WATERFOWL AND FOX ECOLOGY
AT KOKECHIK BAY, ALASKA

- a status report of the 1988 field season

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Key Words

Kokechik Bay	brood surveys
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INTRODUCTION

In terms of abundance and species diversity, Kokechik Bay is a unique goose nesting area on Yukon Delta National Wildlife Refuge (YDNWR). The largest colony of black brant (*Branta bernicla nigricans*) on the refuge is located there and the densities of cackling Canada geese (*B. canadensis minima*) and emperor geese (*Chen canagica*) are the highest for 16 geographical strata on the coastal delta (Stehn 1986). Pacific greater white-fronted geese (*Anser albifrons frontalis*) are also present in limited numbers. Kokechik Bay has been the location of previous ecological investigations of geese (Eisenhauer and Kirkpatrick 1977, Garrett et al. 1983, Scanlon and Jarvis 1984, Garrett and Wege 1985, Petersen 1987) and vegetation patterns (Jackson 1981). Most recently, the Alaska Fish and Wildlife Research Center (AFWRC) has studied the relationship between arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*) predation and goose productivity (Anthony et al. 1987). As a result, the data set for this area spans one of the largest number of years for any region on the Yukon-Kuskokwim delta (Y-K delta), and its importance lies in the historical perspective it provides to future management strategies. For these reasons, as well as in response to requests by native groups and resource agencies within the Pacific Flyway, YDNWR initiated an ecological study in 1988 of waterfowl and their predators at Kokechik Bay.

Objectives

The objectives of this study are:

1. To monitor annual productivity of black brant, cackling Canada geese, emperor geese, and greater white-fronted geese

2. To document arctic and red fox abundance, territory size, den sites, productivity, and impact on waterfowl productivity

3. To assist AFWRC in the evaluation of remote sensing of brant colonies by aerial photography and video imagery.

Study Area

Kokechik Bay is located on the western coast of the Y-K delta and is separated from the Bering Sea by Panowat Spit and Aniktun Island (Fig. 1). Several rivers, including the Kokechik, Kolomak, and Lithkealik, empty into the eastern end of the bay. Immediately north are the Askinuk Mountains, which rise 714 m above sea level. Extensive mudflats on the south shore of Kokechik Bay grade into a low coastal plain that extends 1-5 km south. This study area lies at an elevation of <6 m above sea level and contains numerous shallow lakes and ponds. At the southern boundary of the coastal plain, a bluff rises 20-25 m to rolling, upland tundra. The tundra extends 8-12 km south to Hooper Bay. Permafrost underlies the area to a depth of 70-100 m (Eisenhauer 1976).

Several geobotanical zones occur within the coastal plain (Jackson 1981, Anthony et al. 1987). Immediately adjacent to Kokechik Bay, tidal sloughs and mudflats are separated by a short sedge meadow, dominated by Carex ramenskii, lyme grass (Elymus arenarius), Puccinellia phryganodes, and Pacific silverweed (Potentilla egedii). As the terrain rises above the mean high tide line, a grass-sedge meadow, dominated by rare-flowered sedge (C. rariflora), clustered sedge (C. glareosa), P. phryganodes, and Poa lanata, becomes the primary vegetation type. Low and high pingo communities, separated by grass-sedge meadows, provide the greatest relief on the coastal plain. Both pingo communities are dominated by lichens, mosses, and dwarf shrubs such as crowberry (Empetrum nigrum), Alaska bog willow (Salix fuscescens), and dwarf arctic birch (Betula nana). Tall sedge marsh, dominated by Lyngbye sedge (C. lyngbyaei), occupies the poorly drained area between the pingos and the bluff. Artesian marsh, Hippurus sp. marsh, and Elymus sp. meadow communities occupy small portions of the coastal plain. The north-facing bluff is dominated by low shrubs of Richardson's willow (S. pulchra) and Alaska spiraea (Spiraea beauvardiana) with an understory of spinulose shield fern (Dryopteris dialatata), grasses, and numerous herbaceous species. The upland tundra zone consists of moss-lichen-dwarf shrub communities.

METHODS

A camp staffed by 2 biological technicians was maintained at Camp Lake (Fig. 2) from 23 May to 3 August 1988. During 13-16 June and 7-17 July, personnel moved to a spike camp at Kokechik West. A third biological technician from AFWRC assisted refuge personnel with the fox portion of the study from 6-18 July.

Weather Observations

Weather conditions were monitored daily at approximately 0900 hrs. A maximum-minimum thermometer recorded daily temperature, and a wind gauge was used to measure wind velocity. Precipitation was collected in a cylindrical rain gauge. When clouds or fog were present, visibility and ceiling were also estimated.

