point. The area is cluttered with rusting machinery which the U. S. Navy abandoned some years ago. The machinery was used quite successfully for blinds. Birds were shot on the east side of the spit as they approached, so that the prevailing winds would blow dead birds to shore. Wounded birds which glided over the spit and landed in the sea were not pursued because the wind carried them away from shore.

Station 2 was located at the mouth of North Salt Lagoon. As flocks of eiders passed Brant Point, they sometimes turned before reaching Station 1 and flew over North Salt Lagoon crossing the Naval Arctic Research Laboratory (N.A.R.L.) landing strip and flying out to sea. A dirt bridge over the mouth of the lagoon and scattered oil drums served as blinds. Dead birds usually either drifted to shore with the wind or fell on land. A local Eskimo told me that this was the least

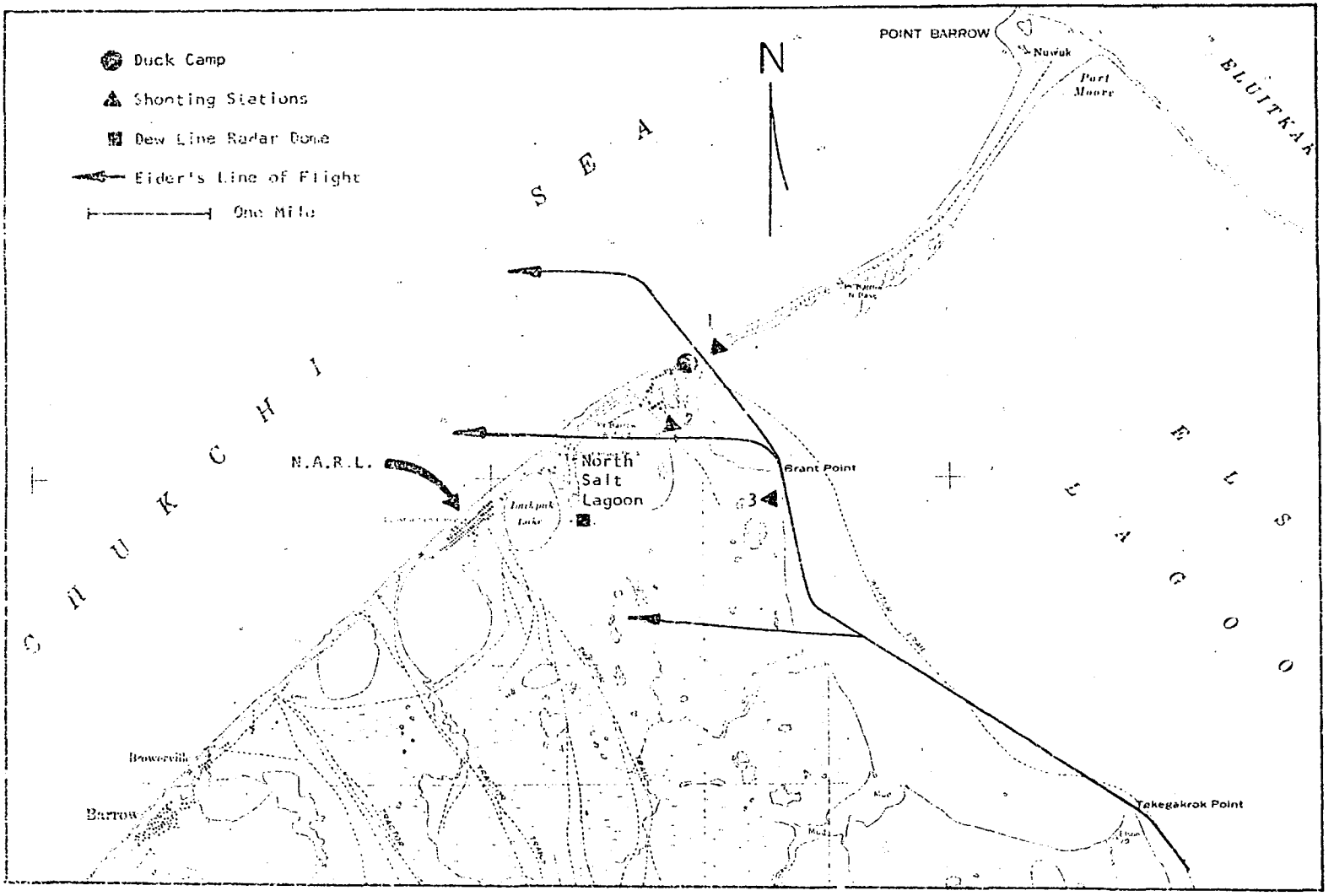


Fig. 5. Map showing the summer study area near Barrow, Alaska.

used station because the birds would not cross here except on clear days when the fog did not prevent them from seeing it as an avenue to the sea.

Brant Point and 1 1/2 miles of shoreline south of it served as Station 3. As eiders flew from Tekegakrok Point to Brant Point, they followed the shoreline closely, thus putting most hunters at this station in an ideal position.

Rising above the shoreline at Station 3 is a bluff about 6 feet in height (Fig. 7) which is marked with numerous drainage gullies. These gullies are deep enough to conceal a hunter and were used extensively. Blinds were also constructed from chunks of sod and oil drums (Fig. 8). Flocks of eiders often came within 20 yards or less of the hunters and flew only 5 to 20 feet above the water (Fig. 9). Even the least skilled hunter took ducks under these conditions. If the wind was from an easterly direction, the downed birds would drift to shore. Especially effective at this station was the technique of firing several shots at the lead bird or cluster of birds in a flock. Then, as the crescent-shaped flock, flying at the hunter's eye level, flew through the shot pattern, several birds would be brought down at one time (Fig. 10). On one occasion I witnessed 13 birds killed and 7 crippled with 3 shots at a single flock by a lone hunter. Similar observations were made by Sonnenfeld (1957).

The water off Brant Point and its adjoining shoreline is

Fig. 6. Shooting Station 1 located at the base of the sand spit which extends to Point Barrow.

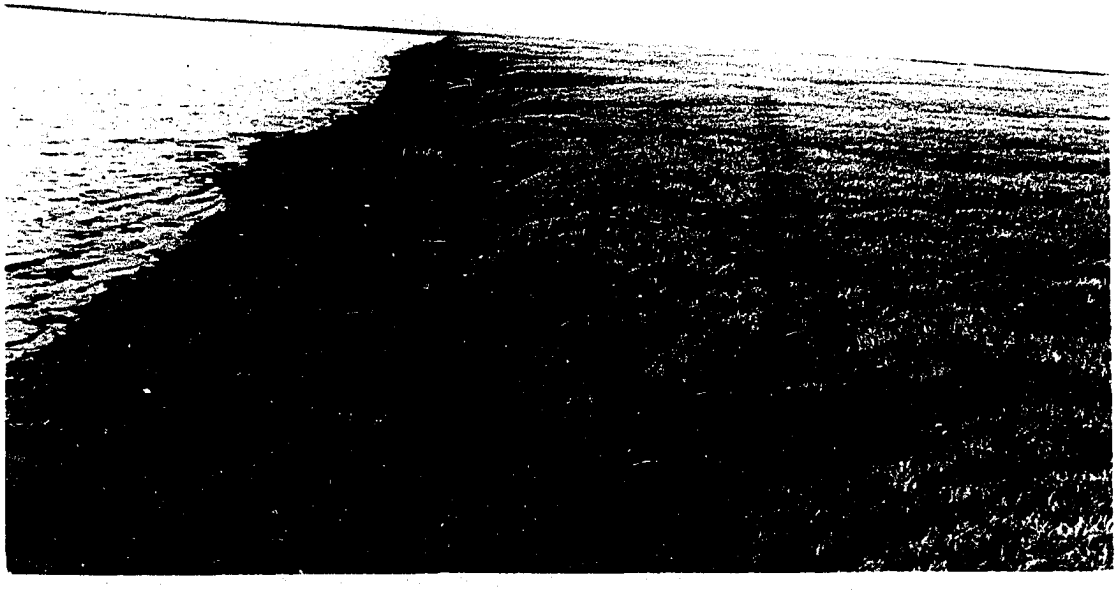


Fig. 7. Shooting Station 3 at Brant Point and the adjacent coastline.

Fig. 8. Eskimo hunters using oil drums for a duck blind at Brant Point.

