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Nesting Ecology, Brood Survival, and Movements of Spectacled Eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1993

by

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EXECUTIVE SUMMARY

Yukon Delta NWR personnel monitored spectacled eider productivity and ecology on Kigigak Island in 1993. Seventy-five spectacled eider nests were found and monitored. Peak nest initiation period for spectacled eiders was 25-26 May, with peak hatch 17-20 June. Although migration and break-up chronologies were "normal" in 1993, clutch size and nest success were lower than 1992, which was a "late" spring. Mean incomplete clutch size was 5.0 eggs (5.5 eggs in 1992). Mean clutch size hatched was 3.9 eggs (4.6 eggs in 1992). Nest success was 63.4% (95% CI: 50.4-79.5%), a decline from 1992's estimate of 92% (95% CI: 83.5-101.2%). Nest success may have been partially affected by failed attempts to eliminate the only two arctic fox from the island.

Fifty-two spectacled eider females were nest-trapped, fitted with tarsal bands (metal and colored plastic), and color-marked with uniquely numbered nasal disks. Seven of 15 resighted 1992 females were recaptured; 11 nested. One juvenile female, banded as a duckling in 1992, was also observed.

Twenty of 52 trapped females also received glue-on, backmounted radio-transmitters. Brood-rearing data were collected on 16 females, though only 4 females carried their radios throughout brood-rearing. Twenty of 22 non-radioed marked females, resighted after hatch, were seen at least once with a brood.

Brood survival (i.e., the probability of a female fledging at least 1 young) was 68.0% Broods moved a mean maximum distance of 0.80 km from the nest by 14 days post hatch (d PH). Mean distances moved between resightings at each 14-day interval were 0.71 km (14 - 28 d PH) and 0.46 km (28 - 42 d PH).

During 174, 1-hour brood observations, only 1 glaucous gull attack on a spectacled eider brood was witnessed; and it was unsuccessful. Approximately 10 other gull/eider encounters were observed; none were serious threats to spectacled eider broods. Our observations suggest that glaucous gulls are not aggressive hunters within their own colonies. Predation or other obstacles

en route to brood-rearing areas are suspected to be important sources of duckling mortality.

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I. INTRODUCTION

The listing of spectacled eiders (*Somateria fischeri*), as a threatened species prompted Yukon Delta National Wildlife Refuge (YDNWR) to continue field work at Kigigak Island for a third straight year. A field camp staffed by 2-9 YDNWR personnel was maintained from 28 April-20 August 1993. Objectives included:

1) monitoring spectacled and common eider *(S. Mollissima)* nesting chronology and productivity.
2) monitoring spectacled eider brood movement and survival.
3) capturing and marking spectacled eider females for survival estimate
4) documenting magnitude, timing, and source of predation, specifically avian, on spectacled eider eggs and broods.
5) eliminating arctic fox *(Alopex lagopus)* from the island.
6) assisting with goose production survey.

II. STUDY AREA

Kigigak Island (32.5 km^2) is located on the west coast of YDNWR and lies at the mouth of Baird Inlet, bordered by the Ninglick River (Fig. 1). Permafrost underlies the island, which contains numerous shallow lakes and ponds, some of which are interconnected with tidal sloughs. During spring and fall, the island is affected by storm tides.

III. METHODS

A. Arctic Fox Removal

During early May, a team of 2 people searched possible arctic fox denning areas for active dens. Once a den was located, the fox was to be shot.

B. Nest Searches

Plots (0.33 km_2) were selected from an area stratified for spectacled eider nesting habitat (Harwood and Moran 1992; Fig. 2) to maximize the number of spectacled eider nests located. Plot search timing also maximized the number of nests found during egg laying (Stehn et al. 1991, Grand 1993). Each spectacled and common eider nest received a unique number, was marked by a white flag, and plotted on an aerial photo. Data recorded included: date, time of visit, species, plot number and/or method of location, number of eggs, presence or absence of female and/or male, abundance of down, condition of nest (laying, incubating, flooded, depredated, abandoned), distance to water, habitat type (upland [areas dominated by pingos and higher, drier grass communities], intermediate [contain some upland and pingo habitat], grassflat [very flat graminoid communities punctuated by water bodies]), nest site, maximum vegetation height, vegetation density and cover of 4 most dominant species (estimate % cover within 1 m of nest) (Grand 1993). Each egg was floated to estimate incubation stage (Westerkov 1950). All eggs were numbered with a felt-tipped marker to document laying sequence, depredation, and hatch. Eggs were covered with down upon leaving to minimize cooling and depredation (Grand 1993).

Nests were visited every 10 days to monitor incubation/hatch. Successful nests hatched ≥ 1 eggs and indicators of success were the presence of pipped eggs, ducklings, or egg shell membranes.

Five 0.33 km^2 goose production plots also were searched. Additional eider nests were found incidentally during daily activities. All eider nests found on goose plots and incidentally were treated as those on eider plots. Spectacled eider nest sites from previous years (1991, 1992) were also checked.

C. Nest Trapping and Marking

Hatch dates were estimated using a 26 day incubation period and nest initiation dates derived from egg laying sequence and float angle data. Bow-net traps (Salyer 1962), as modified by Paul Flint and Barry Grand (pers. commun.), were used to nest-trap females 1-5 days before hatch. Each eider was fitted with a U.S. Fish and Wildlife Service (USFWS) metal band (left leg), yellow with black letter/numbered tarsus band (right leg), and a yellow circle-shaped nasal disk with a black letter and number. Measurements (wing, culmen, tarsus) and weight were recorded (Dzubin and Cooch 1992). Glue-on, backmounted radio transmitters were placed on 20 females. After marking, females were anesthetized with methoxyflurane and placed 1-2 m from the nest to prevent accidental stumbling into the nest while "waking." Biologists left before females awoke to minimize nest desertion (Rotella and Ratti 1990). Females were observed from afar to make sure they "awoke."

D. Telemetry

Four towers were set up for telemetry monitoring. Three were set up in brood-rearing areas and were also used for behavioral observations. The fourth was located at camp. Telemetry monitoring began approximately 1 week after the first eider was tagged and a minimum of 1 location per bird was attempted each day. Visual brood locations and duckling counts were conducted approximately every 14 days after hatch. We used the last known location and present signals to minimize the area searched. Handheld equipment pinpointed females' locations. Once found, number of ducklings and plumage class were recorded. The same information was recorded when resighting marked females without transmitters.

E. Observations

Four towers were set up in potential brood-rearing areas. Spectacled eider broods were observed for 1 hour within 4, 4-hour sampling periods (0600-1000, 1000-1400, 1400-1800, and 1800-2200). An observer would work 2 sampling shifts each day in 1 or 2 towers. Observers recorded: predator attacks/threats (primarily glaucous gull *[Larus hyperboreus]*), including the duration, frequency (if same gull), number of ducklings taken, and behavior of brood and gull during the attack; unique brood number; number of ducklings; whether the female was marked; map location; brood class; presence of other species; time in tower; number of other spectacled eider broods nearby; and "brood behavior" at 5 minute intervals. "Brood behavior" was behavior exhibited by the majority of ducklings. Our 1992 and Keller's (1991) observations showed that behavior of the whole brood rather than the individual was usually well synchronized and ducklings tended to react to attacks or disturbances as a group. The observation period began approximately 30 minutes after the observer entered the tower to avoid disturbance bias. (Keller (1991) reported that disturbance affected activity of eider creches for up to 35 minutes.) A 60X power spotting scope was used to identify and observe broods. If more than one brood was in sight, the focal brood was chosen randomly. Observations were terminated if broods were out of sight for more than 10 minutes.

F. Analyses

1. Nesting Chronology

Mean nest initiation date (Julian) for spectacled and common eiders was calculated only from nests discovered during laying. Mean hatch date (Julian) for eiders was calculated only from nests visited at hatch.

Assuming 1 egg was laid per day, hatch dates were projected and initiation dates were backdated for eider nests with known initiation dates and known hatch dates, respectively. Projected and backdated dates for spectacled eider nests were calculated using respective clutch sizes, the assumption that incubation began with deposition of the last egg, and a 24-day incubation period (Dau 1974). Common eider dates were calculated using clutch size, incubation starting after deposition of the third egg, and a 26-day incubation period (Schamel 1974). Observed rather than calculated hatch dates were used whenever available to calculate Mayfield nest success estimates.

2. Nest Success

Mayfield (1961, 1975) nest success estimates were calculated for spectacled and common eiders following conventions established by Klett et al. (1986). Confidence intervals were calculated from standard error of daily survival rate (DSR) (Johnson 1979).

DBase programs calculated nest success estimates and 95% confidence intervals (Grand and Flint 1993). MAYDATES calculated a Mayfield estimate, while SURVBR calculated a Bart and Robson maximum likelihood estimate (Bart and Robson 1982). Programs and data entry were modified to accommodate successful nests visited after hatch. When the exact hatch date was unknown, probable exposure of the final interval was 50% of that interval. This is comparable to treatment of nests visited after failure. Daily mortality was assumed to be constant. Nest success data from 1991 and 1992 were also re-calculated using these programs. Float angle data were used to approximate eider incubation status (e.g., for trapping purposes), but their imprecision precluded predicting exact hatch dates. Overall exposure periods for spectacled and common eiders were 29 and 28 days, respectively. Exposure periods (i.e. laying plus incubation periods) for eiders were derived by subtracting mean nest initiation date from mean hatch date.

Nest success was also calculated by the "Apparent" method, which is the percentage of nests found that hatched at least 1 egg.

3. Egg Hatching Success

Eider egg hatching success (Apparent) was determined for all nests. Eggs with unknown fates or destroyed by visitor activity were omitted from analysis.

4. Brood Survival

The Mayfield brood survival estimate was generated from the sample of radio-transmittered spectacled eider females using the same procedures as those for calculating nest success. Brood survival was the probability of fledging at least 1 duckling. Separate survival rates were calculated for 14- and 30-day intervals post hatch (visual relocation schedule) because mortality was assumed to be variable during the 4-week exposure period. The product of the 2 estimates produced a 30 d PH brood survival estimate. The 95% confidence interval was derived from the variance of the product of the two estimates (McDonald and Manly 1989). Conservative survival estimates resulted from assuming that females not relocated after hatch (e.g., due to transmitter failure or loss) had lost their entire brood. Females who had lost their transmitters, but were resighted at each interval, were included in calculations. We also assumed that the number of egg shell membranes determined brood size and females with broods had at least 1 duckling of their own.

5. Brood Movement

Brood movement for radio-tagged females was calculated from aerial photos for each 14-day visual location.

IV. RESULTS

A. Arctic Fox Control

No dens were found during the spring search. Two fox were seen during nesting, but elimination attempts were unsuccessful.

B. Break-up Chronology

Spring break-up was "early", approximately 10 days earlier than 1992 (Wege 1993). Island snow cover was melting at arrival. Snow machine travel ended around 30 April. Melt water first formed on large (>10 m diam) ponds on 2 May and they were ice-free by 24 May. Snow cover was 10% by 17 May. Sloughs were 90% ice-free by 21 May and the Ninglick River by 25 May.

C. Spring Arrival

Waterfowl migration arrival and nesting chronology were considered "average" (Wege 1993). Small numbers of glaucous gulls were present in traditional colony areas upon arrival on 28 April. Small flocks of emperor geese (*Chen canagica*) were also seen flying over the island, as well as a few tundra swans (*Cygnus columbianus*) and sandhill cranes (*Grus canadensis*). The first spectacled and common eiders were observed on 11 and 8 May, approximately 14 and 17 days earlier, respectively, than 1992. Numerous pairs, small flocks, and individuals of both species were seen by May 12. Courtship and copulation between an unmarked male and a 1992 marked female spectacled eider was observed on 12 May. Groups of up to 6 spectacled and common eider pairs were observed loafing together. Also, aggressive displays by spectacled eider females towards spectacled eider males other than their mates were observed. On occasion, up to 4 spectacled males were seen with a single female.

D. **Nest Survey**

Spectacled eider nest searches started 23 May, 12 days after the first sighting of spectacled eiders. One 2-person team searched 2 plots per day. The first cycle of plot searches was completed 5 June. Average time spent searching an eider plot was 228 min (115-372 min, n = 24, Fig. 3).

The second search period occurred from 9 to 12 June with a second 2-person team. During the second search, 6 of the original 24 plots were re-searched and 5 new plots were searched. All plots were not re-searched due to time restraints caused by spectacled and common eider nest revisits, goose production plot searches, and nest-trapping. Average search time during the second search period was 178 min (90-240 min, n = 11).

A total of 154 eider nests was found on Kigigak Island, including 75 spectacled, 78 common, and 1 king eider *(S. spectabilis)* (Fig. 4-5). Searching eider plots proved to be the most productive means of locating spectacled and common eider nests (73.4% and 82.7% of all nests found, respectively).

E. Nest Distribution and Abundance

Spectacled and common eider nests were found on 23 and 22 eider plots, respectively (Table 1). Only 3 plots did not contain $\geq$1 nest of 1 these species.

The number of common eider nests found this year was down from 1992 (95 nests), most likely due to plot selection which was designed to maximize spectacled eider nests. The southwest corner and periphery land were not as intensively searched as in 1991 and 1992. As a result, 74.3% of the common eider nests were found on eider plots.

F. Nest Sites

Sixty percent and 39% of spectacled and common eider nests, respectively, were along shorelines (Fig. 6). Islands supported 29% and 9% of all common and spectacled eider nests, respectively. Less than 3% common and spectacled eider nests were on displaced islands and mudflats.

Mean distances from water for spectacled and common eider nests were 1.2 m (0.1-6 m) and 1.1 m (0.1-7 m), respectively. Grassflat habitat was preferred for spectacled and common eiders, supporting 88.0% and 93.6% of all nests found, respectively. No nests were found on less intensively searched upland areas. For 6 recaptures in 1993, mean distance from 1992 nest sites was $\bar{x}$ = 165 m (70-320 m).

G. Nesting Chronology

Nest initiation for both spectacled and common eiders began 8-14 days after arrival. Peak nest initiation for spectacled eiders was 25-26 May (7-8 days earlier than 1992), with 19 May being the earliest date and 25 May the mean date (Fig. 7). Peak hatch was 17-20 June (13 days earlier than 1992), with 14 June being the earliest date and 20 June the mean date (Fig. 8). Peak nest initiation for common eiders was 28 May-1 June. With 22 May being the earliest date and 30 May was the mean date (Fig. 9). Peak hatch was 27-28 June, with the earliest hatch date being 17 June and mean date 27 June (Fig. 10). Suspected renests (n = 2) were eliminated from common eider hatch date calculations.

H. Laying and Incubation Periods

Both nest initiation determined from egg laying sequence and observed hatch date were recorded for 3 and 1 spectacled and common eider nests, respectively, and incubation periods were 22, 24, and 26 days. The range of exposure periods for the 3 spectacled eiders was 25-29 days. The exposure period for the 1 common eider nest was 26 days.

I. Clutch size

Spectacled and common eiders had identical median clutch sizes of 6 eggs (Table 2). Mean incomplete clutch sizes for spectacled and common eiders were 5.2 and 5.0 eggs, respectively, 0.3 and 0.5 eggs less than 1992 (Table 3). Based on the number of egg shell membranes present after hatch, clutch size decreased from clutch completion to hatch by 1.3 and 1.1 eggs, respectively, for spectacled and common eiders. Mean egg measurements for spectacled and common eiders were: length - 67.6 mm (SE = 2.4, n = 362) and 75.6 mm (SE = 3.08, n = 277) and width - 45.5 mm (SE = 1.4, n = 362) and 50.1 mm (SE = 1.5, n = 277), respectively.

J. Nest Success

Mayfield and Bart and Robson nest success estimates were 63.4% and 61.3%, respectively, for spectacled and 46.8% and 48.5%, respectively, for common eiders (Table 4). Nest success for both species was lower than 1992, but higher than 1991.

K. Egg Hatching Success

Apparent egg hatching success rates for all spectacled and common eider nests were 69.4% and 58.0%, respectively (Table 5). For successful nests, hatching increased to 79.4% and 75.5%. As with clutch size and nest success, these values were lower than 1992.

L. Trapping and Marking

Fifty-two female spectacled eiders were nest-trapped banded and measured between 11-28 June (Table 6). Transmitters were attached to 20 of these birds. One transmitter was subsequently found at the nest bowl and placed on another female. Forty-seven (90%) of these nests hatched successfully, including 18 radio-tagged females. Of the remaining 5 nests, 3 were depredated and 2 contained addled eggs. Seven females marked in 1992 were recaptured, 3 of which had lost their nasal tags. Each received new uniquely numbered yellow tarsal bands and nasal tags.

M. Resighting

In 1992, 26 female spectacled eiders were banded on Kigigak Island; 24 of these were also nasal tagged. Fifteen of 24 with nasal disks were resighted in 1993 (63%), and their identity confirmed. Three of these 15 (20%) had lost their nasal disks. An additional 5 marked birds (including 2 with nasal markers) were observed, but their identity was not confirmed. Although nasal disk colors were too faded to identify color, shapes were identified and indicated all were different individuals. This increased the number of resighted birds to 20 (77%). Thirteen of these birds were observed with a male prior to nesting and at least 11 subsequently nested (9 nests and 2 broods were located).

Forty-two ducklings were banded in 1992. A juvenile female, with a red tarsal band, was observed with 2 unmarked females.

Twenty-two of 32 1993 non-radioed females were resighted post-hatch. Twenty were seen in the company of a brood.

N. Telemetry

Signals from 10 of 18 radio-tagged females were not received >1 week after hatch. Six were subsequently located visually and transmitter loss was confirmed. Continuing visual observations indicated all raised broods to ≥6 weeks of age. Fates of the remaining 4 females and their transmitters are unknown. Four of the original 18 radio-tagged females shed transmitters after sending signals for 20-28 days post-hatch. All 4 transmitters were recovered, but only 1 female was subsequently observed. She experienced total brood loss 2 days post-hatch. The remaining 4 females carried their transmitters throughout brood rearing and raised broods to ≥6 weeks of age. Mean brood sizes for 14-, 30-, and 42-day intervals were 3.7 (n = 10), 3.2 (n = 10), and 3.2 ducklings (n = 11), respectively.

1. Brood Survival

Within the 30 d PH interval, 10 broods sustained partial loss, 1 total loss, and 4 were never relocated and were presumed dead. For only 1 clutch did all eggs hatch (n = 7) and all ducklings survive to fledging. Overall brood survival was 68.0% (95% CI: 65.6 - 70.4%).

2. Brood Movement

Data from 11 radio-tagged females were used to document brood movements (Fig. 11). Although 6 females lost their transmitters, all were located each interval. Mean maximum distances moved from the nest by a brood at 14 d PH, 30 d PH, and 42 d PH intervals were 0.8 km (n = 10), 1.1 km (n = 10), and 0.8 km (n = 11), respectively. Greatest distance moved from a nest was 3.1 km (female with 7 ducklings). Mean distances moved between intervals were 0.7 km and 0.5 km, respectively.