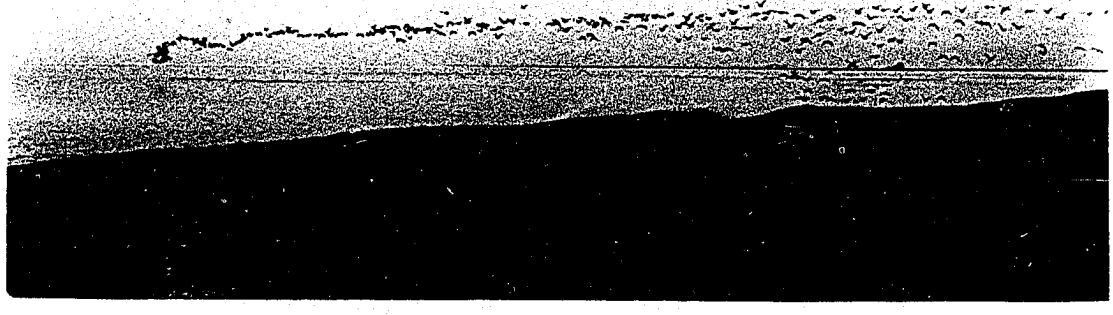


Fig. 9. Low-flying, coast-hugging eiders make an easy target for hunters at Brant Point.

shallow enough at low tide for a hunter to wade out in hip boots to retrieve dead birds. On one occasion three hunters were observed using the low tide to their advantage. Two men waded 40 to 50 yards from shore while the third remained in the blind. As flocks of eiders approached, they were caught in a cross fire which resulted in a harvest of 20 to 25 birds in less than an hour (Fig. 11). The birds seemed to have little fear or, perhaps, no awareness of stationary objects in their line of flight.

Several observations were made of hunters who had taken motorized boats out into the lagoon about 50 yards from shore where they waited for eiders to fly over. This technique was very successful, and a party of three or four hunters could often take up to 50 or 60 birds in a few hours of hunting.

Most hunters preferred the 12-gauge, automatic shotgun. Pump actions and double barrels, in that order of preference, were also used as well as other gauges. Shotguns with sawed-off barrels which give a more scattered shot pattern were not uncommon. For the close ranges at which many of the eiders were taken, the short barrel increased the hunter's chances of hitting several ducks with a single discharge. Unfortunately, this also increased the chances of crippling birds. Those hunters using automatic or pump-action shotguns seldom observed the federal regulation on a three-shot capacity.

The King and Common Eiders are strong birds with a thick covering of down which requires a large shot pellet to

Fig. 10. Shooting into a low-flying, crescent-shaped flock of eiders at Brant Point. Multiple kills were a common occurrence.

Fig. 11. Eiders scattered behind a hunter's blind, the result of only a few hours of hunting at Brant Point.

penetrate it. Shot size No. 2 and 4 were used exclusively, and No. 2 was observed to give quicker kills and cripple fewer birds. Magnum shells of 2 3/4 inch and 3 inch lengths were used extensively as well as standard 2 3/4 inch field loads.

McLean (viva voce) estimated that 25 families were living at the duck camp during the summer of 1970 and that 8 or 9 of them had at least one member employed at N.A.R.L. Since the duck camp site was closer to N.A.R.L. than was the village, many employees set up their tents at the camp to enjoy camping out, fishing with gill nets in Elson Lagoon, and duck shooting, while being close to work. For these men, of course, hunting was restricted to evenings and weekends, while the younger males in the family could hunt at any time. With 24 hours of daylight until late August, the hunters were active at all hours of the day.

On July 13, when first observations were made at the duck camp, it consisted of 43 tents, but as many as 49 tents were counted at one time (Fig. 12). Although some hunting activity had preceded my arrival, the number of birds which had been taken appeared to be relatively small.

Drying racks, where bundles of birds were hung to dry, are set up near the tents (Fig. 13). Birds were dried before being put into ice cellars for storage (McLean, viva voce). According to McLean, hanging them on racks before freezing is also preferred by some for aging the meat. Two other possible

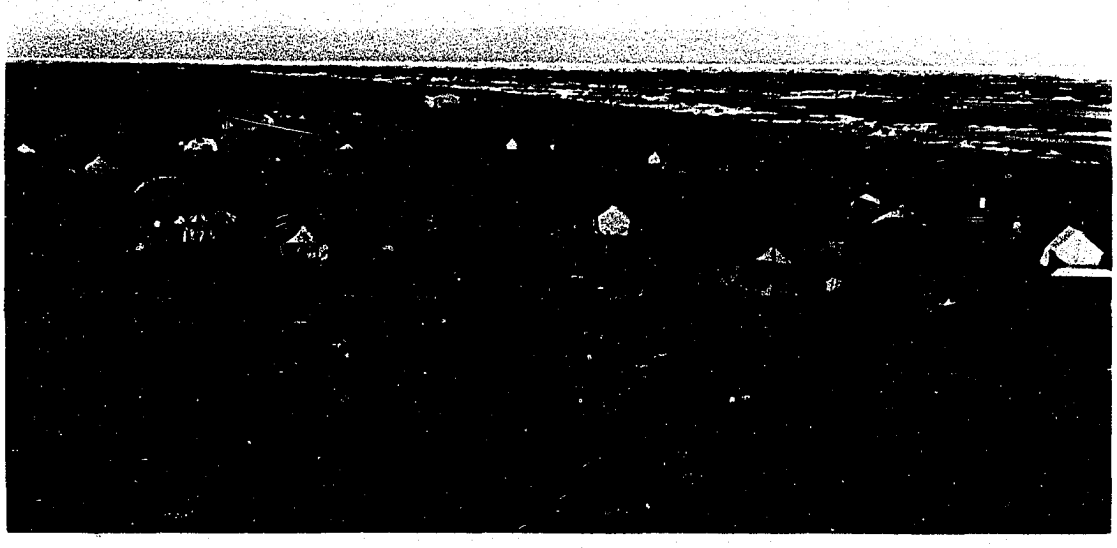


Fig. 12. The duck camp consisted of nearly fifty tents in mid-July, 1970.

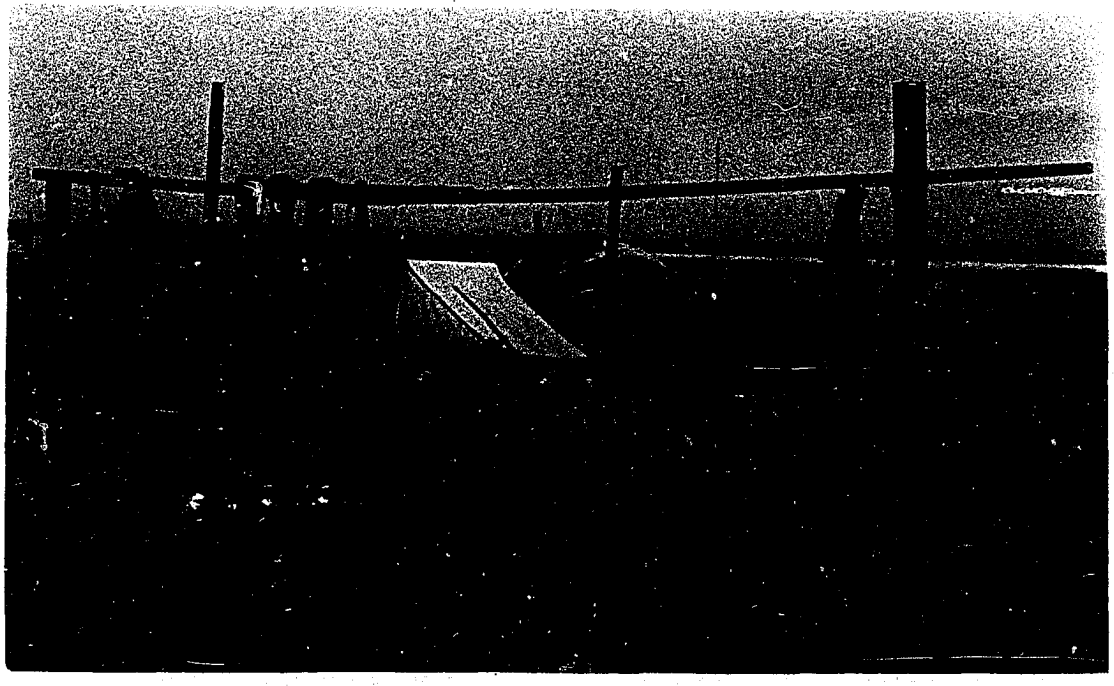


Fig. 13. Eiders in bundles of ten each hang near tents at the duck camp until they are taken to town in late August.

reasons for this practice are the lack of transportation to take each day's bag into town for cold storage and the personal pride which goes with having provided one's family with a large supply of ducks for the winter.

The uncleaned birds were stored for the remainder of the summer and into winter in "ice" cellars which remain below freezing year around because of the surrounding permafrost.

For those duck hunters who did not live at the duck camp, the 6-mile trip from town posed no problem. Taxis were available at Barrow and were used by a few hunters. Some had vehicles of their own, while others rode their snow machines over the tundra to Brant Point. Three hunters even had all-terrain vehicles. Boats, as well, were commonly used for making the trip; and, if necessary, the Eskimo hunter did not hesitate to walk the distance.

Waterfowl Harvest

Waterfowl harvest includes birds bagged, birds crippled, and birds killed but not retrieved. Since most hunters did not use a boat to retrieve their downed birds, they waited for them to drift to shore. This delay in retrieval may have caused some errors in categorizing the birds as being bagged or lost. During July the coastal waters around Barrow were still conjested with drifting ice (Fig. 14), and dead birds often could not drift freely to shore to be retrieved. For this reason, birds shot during that month were not

Fig. 14. Many ducks which fell into ice-conjested Elson Lagoon during July did not drift to shore and were never picked up.

classified as bagged or lost but simply as harvested. During August when the sea ice was gone, harvested birds were classified as bagged or lost; and this served as the basis for determining a harvest loss rate.

During 76 observations, 94 birds (40 per cent) were lost and 139 (60 per cent) were bagged, or 0.68 birds were lost per bird bagged. This could be a slight overestimate of bird loss; but, in light of probable heavier losses in July due to ice conditions as well as the number of birds which undoubtedly carried shot in them some distance before dying, the rate of loss may have reached 40 per cent. Thompson and Person (1963) calculated that 30 per cent of the birds shot in 1953 were crippled. In some cases the loss of birds was reduced by hunters using .22-caliber rifles to kill wounded birds or by hunters having boats to retrieve birds which otherwise would have been lost. Sonnenfeld (1957:396) commented that the loss of cripples is probably due as much to an unwillingness to expend enough effort to retrieve a wounded bird as to an inability to retrieve it. No doubt the loss rate increases as the subsistence value of waterfowl declines and recreational hunting increases.

The amount of hunting activity at the shooting stations varied during the summer, and each station presented different problems in collection of harvest data. To eliminate as many variables as possible, harvest for each shooting station was estimated. These estimates are summarized in Table 4.

Table 4. A summary of harvest estimates for the duck camp area, 1970.

Station	Dates Included	Harvest Estimate	Standard Deviation
1	July 13 to Sept. 7	5,219	744
2	July 13 to August 6	1,044	291
	August 7 to Sept. 7	41	31
3	July 13 to Sept. 7	2,518	556
	Total	8,822	

Since Station 1 was used most often by hunters, more observations were made there than at the other two stations. I assumed that the Eskimos' harvest success would correspond to the number of birds flying at any given time, and Fig. 2 shows this to be true. Hence, observation periods were stratified as before and an estimate of harvest was made for periods of favorable, neutral, and unfavorable winds.

Of 158 observations made at Station 1, 102 were made during favorable periods, 38 during neutral periods, and 18 during unfavorable periods. The mean numbers of birds harvested per half-hour observation were 2.02 ± 0.36 (S.E.), 2.00 ± 0.58, and 0.88 ± 0.68 respectively, for the three kinds of wind. The waterfowl harvest at Station 1 from July 13 to September 1 was estimated at 5,219 birds.

Station 2 was hardly used during August and September; therefore, observations of harvest at this station were made infrequently and only during July and early August. Also, because neutral and unfavorable winds were infrequent during July, all observation periods were grouped together rather than stratified. An average of 0.87 (n=24) birds per half hour harvested at Station 2 extrapolates to an estimated 1,044 birds harvested from July 13 to August 6.

In order to estimate any additional birds harvested at Station 2, it was necessary to estimate both the number of hunter half hours spent at Station 2 from August 7 to September 7 and the hunter success rate. A hunter half hour

is defined as the presence of one hunter at the station during any part of an observation period. Daily spot checks at Station 2 indicated a total of only 138 hunter half hours for this 38-day period. Hunter success was calculated by dividing the total number of birds harvested during observations at that station by the total number of hunters present. I assumed that hunter success during August and September was the same as during July, i.e., 0.30 birds harvested per hunter half hour. The product of the estimated 138 hunter half hours and the success rate yields an additional 41 birds harvested at Station 2 between August 7 and September 7.

Station 3 included about a mile of coastline and, thus, presented a different problem. It was impossible to count harvested birds and classify them as either bagged or lost when hunter groups were often 1/2 to 3/4 mile apart. The best that could be done was to count the number of hunters present during each half-hour observation and, based upon this count, estimate the total number of hunter half hours for this station for the entire field season. Then, since no measure of hunter success at Station 3 was available, I assumed success there to be at least as good as at Station 1, i.e., 0.51 birds harvested per hunter half hour. This success rate times an estimated 4,938 hunter half hours produces an estimated 2,518 birds harvested at Station 3 from July 13 to September 7.

The combined data from the three stations totals 8,822

waterfowl for the duck camp area during the period described. This figure represents about 1 per cent of the more than 842,000 waterfowl estimated to have passed Barrow during the same period. Thompson and Person (1963) calculated a total mortality of 0.5 per cent for a similar time period in 1953.

The 31 adult hunters responding to my questionnaire (Table 5, Questions 1, 2, and 3) reported an average summer bag of 88 birds, while expressing a need for an average of 168 birds to last their families through the winter. Fifty-eight per cent indicated that they did not usually get the numbers of birds they needed.

King Eiders consistently accounted for at least 90 per cent of the birds in hunter bag checks each week, while Common Eiders made up from 2 to 7 per cent during the 7-week period (Table 3). Bag checks and bird caches totaled 2,268 birds, consisting of 92 per cent King Eiders, 4 per cent Common Eiders, 3 per cent Black Brant, and 1 per cent other species. Among the species only occasionally appearing in the hunter bags were Oldsquaws, Spectacled Eiders, Steller's Eiders, loons, and Pintails. Although Oldsquaws are generally not hunted because they reportedly fly too fast and provide too little meat, the younger hunters sometimes shot at them for practice and for fun during lulls in eider hunting activity. Very rarely were Oldsquaws picked up and taken home. While Spectacled Eiders were taken home, on two occasions Steller's Eiders were found lying on the beach and

Table 5. Summary of questionnaires given to 31 adult hunters at Barrow, Alaska, August 31 - September 6, 1970.

Question	Summary of Responses
1. How many ducks have you gotten so far this summer?	None: 3; Under 20: 3; 20-49: 6; 50-99: 7; 100-149: 4; 150-199: 5; 200-250: 2; Over 250: 1; Mean: 88
2. How many ducks do you need to last the winter?	Under 50: 1; 50-99: 8; 100: 4; 150-175: 3; 200-250: 10; 300: 4; 500: 1; Mode: 200; Mean: 168
3. Do you usually get enough ducks to last all winter?	Yes: 13 (42%); No: 18 (58%)
4. What kind of ducks do you shoot the most?	King Eider: 5; Eider*: 25; Black Brant: 1 * Most hunters made no distinction between species of Eiders.
5. What kinds of ducks do you like best?	Eider: 16; Goose: 13; Black Brant: 2
6. Do you trade or sell ducks in winter?	Yes: 3 (10%); No: 28 (90%)

Table 5. (continued)

Question
7. Do you give away ducks as gifts?
8. Do you use the feathers or bones for anything?
9. What?
10. Did you get any ducks this spring?
11. How many?
12. Do you use a boat for duck hunting?
13. Does it have a motor?
14. How many people are living in your house including your wife and yourself?
15. How many in your family hunted ducks this summer?
16. Do you have a full-time or part-time job?

Summary of Responses

Yes	No
26 (84%)	5 (16%)

Yes	No
7 (23%)	24 (77%)

6 responded that pillows were made with feathers, 1 that bones were used for bait on his trapline.