O. Brood Observations

Two hundred and seventy-seven hours and 33 minutes were spent in towers recording 174 1-hour focal brood observations between 26 June and 15 August. Twenty-two observations were terminated due to brood visibility problems. Three towers were used, including 2 in high density (west and center) and 1 in low density (east) brood-rearing areas (Fig. 11). An average of 4 (0-13) and 5 (0-12) spectacled eider broods were seen around the west tower and center tower, respectively, during focal sampling. A mean of 3 (0-8) broods were seen at the east tower.

1. Gull Predation

During 174 observation periods, 8 glaucous gull swoops over spectacled eider broods were observed. Also, a female spectacled eider "bluff charged" an adult glaucous gull feeding its chicks; and on another occasion, an adult glaucous gull chased off a spectacled eider brood resting close to the gull's nest site. The only "serious" gull attack involved a glaucous gull flying into an eider brood. The adult female eider pulled the gull into the water as it tried to escape, and pecked at it. A greater scaup *(Aythya marila)* female also joined in. A second glaucous gull flew in but quickly flew off. The female spectacled eider continued to peck the gull until it escaped. There were approximately 10 individual glaucous gull "swoops" or threats observed on spectacled eider broods, usually resulting in the brood quickly grouping together near the female in open water. Females also reared, flapped wings, and occasionally pecked at gulls that flew too close. When a gull chick learning to fly landed close to a spectacled eider brood, the attending female eider chased it and continued to peck at it until it submerged and could not fly off. Four adult glaucous gulls flew toward them and the eider female withdrew, allowing the chick to swim back to the colony.

Several other "swoops/threats" due to human disturbance were observed. Walking through a glaucous gull colony normally caused eider broods to swim to open water even if they had been on land. Gulls would take flight and swoop at retreating broods.

Without human disturbances, however, spectacled eiders usually kept their distance from gulls when in a colony. On occasion eiders swam or fed very close to gulls without much obvious alarm.

2. Marked Brood Observations

Eighty-five observations of nasal-marked females were recorded during tower focal sampling. Six different females accounted for 56 of the observations. The marked female could not be identified in the remaining 29 observations. Six additional females with broods were individually identified incidentally, but were not observed during focal sampling. Broods (8 of 12) generally remained in the same areas throughout brood-rearing. The same brood was observed a mean of 3.2 times (1-7, n = 12 broods). One brood was observed near the west tower at the beginning of the brood-rearing period (2-8 July), then near the center tower at the end of brood-rearing (2-12 August). Mean brood size of marked broods was 3.8 (class II, n =19 observations) and 2.1 ducklings (class III, n = 6 resightings).

F. Fall Migration

Flocks of common eider males in full breeding and partial eclipse plumage were observed flying along the southwest coast and rafting just offshore beginning approximately 8 June. Most spectacled and common eider males departed between 17-18 June. The last spectacled and common eider males were seen 23 and 18 June, respectively. Spectacled eider females and broods began dispersing from the brood-rearing areas between 9-10 August.

V. DISCUSSION

A. Nesting

Clutch size and nest success for spectacled and common eiders on Kigigak Island in 1993 decreased from 1992. Several factors may have contributed to the decrease. Unlike 1992 when fox were eliminated, the presences of ≥ 2 fox may have increased nest depredation. Fall storm surges in 1992 flattened or damaged vegetation, possibly decreasing suitable nest cover. Five pairs of parasitic jaegers *(Stercorarius parasiticus)* nested on the island and 1 instance spectacled eider nest depredation was observed. Increased camp personnel may have also caused more disturbance.

Dau (1976b) suggested that spectacled eiders have a homing instinct to return to the same nesting sites each year. Our small sample size showed some evidence of this. Six recaptured females nested within a mean of 165 m of their 1992 nest sites. Five other females reared broods in the same areas as 1992 and 4 females captured and marked with broods in 1992 were also found nesting on the island.

Immature (yearling) spectacled eiders were also present on the island. Kistchinski and Flint (1974) mentioned that on rare occasions they "observed and collected small, light females that were probably yearlings." Observation of a yearling female, banded as a duckling in 1992, indicates that juveniles may visit their natal area.

Flocks of 10-15 presumably non-breeding and unsuccessful females were seen within and outside brood-rearing areas through July. Kistchinski and Flint (1974) also observed non-breeding and unsuccessful females remaining through July. Females may stay to fulfill dietary requirements needed for migration to molting area.

B. Brood Observations

During undisturbed observation periods, few glaucous gull-eider or other predator-eider encounters occurred. After a disturbance (usually human), however, glaucous gull encounters with spectacled eider broods increased. Several glaucous gull dives were witnessed during or after a disturbance. Keller (1991) stated that the mean number of predator encounters was about 4-5 times higher after disturbance than before. He observed "after a disturbance 8 interrupted attacks and 2 unsuccessful attacks." Though no successful attacks on spectacled eiders were witnessed on Kigigak during 1993 focal sampling, 1 common eider duckling was incidentally observed being picked up and then released by a glaucous gull. Keller (1991) witnessed 2 successful attacks on common eider creches in Ythan Estuary in Scotland. The attacks were due to human disturbance, where ducklings were straggling and lost contact with their creches, which had fled to water. Single gull attacks or threats were observed in both Keller's studies and our own. Attacks/threats involving multiple gulls were rare even with a human disturbance. Keller also stated that disturbance affected eider creche activity for up to 35 minutes.

C. Brood Survival

Duckling mortality also appears heaviest within the first 2 weeks after hatch in other species (Ball et al. 1975, Mickelson 1975, Swennen 1989, Orthmeyer and Ball 1990, Grand and Flint 1992, Rotella and Ratti 1992). Mendenhall and Milne (1985) reported that common eider ducklings were most vulnerable to predation during the first 2 to 3 weeks of life. Similarly for Kigigak in 1993, telemetry data showed that 13 of 16 broods lost ≥ 1 duckling within 14 d PH and the only attack witnessed was on a brood 14-18 d PH. In contrast, females (n = 3 occasions) left nearly fledged broods and flew to nearby lakes or out of sight of the observer. Glaucous gulls never harassed the unattended brood. Females usually returned within 15-20 minutes.

Predation and/or other obstacles encountered during travel to brood-rearing areas are suspected as main sources of duckling mortality.

Different data gathering procedures in 1992 (visual) and 1993 (telemetry) produced similar brood survival estimates: 63% in 1992, 68% in 1993. These are conservative estimates because: 1) females not relocated after hatch were assumed to have lost their entire brood and 2) number of egg shell membranes determined brood size.

D. Brood Movement

Petersen (1993) recorded movement of 14 km to upland areas at the Hock Slough study area. From telemetry data, it appeared all (n = 13) spectacled eider broods Kigigak Island remained on the island throughout brood-rearing. However, no signals were received from 4 radio-tagged females and they may have left the island. Most broods on Kigigak remained in intermediate/grassflat habitats. One brood, however, spent almost the entire time on an upland lake (camp lake) and surrounding ponds. Another brood was consistently seen in an intermediate lake system, consisting of a large mew gull *(L. canus)* colony, 50 m north of camp.

VI. CONCLUSION

The Yukon-Kuskokwim Delta (YKD) spectacled eider population and has been listed as a threatened species. According to Stehn (1993), if the population continues to decline at an annual rate of 14%, there will be fewer than 90 nests on the YKD by 2012. Continuing to report annual nest success and brood survival data may assist development of population models designed to identify causes of species decline. It is equally important to conduct these studies at different field sites since Hock Slough and Kigigak Island differ in habitat, gull densities, and nest success estimates. Impact of arctic fox on nesting Kigigak Island eiders remains unquantified and requires additional research.

Although brood observations have shown minimal predation, impact of broods traveling to brood-rearing areas on duckling mortality remains unknown. The contribution of duckling mortality to the population decline remains unknown.

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APPENDIX A

Trapping and Marking Spectacled Eiders

Objectives identified by the Spectacled Eider Recovery Team indicate that continued trapping and marking of spectacled eiders is necessary. Harwood and Moran's 1992 report detailed processes, difficulties, impressions, and tips in trapping and marking spectacled eiders. Presented here are difficulties, improvements, and additional processes from the 1993 field season.

I. Nest Trapping

Bowtrap construction, setting, spring, and results were similar to 1992 (Harwood and Moran 1992). We found that using new springs improved the efficiency of the bowtrap. Setting traps and returning later was also found to be more efficient than the 1992 procedure. They were still effective and less bulky near the eiders head, however.

Two of the 52 trapped females damaged 1 of 6 and 2 of 6 eggs from their clutches. A "baggier" net reduce egg damage from 1992 (Harwood and Moran 1992). Time limitations caused most nests to be trapped closer to hatch than the optimum period of 2-5 days pre-hatch. Nest trapping should have started earlier to avoid this problem.

Anesthetizing females again proved troublesome. Five females were not anesthetized because one bottle of methoxyflurane was inert. Females went under faster with a quart size zip-lock bag and less air entering the bag. If the females were not going under, we allowed them fresh air every 2-3 minutes, to avoid suffocation. Recovery behavior was similar to 1992. Though no nest desertion was positively attributed to trapping activities, 2 nests were depredated subsequent to trapping.

The 1993 trapping season included 2 unusual situations. One female was trapped on her depredated empty nest. Another female permitted close approach and was trapped on her nest by simply dropping the net over her. Eggs were 5 days from hatch, were not damaged, and all 6 subsequently hatched.