Yes	No
17 (55%)	14 (45%)

Under 10	20-30	50	150	Mode	Mean
7	7	2	1	20	26

Yes	No
16 (52%)	15 (48%)

Yes	No
13 (81%)	3 (19%)

Mean Household Size
7.2

None	One	Two	Three	Four	Five
2	14	10	3	0	2

Full-time	Part-time	No Job
23	3	5

Table 5. (continued)

Question	Summary of Responses
17. Do you hunt for most of your meat or buy it?	Hunt: 20 (64%) Buy: 7 (23%) Hunt half and buy half: 4 (13%)
18. What are your first, second, and third most important sources of meat?	Rank — Score*: caribou 90; fish 24; whale 22; seal 19; ducks 7; walrus 5; reindeer 3; beef 3; moose 2; polar bear 1. *Meats were scored by giving 3 points for first, 2 points for second, and 1 point for third. On only 3 questionnaires was caribou not listed first.

did not appear to be utilized. I was unable to learn the reason for this. Loons were shot quite often by young boys bored by several hours of sitting in a blind but were only occasionally retrieved. Several observations were made of young Eskimo boys shooting phalaropes, gulls, and sandpipers to amuse themselves.

Although female eiders were said to be preferred over males because they are fatter and more flavorful and juveniles were preferred over both because they are more tender, no special efforts were made to hunt any of the three. In addition to the species composition of the harvest, hunter bag checks were used to record the number of hours which a hunter had spent hunting to account for his bag of ducks. While the overall average was 1.60 birds bagged per hunter hour, the fluctuations in hunter success corresponded with the vicissitudes of waterfowl flight intensity (Fig. 2).

Waterfowl were often wasted in the field during the 1970 summer migration but probably were not wasted in the home. Ducks which made it to the drying racks or frost cellars were undoubtedly utilized. Some waste occurred when hunters, usually young ones, shot more ducks than they could carry in one trip from Brant Point back to camp. Bundles of ducks were often left behind, and not all were picked up later. A pile of 196 eiders, the result of a single overnight hunt at Brant Point by four hunters, was not picked up until one month later. In addition, many dead birds drifted in from

the lagoon and were not picked up because no one seemed to know who had shot them or how long they had been lying in the water. As mentioned earlier, wanton waste also occurred when no attempt was made to retrieve crippled birds.

Since many Eskimos were employed full time and were able to hunt only in the evenings or on weekends, hunting pressure was lowest during the working and sleeping hours and highest between 6 p.m. and midnight (Fig. 3). From 6 p.m. to midnight an average of 5.8 hunters were present at Station 1 firing an average of 9.8 shots and harvesting 2.8 birds per half hour. Thompson and Person (1963) used a longer observation period but described smaller averages of 4.1 hunters firing 11.5 shots and harvesting 5.0 birds per hour. A noticeable increase in duck hunting activity, therefore, appears to have taken place since 1953.

Spencer (1959) stated that hunting at the duck camp was primarily an activity for old people who were not capable of more strenuous hunting activities. Table 6 indicates this is not the case today. Instead, the percentages of hunters age 25 to 50 and those over 50 were considerably less than the percentages of their respective age groups in the Native male population of Barrow, while the percentage of hunters age 12 to 24 was considerably greater than the percentage of this age group in the population. The figures are perhaps slightly biased, since more observations of hunter-age composition were made during regular working hours when many of the hunters

Table 6. Duck hunting pressure for three age groups at the Barrow duck camp, July 13 to September 7, 1970.

Estimated Hunter Age	No.	Per Cent of Hunting Activity	Per Cent of Barrow Native Male Population Over Age 12*
12 - 24 yrs.	199	57	41.0
25 - 50 yrs.	108	30	40.7
Over 50 yrs.	45	13	18.2

* Percentages adapted from the Barrow Comprehensive Development Plan, Alaska State Housing Authority, 1970.

age 25 to 50 were unable to hunt and the younger and older hunters seemed to spend more hours hunting in a single outing, hence, increasing their probability of being counted. Eskimo women were observed hunting ducks on three occasions. Eight or nine white hunters were also seen hunting before the regular September 1 season opening.

Inland Migration

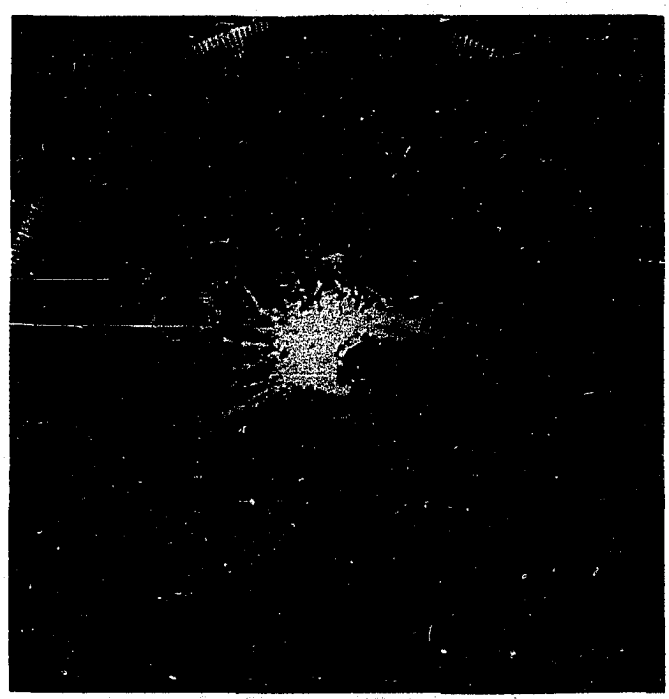
Investigators are not in complete agreement about the possibility of eiders migrating inland over the tundra. Murdock (1885) reported eiders, though not many, moving eastward south of Barrow. Observations made inland from the coast during the 1970 spring migration confirmed such movements which were probably caused by shifting ice conditions near Barrow in the eiders' preferred route up the open lead. However, the "...great bird highway which leads inland...up the Kobuk, Noatak, and Selawik Rivers...over the Endicotts [mountains]" which Bailey (1948:31) described as a bird route to nesting grounds east of Barrow via the Colville River, is most certainly not used by eiders. Although Bailey (1948) did not specifically name eiders as using this route, Myres (1958), on the basis of spring sightings which he made of Spectacled, Steller's and King Eiders on the Mead and Inaru Rivers south of Barrow, suggested that they do. The numbers of birds that he saw were not large; and it seems more likely that, since these three species breed on the tundra, they

were probably not migrating when he saw them. Irving (1960:43) reported a pair of Steller's Eiders at Anaktuvuk Pass but believed the observations was too anomalous for inclusion in his list of Anaktuvuk birds. Irving (viva voce) does not believe that eiders use the "great bird highway."

Time-lapse photographs of DEW radar screens at Wainwright, Barrow, and Lonely (near Pitt Point) are being used to study bird migrations by Warren L. Flock of the University of Colorado. These photographs (Fig. 15) show large numbers of birds migrating west over the arctic coastal plain during the summer migration. Eskimo informants at Barrow believe these birds to be Black Brant and geese, which, to a large extent, do not use the coastal migration route. Black Brant have been reported to fly overland from nesting sites east of Barrow and to emerge at Peard Bay (Remington in Gabrielson and Lincoln, 1959:39) where they continue south along the coast.