II. Transmitters

According to AFWRC personnel, too conservative super-glue application allowed female eiders to pull off radio-transmitters. A "clump" of feathers still glued to retrieved transmitters was always found.

Thirteen females were known to have lost transmitters during the monitoring period (11 June-15 August). Two were lost at the nest bowl, though only 1 was placed on another female. For 2 of the 11 females which still had transmitters after hatch, there was information on neither the bird nor the transmitter. Six transmitters were found and 7 birds were seen with no transmitters. Four females kept their transmitters throughout the brood-rearing period. The majority of the transmitters fell off or were pulled off within 28 d PH.

III. Resightings

Nasal tags applied to females in 1992 allowed us to identify individuals before nesting. Colors observed and listed in order of visibility were white, yellow, orange, tan, blue, green, and purple. Tag shape was usually identified first. Depending on the color's condition, the bird would then be identified. With a white background especially snow, the nasal tag could be detected up to 100 m away. Nasal tag fading/discoloration sometimes confused observerations. In the case of 2 square tags (red and blue), the area towards the tag center was faded with the original color remaining around the outside. Tan discolored the least. White was not observed in hand because tags fell off before recapturing the female. Color fading also varied between individual tags. If discoloration was severe, observations with a 60X spotting scope could not be made at distances greater than 70 m. From a distance of 20 m, color could not be determined for a severly faded tag.

Early in initiation or incubation, the best way to determine if a bird is banded was to observe her legs as she flushed from the nest. Nasal tags are difficult to see at this time because females flush at greater distances than later in incubation. Though the new style yellow circle nasal disks will be visible, numbers are very small and hard to read and may present a problem identifying the female if a nest is abandoned or depredated before the next visit. Reading numbered nasal tags from towers was also difficult at distances $\geq$40 m.

Recaptured birds all showed signs of nasal wear. The wire caused nares to be wider and more conspicuous than for unmarked females. This could be the result of an enlargement of the nares themselves, or a deterioration of the internasal septum. A few of these birds had a bump on the maxilla above the nares. While the wire is curved to the shape of the nares to provide a snug fit for the nasal tag on the bill, the curvature may be rubbing against the maxilla, causing inflammation or deformation. The square nasal tag, which was hardest to fit, caused extreme local feather wear at the base of the bill. The tag's loose fit was the probable cause. Another square tag was pulled off a female by the net during trapping process. The net apparently pulled off the a tag. Three, possibly 5, females lost nasal tags over the winter. Another bird lost one between arrival and incubation. Loose fitting or improper crimping may have been the cause.

APPENDIX B

Spectacled Eider Brood Observations

Brood visibility was one of the most challenging aspects of the study. Many broods were lost from sight due to high slough banks or tall grass. Other, broods probably went undetected due to these obstacles. Observations were terminated once the observer was unsure of a brood's location.

Placing observation towers in traditional brood-rearing areas maximized the probability of brood presence. These areas were also glaucous gull colonies, both large (>20 nests) and small (<6 nests). Few attacks were observed because most mortality occurred within 14 days post-hatch and most broods observed were ≥10 days old. Observations during travel are difficult to observe because broods are well hidden in grass or small ponds and females "slink" through open grass areas. Keeping them in view for an extended period of time is difficult. There is also a large area to observe. Many more towers would need to be set up to get an adequate sample.

Table 1. Number of spectacled eider and common eider nests, Kigigak Island plots, 1993.

Method	Plot Number	Spectacled eider	Common eider
Eider	1	1	0
	2	0	0
	3	0	0
	4	4	2
	5	2	2
	6	3	1
	7	3	1
	8	2	1
	9	1	2
	10	5	2
	11	5	3
	12	2	0
	13	4	4
	14	3	1
	15	6	3
	16	4	2
	17	2	4
	18	0	3
	19	3	2
	20	1	1
	21	0	10
	22	1	2
	23	0	5
	24	2	4
	25	0	0
	26	5	1
	27	1	2
	28	1	0
	29	1	0
Subtotal	29	62	58
Goose Production	27	0	0
	105	0	2
	108	0	1
	131	0	0
	132	1	1
Subtotal	5	1	4
Incidental		12	16
Total		75	78

Table 2. Eider complete clutch size frequencies, Kigigak Island, 1993.

	Clutch Size									
Species	1	2	3	4	5	6	7	8	9	10
Spectacled Eider (n=74)[a]	0	1	6	8	26	28	4	1	0	0
Common Eider (n=69)[b]	1[c]	2	3	13	24	20	6	0	0	0

[a] One nest omitted due to probable human disturbance during laying.
[b] Nine nests ommitted due to probable human disturbance during laying.
[c] Nest found late, rest of clutch may have been depredated.

Table 3. Eider clutch size averages[a], Kigigak Island, 1993.

	Spectacled Eider			Common Eider		
Category	$\bar{x}$	n	SE	$\bar{x}$	n	SE
Mean clutch size laid						
All nests	5.0	69	1.2	5.2	74	1.1
Successful nests	5.2	58	1.2	5.3	47	1.0
Mean clutch size hatched						
All nests	2.8	66	2.2	3.3	74	2.2
Successful nests	3.9	58	1.7	4.2	47	1.6

[a] Data from nests with unknown fates or whose fates may have been influenced by visitor impact were eliminated. Eggs with unknown fates were considered unhatched.

Table 4. Eider nest success, Kigigak Island, 1991-1993.

Method	Spectacled Eider			Common Eider		
	1991	1992	1993	1991	1992	1993
MAYDATE[a]						
Total nests	21	64	74	34	94	72
Exposure (days)	157.5	1043	1025	259	1647.5	972
Nests failed	8	3	16	18	8	26
Daily survival rate	0.9492	0.9971	0.9844	0.9305	0.9951	0.9733
% Successful	22.1	92.0	63.4	13.3	87.3	46.8
95% CI	7.4-63.0	83.5-101.2	50.4-79.5	5.1-33.9	79.2-96.1	34.7-62.9
SURVBR[b]						
Daily survival rate	0.9490	0.9971	0.9832	0.9301	0.9947	0.9745
% Successful	22.0	92.0	61.3	13.2	86.1	48.5
Apparent						
Total nests	23	64	75	42	91	74
Nests hatched	14	60	58	18	81	47
Nests failed	9	4	17	24	10	27
% Successful	60.9	93.8	77.3	42.9	89.0	64.8

[a]MAYDATES is a dBase program that calculates 95% confidence intervals and Mayfield nest success estimates (Grand and Flint 1993).

[b]SURVBR is a dBase program that calculates 95% confidence intervals and Bart and Robson maximum likelihood estimates (Grand and Flint 1993).

Table 5. Hatching success and fates of eider eggs, Kigigak Island, 1993.

	Spectacled Eider	Common Eider
Egg Hatching Success (all nests)		
Total nests	75	78
Eggs laid	350	319
Eggs hatched	243	185
Maximum % hatched	69.4	58.0
Egg Hatching Success (successful nests)		
Total nests	58	47
Eggs laid	306	245
Eggs hatched	243	185
Maximum % hatched	79.4	75.5
Egg Fates		
Laid[a]	390	374
Hatched	243	185
Unhatched	111	134
Depredated	88[b]	108
Abandoned (natural causes)	8	17
Abandoned (human induced)	0	0
Addled	10	8
Runt	1	1
Damaged (visitor/trap)	4	-
Unknown	36	55

[a] Number of eggs laid is larger than number used in egg hatching success calculation because eggs from nests whose fates were unknown or influenced by visitor impact were not used.

[b] Eleven eggs (2 nests) were depredated subsequent to trapping. The disturbance may have attracted predators and/or caused females to abandon their nests.

Table 6. Measurements of 52 nest-trapped adult female spectacled eiders, Kigigak Island 1993.

Measurement	Mean	SE	Range
Weight (g)	1191	102.4	1000 - 1425
Wing (mm)	255.39	7.3	234.6 - 272.2
Culmen (mm)	25.75	1.9	20.6 - 29.1
Tarsus (mm)	57.10	1.9	53.4 - 60.7