The possibility that the birds in the radar photographs are eiders is a qualified one. It is unlikely that adult eiders travel over the tundra when the coastal route is available to them. Svärdson (1953) reported that eiders take a direction almost opposite to that of their ultimate destination to avoid flying overland, and Dorst (1962) wrote of eiders detouring around the southern tip of Sweden to avoid flying overland. When the sea ice returns to Barrow in October and accumulating snow erases the coastline which

(a)



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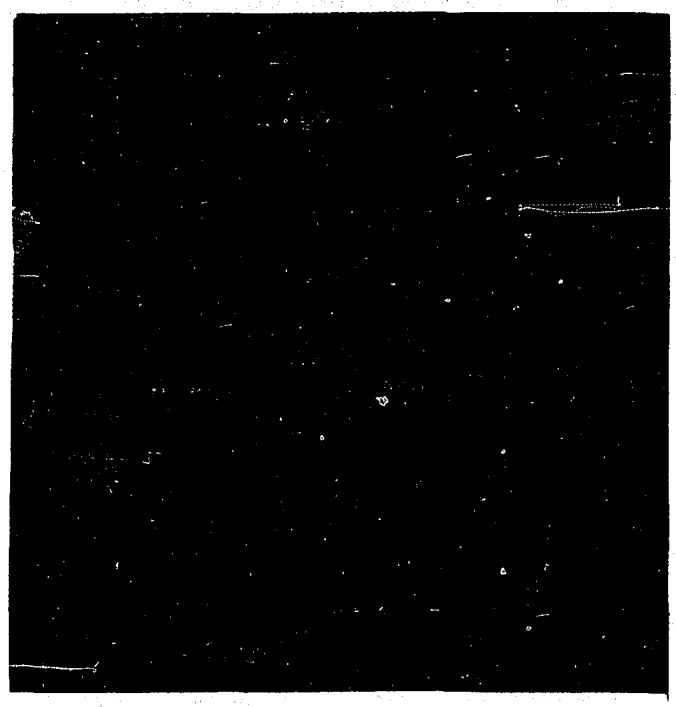

Fig. 15. Five-minute, time-lapse photographs of the Barrow DEW radar screen. The duck camp is located near the center of the screen and bird movements within a 40-nautical-mile radius are shown; (a) shows heavy bird movement around Point Barrow toward the southwest; (b) shows large numbers of birds moving west overland. (Photos courtesy of Warren L. Flock, Univ. of Colo.)

eiders follow, it is likely that some eiders returning from the east fly south of Barrow. This would be especially true of juvenile birds which are reportedly less wary of land masses in their flight line.

Collected Birds

Data collected on spring and summer waterfowl included: date of collection, species, sex, age, body weight, and gonad weight. From Eskimo-killed birds, only the date of kill, species, sex, age, and body weight were available.

Body weight was obtained for 74 spring and 147 summer waterfowl including four species of eiders, Oldsquaws, and a Black Brant, and are presented in Appendices I and II. The average body weight of male King Eiders was 11 per cent more in the spring than in the summer. Similar weight differences were found among the other eiders. Measurements of subcutaneous fat deposits on the breasts of King Eiders showed a general decline in fat depth ranging from 6mm in spring to 3mm in summer. The fatty protuberances on the noses of male King Eiders were also noticeably smaller in summer migrants. Myres (1958) found starving birds on the tundra with no subcutaneous fat and with shrunken nose lobes.

A comparison of average male and female King Eider body weights showed no significant difference for either spring (♂ 1,895 grams, ♀ 1,825 grams) or summer (♂ 1,675 grams, ♀ 1,676 grams) migrants. Thompson and Person (1963) reported

a highly significant difference between summer male King Eiders (1,668 grams) and summer females (1,567 grams).

No spring female Common Eiders were collected, but a comparison of summer females (2,157 grams) and summer males (2,335 grams) showed a very significant ($p<0.01$) mean body weight difference.

Collected ovaries and testes were stored in 70 per cent ethyl alcohol and later air dried and weighed. These weights are presented in Appendices III and IV.

IMPORTANCE OF THE WATERFOWL HARVEST

Barrow Standard of Living

Compared to other Alaskan Native communities, Barrow is relatively affluent. A lack of commercial enterprises other than services, however, leaves the village almost wholly dependent upon the federal government activities there. Alaska State Housing Authority (A.S.H.A.) figures for 1970 show that 38 per cent of the Barrow area employees were employed by the government. This dependence upon the government has over the years given Barrow a boom-and-bust economy. Economic booms accompanied the U. S. Navy's search for oil on the North Slope, the fur industry's rush for fox skins, and the construction of the naval installation, DEW stations, airport, hospital, and school (Rice, Saroff, and Fuller, 1964). Each boom was followed by an economic bust when unemployment forced the Natives to either emigrate to larger population centers or return to subsistence hunting (Sonnenfeld, 1957).

The A.S.H.A. reported nearly one third of the employed Natives to be only seasonally employed in 1970. Employment may be 20 per cent above the annual average in summer and 20 per cent below it in winter (Rice et al., 1964). Recent estimates of 25 to 40 per cent and 40 per cent unemployment were made by Hippler (1969) and Wiser (viva voce) respectively. With a population which more than doubled from 1940 to 1950

and again more than doubled since 1950 (A.S.H.A., 1970), Barrow can only experience increased unemployment without expanded job opportunities.

Cash incomes are high in Barrow compared to other Alaskan Native villages. Table 7 shows the mean household income in Barrow during 1969 to be $8,444, with over 20 per cent of the households reporting an income of $12,000 or more. However, because of such large families, 6.2 people per household, the per capita income of $1,375 was only about one third of the statewide figure for 1968 (A.S.H.A., 1970).

Unearned income in the form of state and federal aid is becoming increasingly important to Barrow Natives. In fiscal year 1969 the U. S. Bureau of Indian Affairs administered general assistance to 12 cases for a total of $5,692 as compared to 56 cases and $40,144 in fiscal 1970 (Wiser, viva voce). Inflation, increased population, a decline in job opportunities, and a more general awareness of assistance programs were the reasons given by Wiser for this sharp increase in aid.

According to the A.S.H.A. (1970), welfare plays a minor role in the Barrow economy. While the average monthly income for all employed Natives was about $200,000, the total state welfare payments for October, 1969, accounted for only about 6 per cent of this sum. A summary of state welfare aid to Barrow residents for September, 1970, is presented in Table 8.

Table 7. Native household incomes for Barrow, Alaska, 1969.

Income	Sample Size	Per Cent
$ 0 - 2,999	30	15.4
$ 3,000 - 5,999	36	18.5
$ 6,000 - 8,999	38	19.5
$ 9,000 - 11,999	51	26.2
$12,000 - and up	40	20.5
Total	195*	100.1

Average Household Income $8,444
Median Household Income $8,500
Approximate Per Capita Income ... $1,375

Source: Barrow Comprehensive Development Plan. Alaska State Housing Authority. 1970.

* This represents about 70 per cent of the total Native households in Barrow.

Table 8. State welfare assistance to Barrow, Alaska Natives for September, 1970.

Type of Assistance	No. Cases	Average Case Payment	Total
Old-Age Assistance	57	$ 107.32	$ 6,117
Aid to the Blind	1	110.00	110
Aid to Families with Dependent Children	52	278.20	14,467
Aid to the Disabled	11	172.73	1,900

Source: Alaska Department of Health and Welfare. Division of Public Welfare.

Unemployment insurance benefits for 1970 in the Barrow area were paid to approximately 126 different individuals and totaled $142,699 with approximately 47 individuals receiving an average benefit of $58.44 each week (Alaska Department of Labor, pers. comm.). Although employment benefits are not available on an ethnic basis, the Alaska Department of Labor estimated that the Natives of Barrow accounted for about 90 per cent of the benefits paid.

As of June, 1970, unearned income in the form of Social Security was being paid to 149 Barrowites, averaging $65.10 per individual per month (Social Security Administration, pers. comm.).

A persistent problem exists with unearned income -- the maximum payment often is not sufficiently large to compensate for the high cost of living in an Alaskan village. The most recent estimate of the cost of living in Barrow by the A.S.H.A. (1970) puts the Barrow cost of living 71 per cent above that of Anchorage and nearly 100 per cent above that of Seattle. Hence, as many as five of six Alaskan families may receive aid below their needs (Federal Field Committee for Development Planning, 1968).

Interaction of Wage and Subsistence Economies

The introduction of a money economy to Barrow dates back to the 1850's when commercial whaling activities began there. Since that time, the Natives of Barrow have experienced a

steadily increasing cash economy. According to Spencer (1959), virtually every family today profits directly or indirectly from the cash of wage-earning residents. However, the limited opportunities associated with the seasonal work available in the village have left some Eskimos dependent upon wildlife for food. While they mentally cling to the idea of living off the land (Scott, 1951), the Natives also want a better standard of living. Therefore, cash is used to purchase such things as guns, ammunition, snow machines, boats and motors, and food items needed to supplement a diet of wild meat. Evidence that the entire village is adjusting to a money economy is indicated in the A.S.H.A. (1970) report that over 90 per cent of the Native families questioned purchase more than half of their food. The number of families purchasing such large percentages of meat is probably less (Table 5, Question 17).

According to VanStone (1960:188), there are two major qualifications for material success in a village where subsistence and wage economies are mixed: skill and perseverance in subsistence techniques and the ability to take advantage of seasonal employment opportunities, neither being sufficient by itself to guarantee that success.

The Role of Waterfowl Hunting in the Barrow Economy

Sonnenfeld (1957:20) stated that the importance of wildlife to the Eskimo is determined by (1) quantity, (2) availability, and (3) desirability. In the spring, waterfowl are

available but are generally desirable only if whaling and sealing efforts have been unsuccessful. Whether they are more important in summer than other available game, such as caribou, fish, seals, and walruses, depends much on the individual hunter. Summer is a time for gathering large stores of meat for winter; but, if an Eskimo is employed, his hunting opportunities are restricted.

Solomen (viva voce) indicated that the number of families living at the duck camp has increased with a corresponding increase in Native employment at N.A.R.L. Hence, with more Eskimos working during the day, there are more evening and weekend hunters at the nearby duck camp. Summer eider hunting has, thus, increased in popularity.

Whether or not there is an economic advantage in hunting eiders in the summer over buying meat is questionable. The initial investment for a shotgun at Barrow prices is at least $150, and the cost of a box of 25 shells ranges from $4.45 to $6.10. Using five dollars per box as an average cost, each shot fired costs the duck hunter 20 cents. With a shooting average of 3.19 shots per bird bagged (Table 9), each bird bagged represents an expenditure of 64 cents for ammunition alone. The average weight of a summer King Eider (Appendix II) is 1,675 grams or 3.7 pounds; but in preparing one for the soup pot, as is commonly done, slightly less than 50 per cent of its gross weight is edible. Therefore, if 1 3/4 pounds of meat are usable from each King Eider, the

Table 9. Shooting success of Eskimo duck hunters at Barrow, Alaska, 1970.

Source	No. of Observations	No. of Shots	No. Birds Bagged
Sample Periods	129	423	125
Other Observations	207	749	242
Total	336	1,172	367

Shooting Average = 3.19 shots per bird bagged

meat costs about 37 cents per pound, based upon ammunition costs and shots per bird bagged. Depending upon what kind of transportation is used, if any, to get to and from the duck camp, this cost could increase appreciably. Taxi fare from Barrow to the shooting stations was eight dollars one way, and the oil and gasoline mixture used in snow machines and outboard motors was one dollar per gallon. Occasionally hunters take time off from work without pay for a few days of hunting. Therefore, taking into account the initial cost of a shotgun, ammunition and transportation costs, as well as wages lost for time off and other expenses incurred, the eider duck costs considerably more than 37 cents per pound. Caribou meat and fish, which are favored more than ducks, can be purchased locally for 60 cents per pound. Hence, eider shooting at the duck camp carries little, if any, money-saving advantage over buying wild meat.

Waterfowl hunting does have a stimulating effect on the village economy since it puts more money into circulation. Table 10 indicates a conservative estimate of the annual expenditure for shotshells and shotguns to be $19,525, the major portion of which is used in duck hunting.

Waterfowl are most commonly utilized in the preparation of a soup consisting of two or three skinned and eviscerated ducks, rice, onions, salt, and water. When the soup is eaten, the bones are picked clean of all meat. The majority of hunters questioned (Table 5, Questions 8 and 9) indicated

Table 10. Shotgun and shotshell sales at Barrow, Alaska, during 1970.*

Store	New Shotgun Sales	Estimated Value (@ $175 per gun)	Estimated Shotshell Sales (rounds)	Estimated Value (@ $5 per box)
Shontz'†	22	$3,850	20,000§	$ 4,000
Brower's**	21	$3,675	40,000††	$ 8,000
Totals	43	$7,525	60,000	$12,000

* Figures as of September 1, 1970.
† Jack Franz (viva voce).
§ Field loads only.
** Tom Brower (viva voce).
†† Annual inventory.

that the feathers and bones are not generally utilized. Barry ([undated]) found the western Canadian Eskimo using goose down for pillows, parkas, and blankets. He also stated that geese are commonly traded and sold among these people. This did not seem to be true at Barrow (Table 5, Questions 6 and 7), although the eiders were commonly given as gifts.

The diet of the Barrow Eskimo today is a combination of the traditional and the modern. Barrow Eskimos prefer wild meat; and according to Nelson (1969), they are willing to pay high prices for it. Those who are unable to hunt buy wild meat from other hunters or from local merchants. Seals are reported to be the staple of Barrow's subsistence by Murdock (1885), Sonnenfeld (1957), and Chance (1966); but, when 31 hunters were questioned about the most commonly eaten meats in their homes, caribou was the overwhelming favorite (Table 5, Question 18). The shift from seal to caribou was probably caused by the replacement of sled dogs by snow machines. The dogs were often fed seal meat, and the snow machines have made caribou more accessible.

Caribou are eaten throughout the year and supply the largest amount of meat to the most people. Chance (1966) calculated that a full-time hunter with a family of five would kill an average of 24 caribou each year.

From the sea, fish, whales (Balaena mysticetus), and walruses (Odobenus rosmarus) are much desired; but only the availability of fish is dependable.

Land animals other than caribou contribute little to the food resources of the village. Moose are located too far from Barrow to be sought overland, and furbearers are generally not eaten. Polar bears are taken occasionally and are well liked, but their occurrence is too infrequent for them to be an important food source. Although the Eskimo diet centers around wild meat; coffee, tea, flour, sugar, canned milk, bread, crackers, canned fruit, soft drinks, and candy have become important supplements.

The Traditional Importance of Waterfowl

Waterfowl have long been utilized by the peoples of the entire northern circumpolar area. Störa (1968) reported the harvest of molting waterfowl in Swedish Lapland, Norwegian Finmark, northern Russia and Siberia, Greenland, and Iceland as well as in arctic North America, including Canada and Alaska. The importance of waterfowl to these northern peoples went beyond supplementing their diet. In addition to food, waterfowl provided down and feathers for clothing, dog food, and items for barter. In local folklore, names were given to special times of the year relating them to the seasonal waterfowl harvests.

Annual drives of flightless, molting birds and traditional egg-gathering activities have been abandoned in the Barrow area, but the fowling tradition continues at the summer duck camp and to a lesser extent in the spring whaling camps.

Bolas, pre-firearm devices used to knock down passing waterfowl, have been found at an archeological site near the duck camp, a discovery which indicates that duck hunting there dates from at least 500 to 1000 A.D. (Thompson and Person, 1963).

Although the former ceremonial life of the Barrow Eskimos centered around whaling (Spencer, 1959), other hunting activities, including fowling, played some part in the local folklore. Among several ceremonial dances performed on festive occasions, at least one portrays the annual eider hunt. Barry ([undated]) found the spring goose hunt to be a festive event among Canadian Eskimos.

A few summer-killed ducks are always saved for special meals and holiday feasts, such as Thanksgiving and Christmas. Ducks are a favorite gift to old women or less fortunate hunters (Solomen, viva voce). Nelson (1969) also reported this tradition at Wainwright.

Several factors contribute to the continuing tradition of subsistence hunting activities. The Eskimos' dependence upon foods which are available only at certain seasons of the year has tended to strengthen the tradition of annual hunting events. Each season has become associated with specific hunting activities, and the unpredictability of each season's success has perhaps also extended tradition.

As Hippler (1969) pointed out, in the past the entire life of an Eskimo was spent preparing for a hunt, hunting or

processing the products of a successful hunt. It is not surprising then that Spencer (1953:24) described the Eskimos' quest for food as a "primary drive." A great deal of prestige is associated with the successful hunter; and, if hunting were discontinued, his prestige would decline (Hippler, 1969).

Anderson (1935) described the Eskimo as improvident and controlled by precedent. Hence, Klein's (1966) observation that the Eskimo feels both the need and the right to take waterfowl seems to follow logically. Barry ([undated]) found the attitude of the Canadian Eskimo to be similar. They felt that since they had always hunted spring waterfowl, had large families to feed, were not wasteful, and had very limited employment opportunities, they would continue their traditional hunting activities even under threat of arrest.

At Barrow in 1961 an attempt was made to enforce the federal restriction on spring and summer duck hunting. The result was 141 arrests. When three hunters were apprehended by federal officers, 138 other Eskimos turned themselves in in protest (Day, 1969). Since that time, no enforcement attempts have been made; and the traditional hunt has continued.

The strength of traditional duck hunting is also illustrated by the Barrow Eskimos' lack of regard for other game laws. In addition to wanton waste and unplugged shotgun violations, many hunters did not purchase migratory bird hunting stamps. The U. S. Post Office at Barrow sold only 9

duck stamps in 1970. Although information on the sale of hunting licenses is not available on an ethnic basis, the Alaska Department of Revenue reported that 96 regular resident hunting licenses and 27 subsistence hunting licenses were sold.