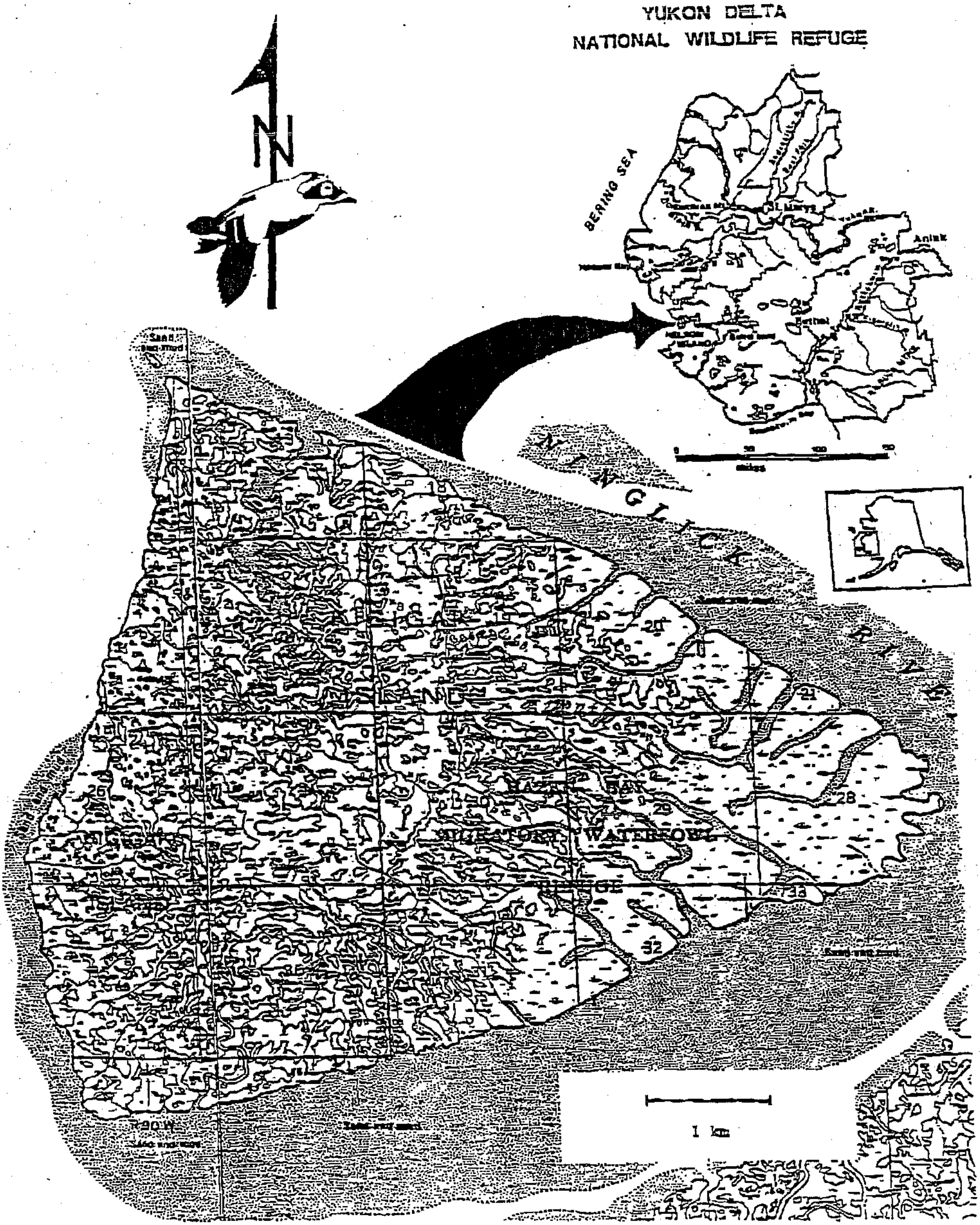
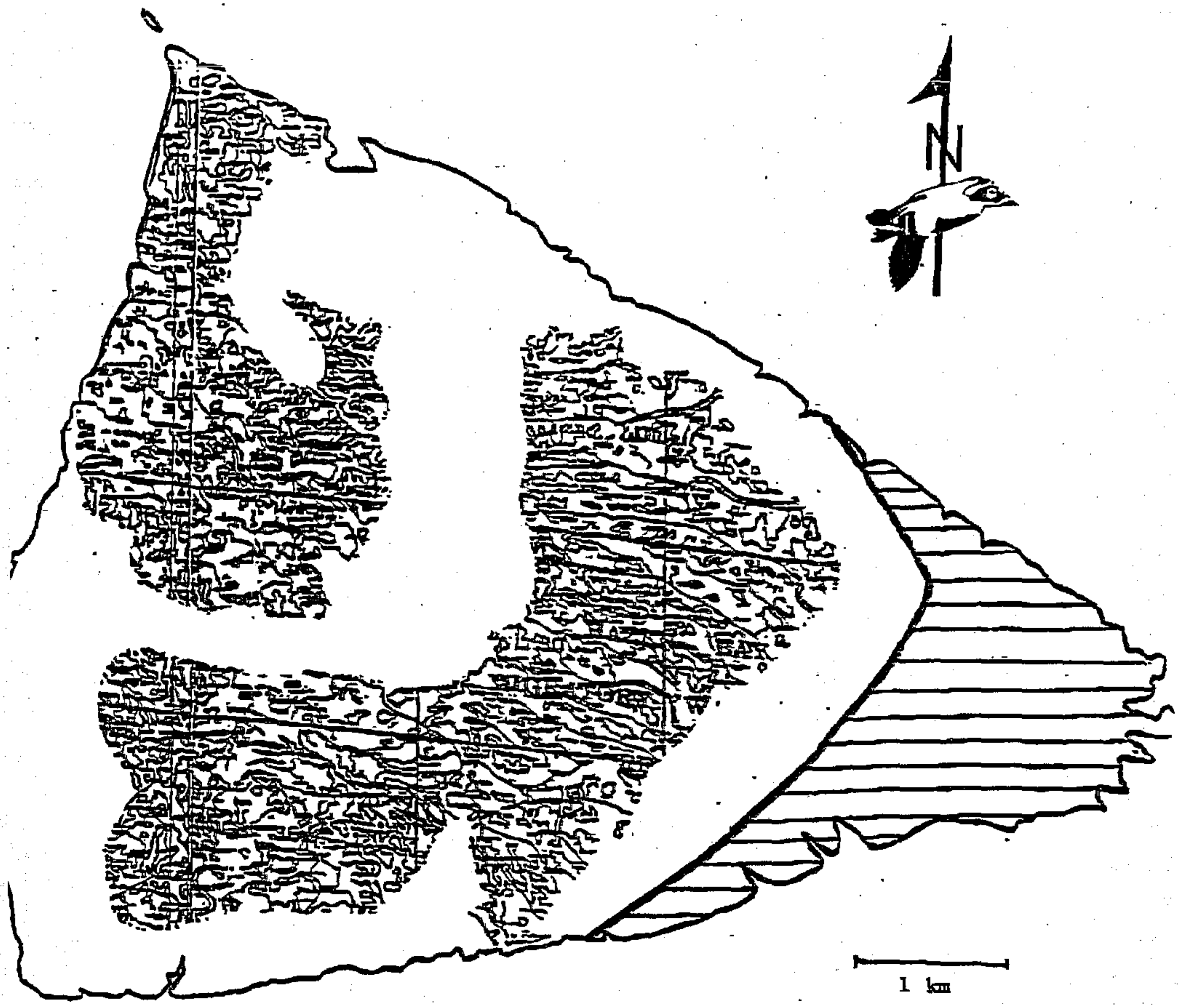


Figure 1. Kigigak Island, YDNWR, Alaska.



Topographic area = spectacled eider nesting areas

Blank area = spectacled eider non-nesting areas

Striped area = off study area

Figure 2. Kigigak Island stratified for spectacled eider nesting habitat, 1993.