Sonnenfeld (1957) felt that extended employment may have decreased the role of traditional hunts but also reported that high turnover in Native employment indicated the persistence of old ways. According to VanStone (1960:188), when the point is reached where living in the village leaves too many wants unsatisfied, the community will begin to disintegrate; and it is the traditional subsistence economy which has mainly been responsible for preventing this disintegration.

All of the reports on subsistence hunting indicate that duck hunting is not of major importance to the total subsistence of the Barrow Eskimo. However, local informants and my general impression of the literature reviewed suggest that the duck camp has increased in popularity. With more Eskimos now being employed, rising cash incomes have reduced the need for subsistence hunting but have increased its recreational value.

CONCLUSIONS AND RECOMMENDATIONS

Barrow is undergoing a long and irreversible acculturation in which centuries of traditional subsistence living are being replaced by modern man's money economy. The mixture of subsistence and wage economies existing there today is characterized by most Eskimos' seeking full-time or seasonal employment, while a few cling to the old way of life and depend nearly entirely on hunting as their livelihood.

Unemployment is high; and, for many, only seasonal employment opportunities exist. Those Eskimos who have cash incomes use them to improve their material lifestyle. Wage earning, if available, takes precedence over subsistence hunting; but, unless employment opportunities expand at Barrow, the village will continue to depend on wildlife for food.

Waterfowl have been hunted traditionally at Barrow for hundreds of years. Today the annual harvest of thousands of birds continues, even though it may not be economically advantageous. The role of hunting in many Eskimo households with sizable annual incomes has shifted from subsistence to recreation. However, Eskimos are controlled by precedent; and hunting will remain of utmost importance to them, even though they may no longer depend on the meat that it provides.

The 1 per cent harvest of waterfowl at Barrow is less significant when compared to the 15 per cent Native harvest

of Cackling Geese (Branta canadensis minima) and White-fronted Geese (Anser albifrons albifrons) or the 6 per cent Native harvest of Emperor Geese (Philacte canagica) reported by Klein (1966) in the Yukon-Kuskokwim Delta. However, I do not feel that the harvest at Barrow should be taken too lightly. Barry (1968) reported a spring 1964 die-off of 100,000 birds among the eiders using the Beaufort Sea migration route. Such incidents can compound the importance of any subsequent harvest; and, if ice conditions were to cause such a die-off in successive years, the effect upon the eider population could be disastrous. In addition, the population increase at Barrow and other villages along the western Alaskan coast where eiders are harvested and the increased popularity of duck hunting at Barrow will, in the future, result in increased annual harvests of eiders. Townsend (1914) reported Common Eiders (Somateria mollissima dresseri and Somateria mollissima borealis) in the North Atlantic reduced to a dangerously low level by Native hunting and egg gathering and by white fishermen.

Even though eiders are rarely hunted by non-Native sportsmen in Alaska and the eider harvest has little or no effect on the continental supply of ducks, they should not be ignored in Alaska's waterfowl management efforts. With the increased attention now being given to the natural resources of the Arctic, the importance of eiders should be recognized.

If the federal regulations can be legally amended by the

Secretary of the Interior as suggested by Day (1969:242), the needs of different villages would be best met by setting different season dates which are appropriate for particular geographic areas. For example, at Barrow, the summer waterfowl are hunted most heavily; but at Wainwright, only 90 miles from Barrow, and in the Yukon-Kuskokwim Delta the spring waterfowl hunting is more important (Klein, 1966).

A summer season at Barrow would have several advantages over a spring season: (1) the open season would coincide with the Eskimos' traditional move from the village to the duck camp; (2) the ducks being harvested would be leaving the breeding grounds and, hence, their reproductive potential for the year would not have been wasted; and (3) by having the open season in summer, opening and closing dates could be adjusted so that the harvest could be limited to male eiders (c. July 1 to August 10), female eiders (c. August 10 to September 1), or to adult eiders (July 1 to August 31). Since the juvenile eiders seldom arrive before September 1, they also could be managed by adjusting the season dates. Although it would be impractical to attempt species management of the eiders, the harvest of Black Brant could be selected for or against by setting the season dates to include or exclude their arrival at Barrow (c. August 15). This would also be possible for Oldsquaws which begin migrating past Barrow in late August.

In the drafting of the Migratory Bird Treaty between the United States and Great Britain (for Canada), little consi-

deration was given to the distribution of bird species and to the real needs of many Native peoples of Alaska and Canada. Even though the taking of auks, auklets, guillemots, murres, puffins, and their eggs by Eskimos and Indians is allowed at any season, these birds are at sea during most of the year and are available to coastal Natives only during nesting when the birds occupy rocky cliffs or small islands.

There is no doubt that the treaty has been largely responsibile for the preservation of waterfowl resources which might otherwise have been thoughtlessly overexploited. Nevertheless, the treaty has not been fair to and has discriminated against the Natives of arctic Alaska and Canada by prohibiting the harvest of waterfowl prior to September 1 of each year. By this time, a large portion of the waterfowl has left the northern breeding grounds and is no longer available to many Native villagers.

I believe the three steps -- education, regulation, and wildlife management -- suggested by Scott (1951) would be a good beginning to the proper management of waterfowl in the Native villages of Alaska. By educating the Native peoples, possibly through village councils, they could be made aware of sound wildlife management practices and, therefore, be expected to adhere voluntarily to regulations set forth. Since the enforcement of waterfowl hunting regulations has been virtually ignored (except for the 1961 incident at Barrow), regulation of any legalized spring or summer season

may be difficult. However, I do feel that, if such a season were allowed, efforts should be made to enforce other regulations, such as the migratory bird hunting stamp and state hunting license requirements, the wanton waste law, and the maximum three-shot capacity requirement of all shotguns. Shooting hours are impractical at Barrow since Eskimos who are employed depend on the evening hours of arctic daylight for hunting. The daily bag limit of 15 eiders presently allowed during the regular waterfowl season and a possession limit of 60 ducks would be ample for both full-time and part-time hunters, especially since many families have more than one member hunting. Hunters with low incomes who purchase 25-cent subsistence hunting licenses depend more on wildlife for food and, therefore, might be allowed a larger possession limit. Finally, in order to properly manage the eider populations to be harvested, further research should be conducted on the productivity and general biology of this valuable wildlife resource.

REFERENCES CITED

Alaska State Housing Authority. 1970. Barrow comprehensive development plan. 160 pp.

Anderson, H. Dewey and Walter Crosby Ells. 1935. Alaska Natives; a survey of their sociological and educational status. Stanford Univ. Press, Palo Alto, Calif. 472 pp.

Anderson, Rudolph M. 1913. Report on the natural history collections of the expedition, pp. 436-527. In V. Stevansson, My Life with the Eskimos. Macmillan Co., New York, N. Y. 538 pp.

Bailey, Alfred M. 1948. Birds of arctic Alaska. The Colorado Museum of Natural History Popular Series, Number 8. 317 pp.

Barry, Thomas W. 1968. Observations on natural mortality and native use of eider ducks along the Beaufort Sea coast. Canadian Field-Naturalist 82(2):140-144.

_____. Undated. Utilization of birds in the Mackenzie Delta region. Annual progress report to the Canadian Wildlife Service. Typewritten, 39 pp.

Bartonek, James C. 1969. Arctic slope and trans-Alaska pipeline task force report: the bird resources of Alaska's arctic slope and petroleum development. Northern Prairie Wildlife Research Center, Jamestown, North Dakota. Unpublished administrative report. 28 pp.

Bent, Arthur C. 1962. Life histories of North American wild fowl. Part II. Dover Publications, Inc., New York, N. Y. 314 pp.

Chance, N. A. 1966. The Eskimo of North America. Holt, Rinehart, and Winston, New York, N. Y. 107 pp.

Day, Albert M. 1969. Northern Natives, migratory birds, and international treaties. Report to the Director, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service. 248 pp.

Delacour, Jean T. 1959. The waterfowl of the world. Volume 3. Country Life Limited, London. 270 pp.

Dorst, Jean. 1962. The migration of birds. Houghton Mifflin Co., Boston, Mass. 476 pp.

Federal Field Committee for Development Planning in Alaska. 1968. Alaska Natives and the land. Anchorage, Alaska. 565 pp.