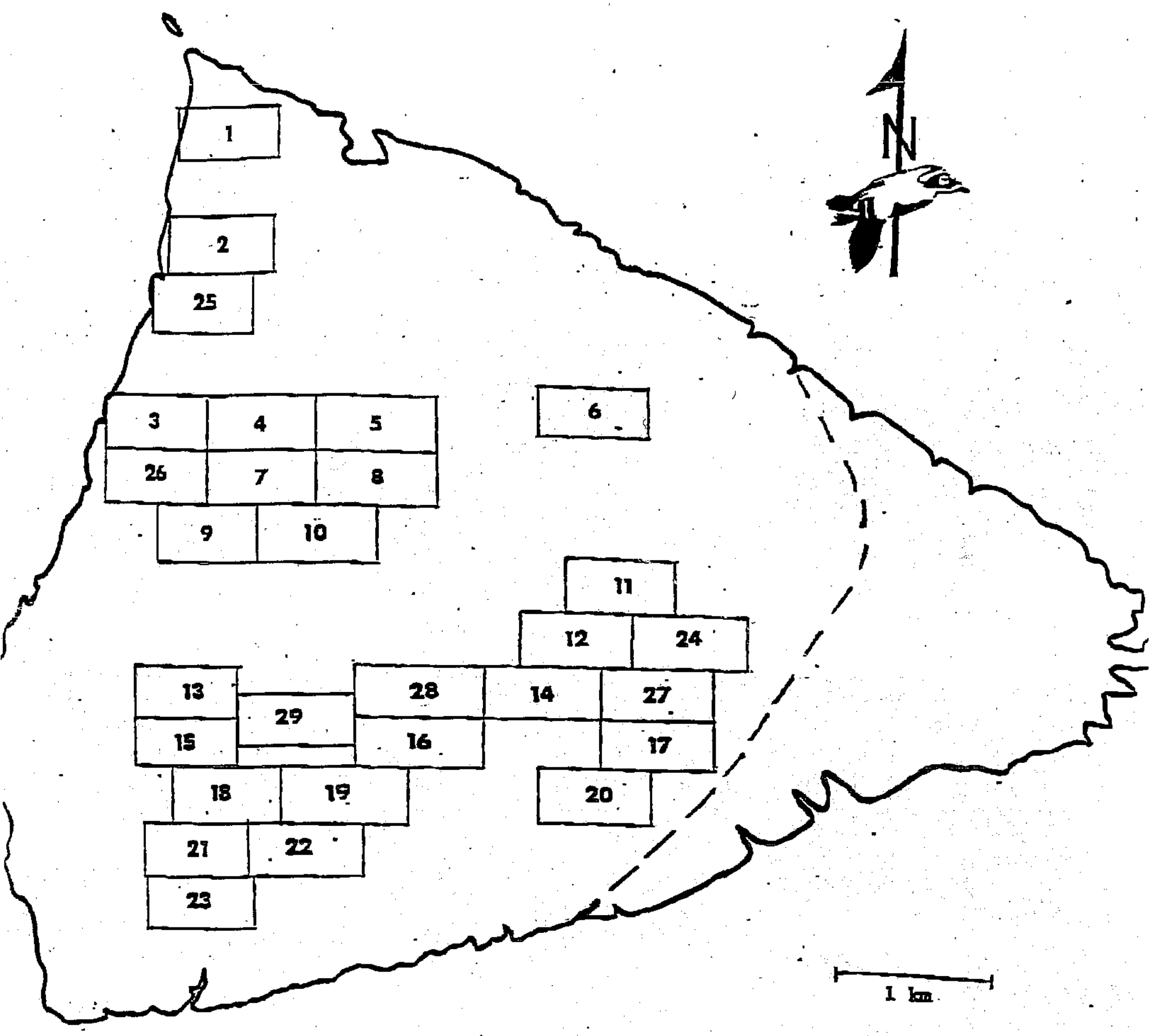
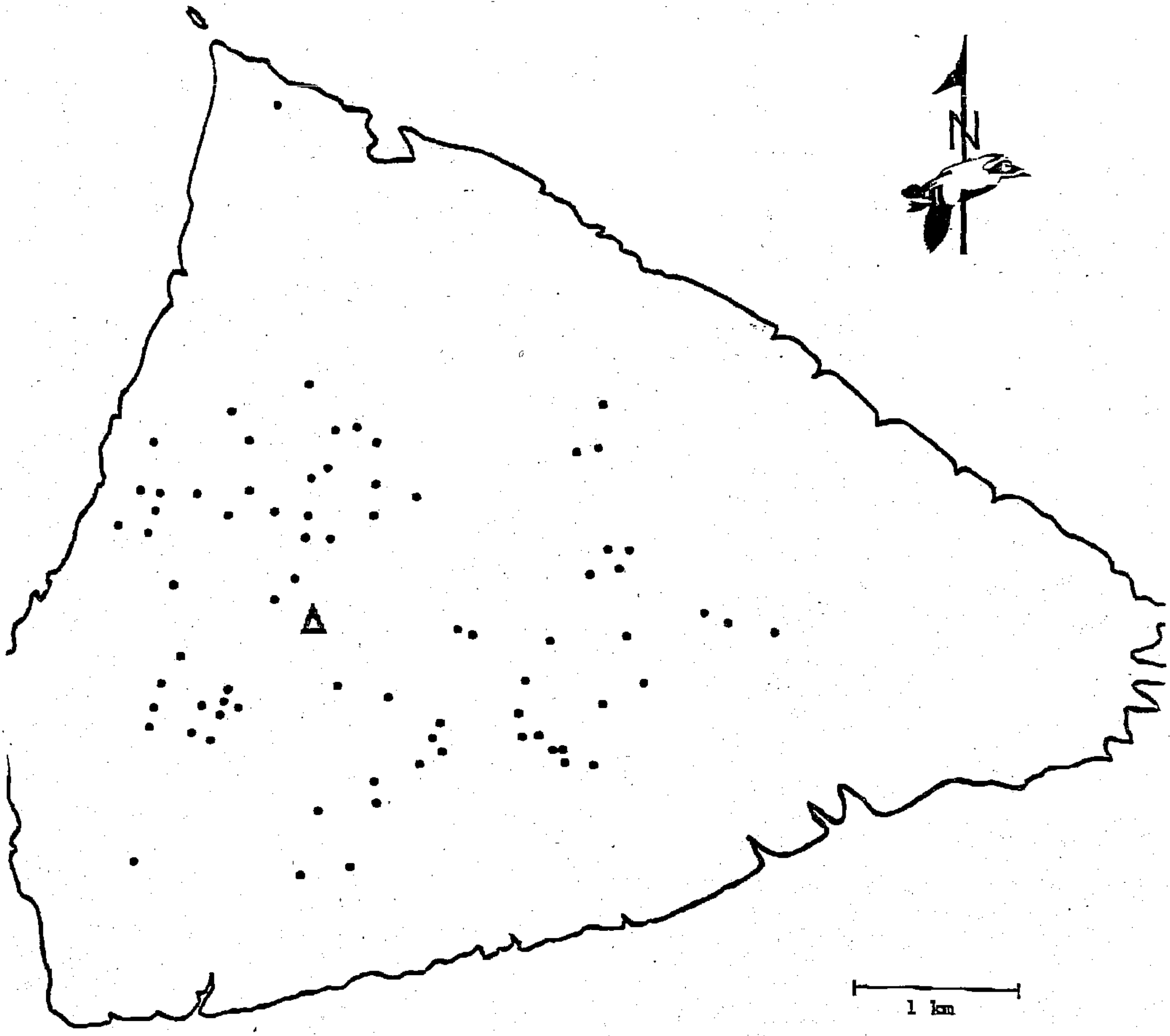


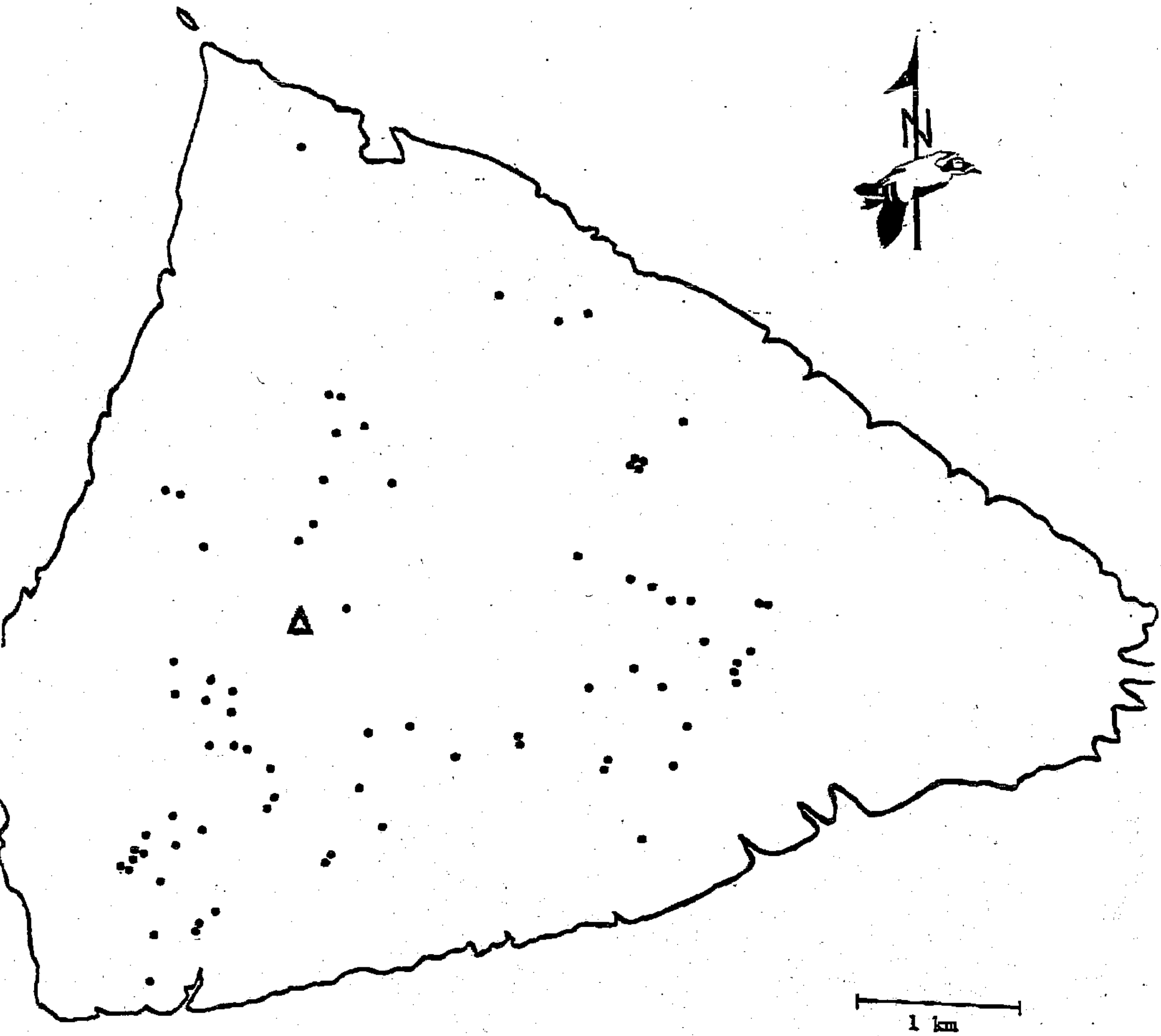
Figure 3. Distribution of eider nesting plots, Kigigak Island, 1993.



• Spectacled eider nest

Δ Camp location

Figure 4. Locations of spectacled eider nests found on Kigigak Island, 1993.



• Common eider nest

Δ Camp Location

Figure 5. Locations of common eider nests found on Kigigak Island, 1993.

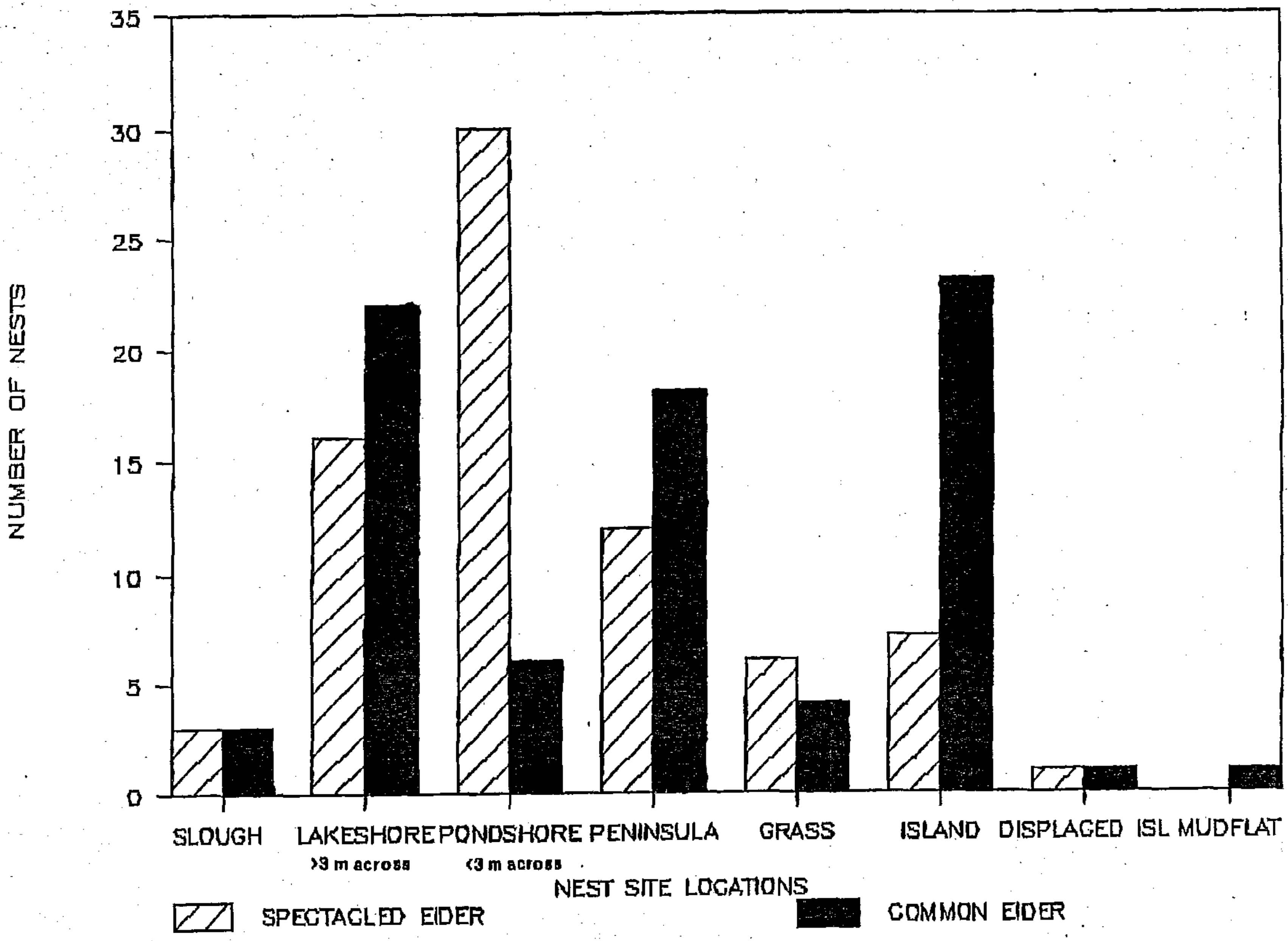


Figure 6. Frequencies of eider nest site selections, Kigigak Island, 1993.

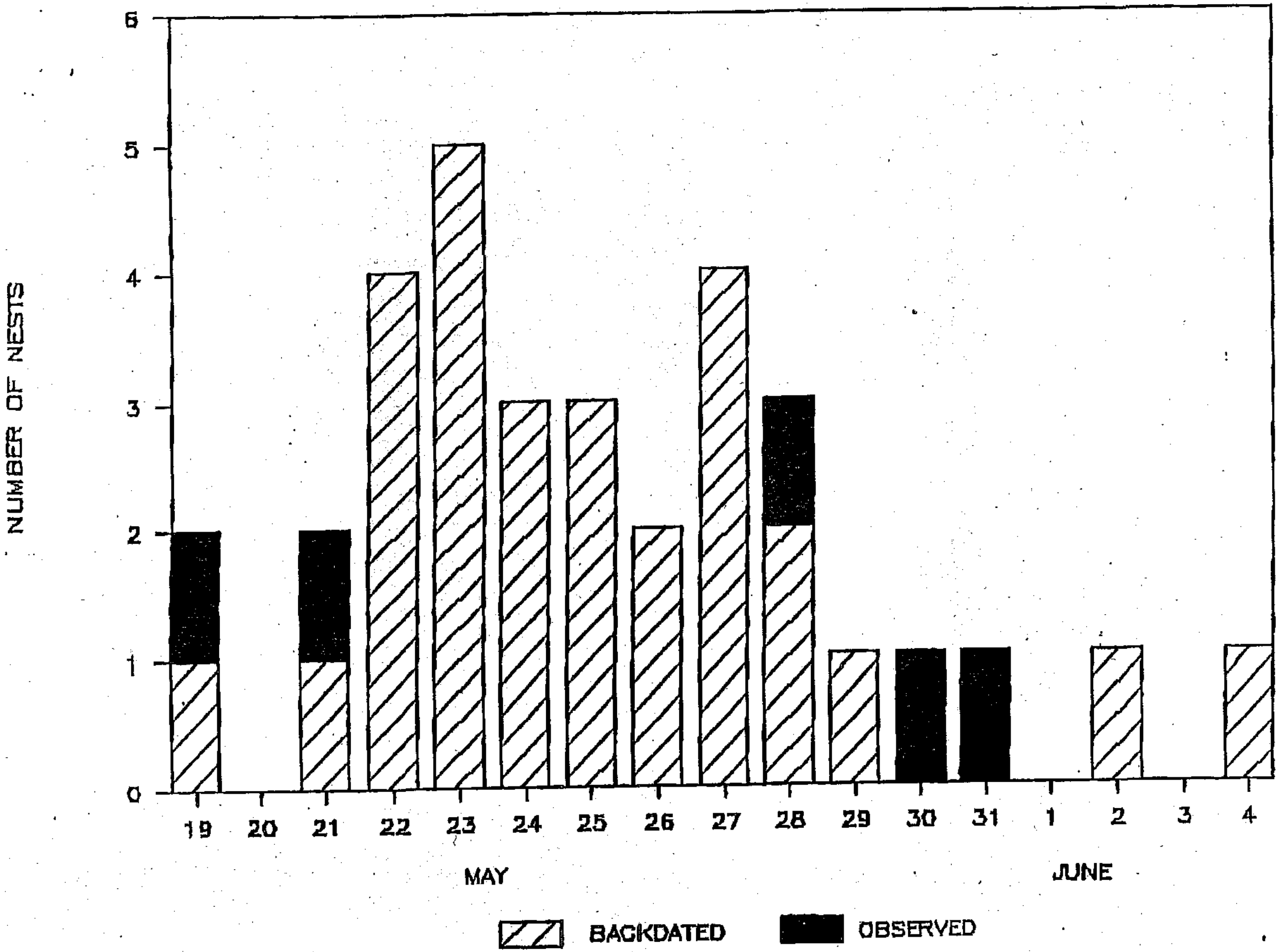


Figure 7. Nest initiation dates for spectacled eiders, including both observed and those backdated from known hatch dates, Kigigak Island, 1993.