Gabrielson, I. N. and F. C. Lincoln. 1959. The birds of Alaska. The Stackpole Co., Harrisburg, Pa., and the Wildlife Management Institute, Washington, D. C. 922 pp.

Gavin, Angus. 1970. Ecological survey of Alaska's north slope. Atlantic Richfield Co. Unpublished. 13 pp.

Hippler, Arthur E. 1969. Barrow and Kotzebue: an exploratory comparison of acculturation and education in two large northwestern Alaska villages. Univ. of Minnesota, Minneapolis, Minn. 64 pp.

Irving, Laurence. 1960. Birds of Anaktuvuk Pass, Kobuk, and Old Crow. U. S. National Museum. Bulletin 217. Smithsonian Institution, Washington, D. C. 409 pp.

Klein, David R. 1966. Waterfowl in the economy of the Eskimos on the Yukon-Kuskokwim Delta, Alaska. Arctic 19(4):319-336.

Kortright, F. H. 1942. The ducks, geese, and swans of North America. Stackpole Co., Harrisburg, Pa., and the Wildlife Management Institute, Washington, D. C. 476 pp.

Leffingwell, Ernest. 1919. The Canning River region, northern Alaska. U. S. Geological Survey. Professional paper 109. U. S. Department of the Interior, Washington, D. C. 251 pp.

Murdock, J. 1885. Birds, pp. 104-128. In Ray, P. H., Report of the international polar expedition to Point Barrow, Alaska. U. S. Government Printing Office, Washington, D. C. 695 pp.

Myres, M. T. 1958. Preliminary studies of the behavior, migration, and distributional ecology of eider ducks in northern Alaska. Interim progress report to the Arctic Institute of North America. 14 pp.

Nelson, Richard K. 1969. Hunters of the northern ice. Univ. of Chicago Press, Chicago, Ill. 429 pp.

Rice, E. F., J. Ronald Saroff and William B. Fuller. 1964. Barrow Community Development Study. University of Alaska, College, Alaska. 103 pp.

Scott, Robert F. 1951. Wildlife in the economy of Alaska Natives. Transactions of the Sixteenth North American Wildlife Conference. pp. 508-523.

Snyder, L L. 1957. Arctic birds of Canada. Univ. of Toronto Press, Toronto, Canada. 310 pp.

Sonnenfeld, J. 1957. Changes in subsistence among the Barrow Eskimos. Ph.D. Thesis. John Hopkins Univ., Baltimore, Maryland. 561 pp.

Spencer, R. F. 1953. The hunted and the hunters. Pacific Discovery 6(3):22-27.

_____. 1959. The north Alaska Eskimo: a study in ecology and society. U. S. Bureau of American Ethnology. Bulletin 171. U. S. Government Printing Office, Washington, D. C. 490 pp.

Störa, Nils. 1968. Mass capture of waterfowl in northern Eurasia (in Swedish, English summary). Acta Academiae Aboensis, Ser. A. 34(2):1-333.

Svärdson, Gunnar. 1953. Visible migration within Fenno-Scandinavia. Ibis 95:181-211.

Thompson, Daniel Q. and Richard A. Person. 1963. The eider pass at Point Barrow, Alaska. Journal of Wildlife Management 27(3):348-358.

Townsend, Charles W. 1914. A plea for the conservation of the eider. Auk 31:14-21.

VanStone, James W. 1960. A successful combination of subsistence and wage economies on the village level. Economic Development and Cultural Change 8:174-191.

VIVA VOCE REFERENCES

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Mr. Jack Franz	Long-time resident and part owner of general store at Barrow, Alaska.
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Mr. Richard Wiser	Barrow-area social worker for the Bureau of Indian Affairs.

APPENDIX

Appendix I. Body weights for some adult spring waterfowl taken at Barrow, Alaska, 1970.

Species	Sex	Sample Size	Mean Weight (grams)	Standard Deviation	Standard Error
King Eider	M	9	1,875	193	64
	F	12	1,825	217	63
Common Eider	M	5	2,524	211	94
Spectacled Eider	M	7	1,687	94	35
	F	9	1,684	170	57
Steller's Eider	M	4	821	40	20
	F	4	846	29	15
Oldsquaw	M	17	878	92	22
	F	9	774	59	20

Appendix II. Body weights for some adult summer waterfowl taken at Barrow, Alaska, 1970.

Species	Sex	Sample Size	Mean Weight (grams)	Standard Deviation	Standard Error
King Eider	M	60	1,675	83	11
	F	46	1,676	104	15
Common Eider	M	22	2,335	140	30
	F	6	2,157	49	20
Spectacled Eider	F	2	1,450	--	--
Steller's Eider	F	7	761	41	15
Oldsquaw	M	2	900	--	--
	F	1	766	--	--
Black Brant	F	1	1,447	--	--

Appendix III. Reproductive organ weights (air dried) from adult spring waterfowl at Barrow, Alaska, 1970.

Collection No.	Species	Sex	Left Testis Weight (grams)	Right Testis Weight (grams)	Ovary Weight (grams)	Date Killed
7	King	M	.2538	.1021		6-14
5	Eider	M	.4243	.2296		6-06
1		F			.1848	5-21
2		F			.7476	5-27
4		F			.3692	5-28
15		F			.9546	6-06
12		F			1.3074	6-15
8	Common	M	.7293	.4801		6-13
14	Eider	M	.9623	.3728		6-06
21	Spectacled	M	.2892	.1680		6-15
22	Eider	M	.6484	.3039		6-15
23		M	----	.2859		6-15
18		F			3.4862	6-15
19		F			1.2785	6-15
20		F			.3813	6-15
24		F			1.5510	6-15
26	Steller's	M	.1180	.0707		6-15
175	Eider	M	.1174	.0927		6-19
25		F			.4811	6-15
176		F			.4835	6-19
16	Oldsquaw	M	.5265	.5309		6-17
167		M	.0233	.0201		6-12
168		M	.7159	.3000		6-12

Appendix III. (continued)

Collection No.	Species	Sex	Left Testis Weight (grams)	Right Testis Weight (grams)	Ovary Weight (grams)	Date Killed
169	Oldsquaw	M	.4867	.1969		6-12
170	(continued)	M	.1884	.1789		6-12
171		M	.7023	.3123		6-12
17		F			.2194	6-17
173		F			.2299	6-12

Appendix IV. Reproductive organ weights (air dried) from summer waterfowl at Barrow, Alaska, 1970.

Collection No.	Species	Sex	Age	Left Testis Weight (grams)	Right Testis Weight (grams)	Ovary Weight (grams)	Date Killed
119	King	M	A	.0540	.0148		7-19
120	Eider	M	A	.0424	.0201		7-19
121		M	A	.0425	.0394		7-19
150		M	A	.0279	.0150		7-25
151		M	A	.0477	.0426		7-25
152		M	A	.0417	.0261		7-25
157		M	A	.0289	.0170		7-31
158		M	A	.0457	.0201		7-31
159		M	A	.0406	.0299		7-25
163		M	A	.0446	.0202		7-17
164		M	A	.0286	.0325		7-17
165		M	A	.0454	.0271		7-22
180		M	A	.0253	.0225		8-01
181		M	A	.0339	.0215		8-01
182		M	A	.0259	.0154		8-01
122		M	I	.0063	.0058		7-21
178		F	A			.0955	8-22
179		F	A			.1608	8-20
188		F	A			.1096	8-31
189		F	A			.0393	8-31
194		F	A			.1392	9-06
195		F	A			.0795	9-06
123		F	I			.0504	7-21
196		F	J			.0178	9-07
160	Common	M	A	.0633	.0503		7-21
184	Eider	M	A	.0471	.0284		unknown

Appendix IV. (continued)

Collection No.	Species	Sex	Age	Left Testis Weight (grams)	Right Testis Weight (grams)	Ovary Weight (grams)	Date Killed
185	Common	M	A	.0766	.0394		unknown
124	Eider	M	I	.0244	.0188		7-21
187	(continued)	F	A			.0771	unknown
186		F	I			.0621	unknown
153	Steller's	F	A			.0605	7-25
154	Eider	F	A			.0556	7-25
155		F	A			.0517	7-25
156		F	A			.1861	7-25
161		F	A			.0633	8-06
162		F	A			.0561	8-06
183		F	A			.1367	7-30
191	Oldsquaw	M	A	.0057	.0069		9-04
192		M	A	.0062	.0076		9-04
190		F	A			.0542	9-04
193	Black Brant	F	A			.1062	9-06