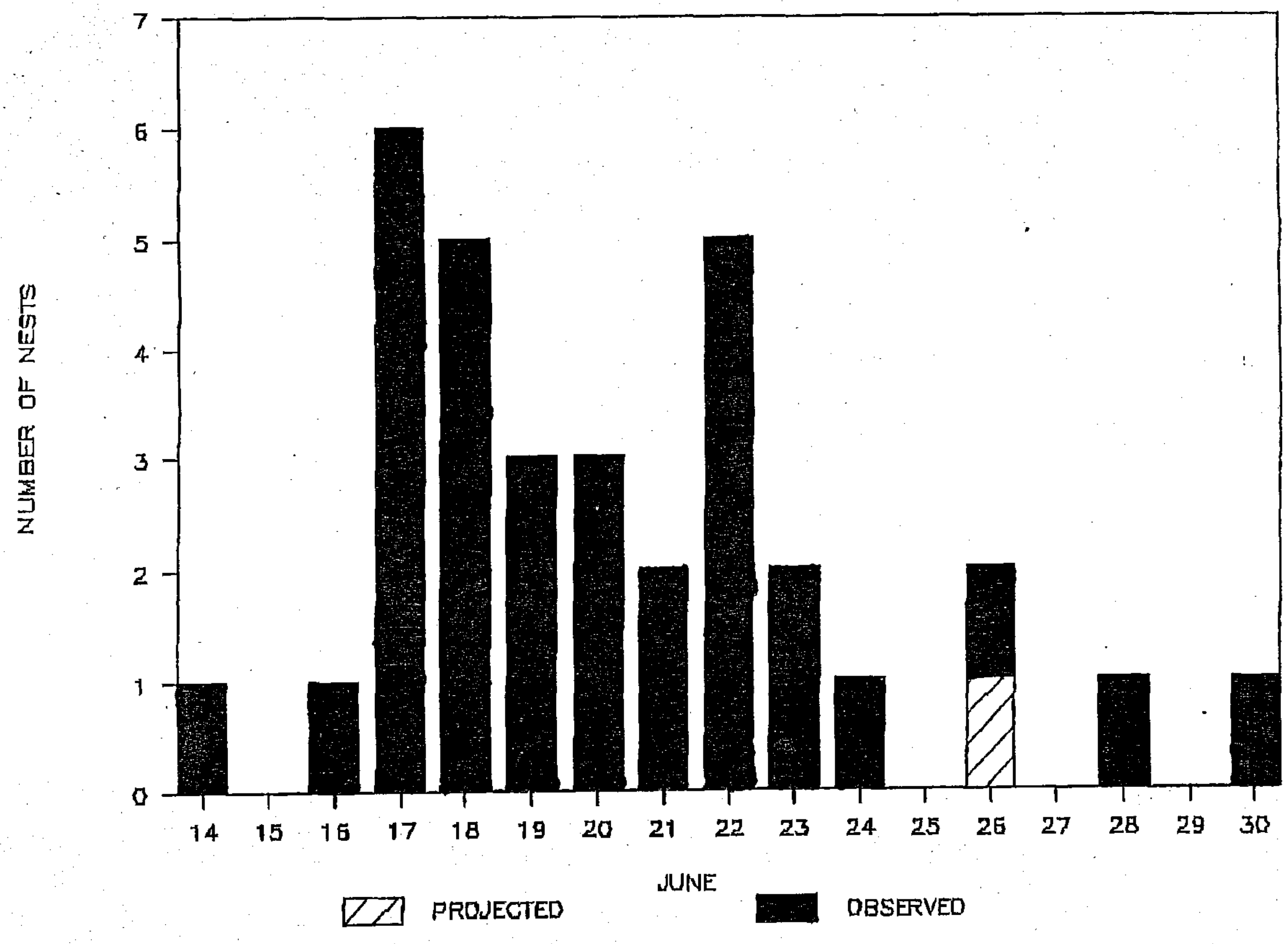


Figure 8. Hatch dates for spectacled eiders, including both observed and those projected from known initiation dates, Kigigak Island, 1993.

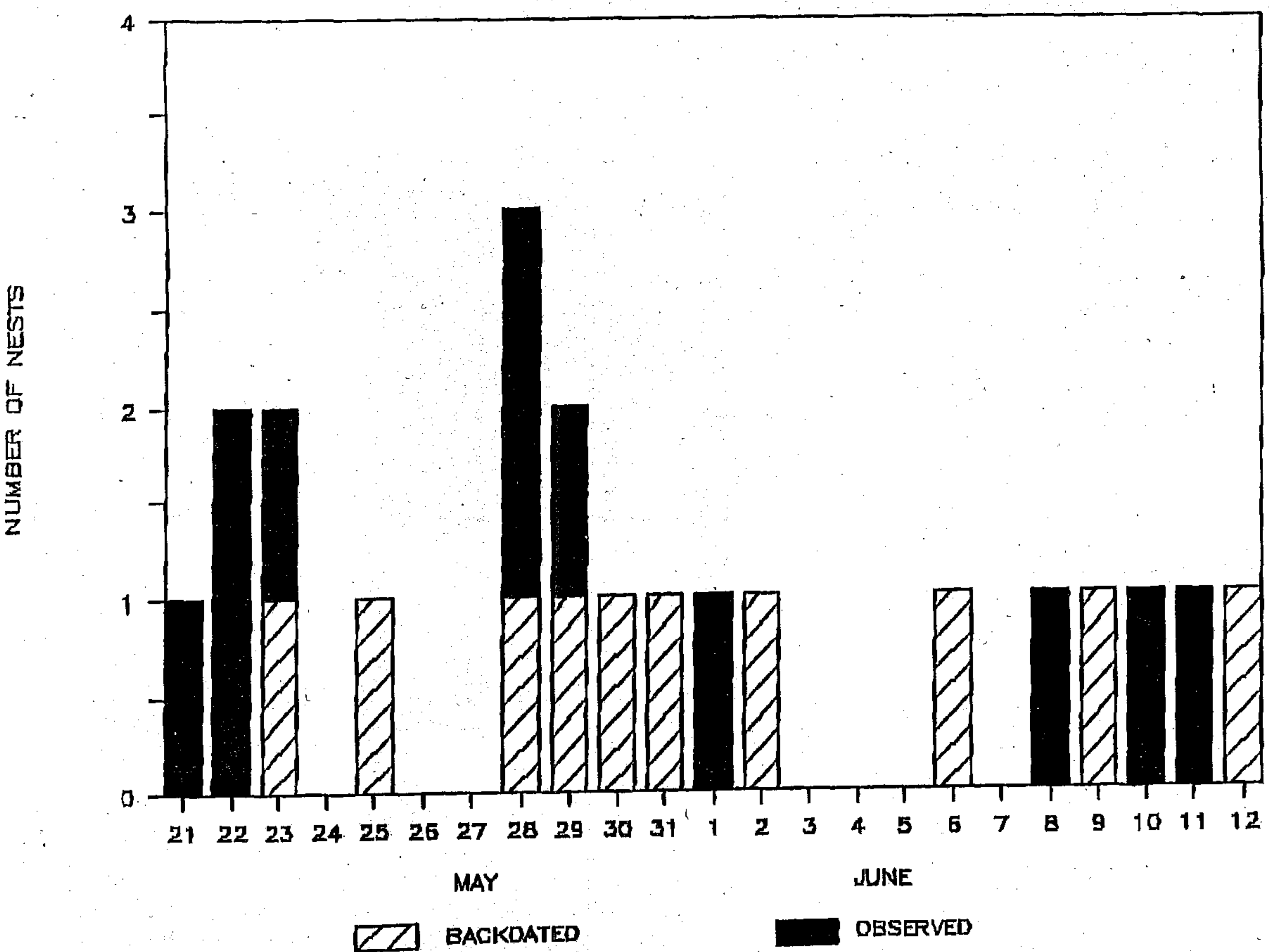
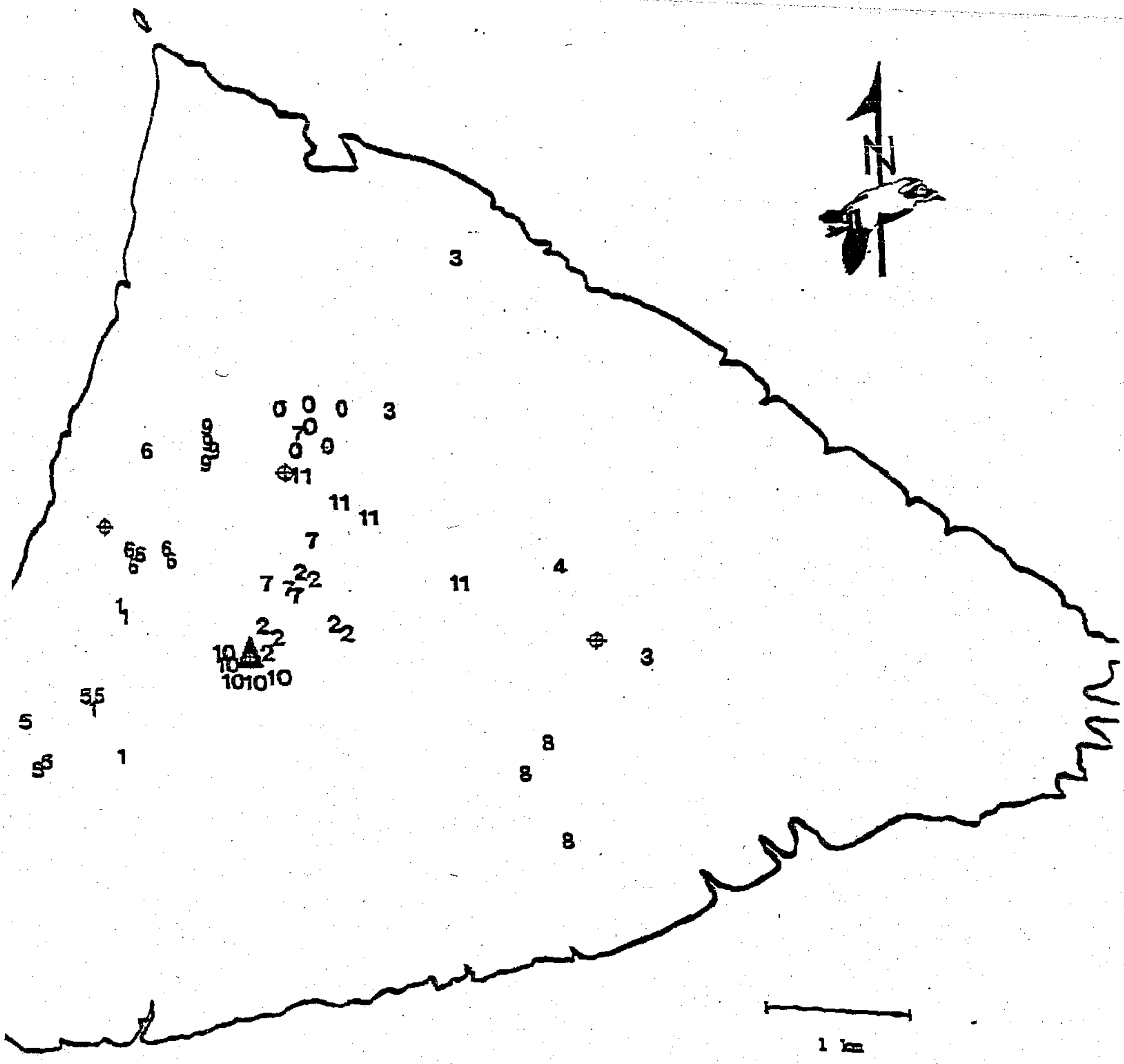


Figure 9. Nest initiation dates for common eiders, including both observed and those backdated from known hatch dates, Kigigak Island, 1993.



\# = Visual locations of broods

⊕ = Tower location

▲ = Camp / tower location

Figure 11. Visual locations of broods on Kigigak Island, 1993.