Study Plots, Location, and Search

Twelve study plots were established to measure productivity of brant, cacklers, emperors, and whitefronts (Fig. 2). By the time field work began (23 May), nest initiation had progressed to the point that a prescribed nest visitation schedule (calibration) was precluded (Garrett et al. 1983). Additionally, no secondary plots were established. A total of 5 validation and 7 primary plots were surveyed. Several types of study plots were established (Table 1), including 0.32 km^2 random plots used for the delta-wide goose productivity surveys (Stehn 1986), 30 m wide and 1.6 to 2.0 km transects used for the evaluation of remote sensing of brant colonies by aerial photography, and variable-sized plots established solely for this study. Although the locations of random plots were previously determined, transects and other plot types were systematically located in areas having high concentrations of nesting geese.

Validation plots were surveyed 4-5 times, and primary plots were surveyed 2-3 times. Two validation and 1 primary plot surveys occurred prior to hatch. While the prescription called for only 2 pre-hatch visits to validation plots, an additional survey made in 3 validation plots was conducted to ascertain completion of nest initiation. More than 1 post-hatch visit was made to all validation plots and 1 primary plot to determine the outcome of nests still being incubated during the first post-hatch visit. During the first and second visits to validation plots and the first visit to primary plots, a thorough search was made to find all active and inactive nests. Searches focused on islands, peninsulas, shorelines and meadows. Data were also collected for nests found incidental to plot searches (e.g. while walking between plots, during small mammal trapping, and while conducting observations of arctic fox). Nest data were recorded following prescribed procedures (Wege 1984, Stehn 1986). All sightings of neck-banded geese were recorded.

Nest Initiation

Incubation initiation dates were determined by back-dating from hatch. Incubation periods were assumed to be 23, 26, 24, and 26 days for brant, cacklers, emperors, and whitefronts, respectively. Nest initiation was back-dated from initiation of incubation based on mean incomplete clutch size for each species. It was assumed that 1 egg/day, up to 4 eggs, and then 1 day was skipped for clutches of ≥ 5 eggs (Garrett and Wege 1985).

Clutch Size Determination

Incomplete clutch sizes were calculated on the basis of the most eggs observed during pre-hatch visits to a nest (Garrett et al. 1983). Clutch size means and frequencies were examined in relation to species and nest location.

Hatch Date Determination

Incubation had begun prior to the arrival of personnel on the study area. Exact hatch dates were determined from frequent nest visits during hatch. If eggs were pipped during a nest visit, the hatch date was identified as the following day. The presence of goslings signified that hatch had occurred that day. If hatch occurred between visits, the median date represented hatch when $\geq$2 days separated visits. Projected hatch dates were based on float angle data gathered during incubation. The median date was selected to represent hatch when float angles indicated a range of expected hatch dates.

Nest Success

Nest success was expressed as the percentage of nests that hatched at least 1 egg. The presence of pipping eggs, goslings, or detached membranes and numerous shell fragments in or near a nest indicated hatch. Active nests with unhatched eggs at the last visit were labeled undetermined status. These nests were not used to calculate nest success. Nest success was examined in relation to species, clutch size, nest location, and number of nest visits (i.e. validation vs. primary plots).

Nest Depredation

For depredated nests, the specific predator was identified only when it was seen at the nest. When only signs of a predator were present at the nest (e.g. tracks, scats, or pecked egg shells), the incident was characterized as suspected avian or mammalian depredation. Egg loss occurring with a lack of the above evidence was attributed to unknown predators. Depredation was attributed to human disturbance when the presence of field personnel resulted in egg loss to jaegars (*Stercorarius* spp.) or gulls (*Larus* spp.).

Subsistence Activities

Subsistence activities within the study area were monitored to identify the amount and area of impact. No contact was made with individuals engaged in these activities.

Brood Surveys

Brood surveys were conducted along mudflats and tidal sedge flats adjacent to Kokechik Bay. Additional observations were made opportunistically (e.g. during nest visits or small mammal trapping). The number of goslings in each brood were counted and categorized according to age (Class I, II, and III) as described by Bellrose (1976). Mean brood size was summarized weekly by species and age class.

Fox Ecology

During late April, arctic fox with active radio collars were recaptured and fitted with new radio collars by M. Anthony (AFWRC). Additional fox were captured between 7-17 July and fitted with radio collars and/or numbered ear-tags according to procedures describe by Anthony et al. (1987). Kits were marked with numbered ear-tags and colored ear markers that identified natal den site. Remote-controlled kit traps, developed by M. Wotawa (AFWRC), were field tested during July trapping.

Radio-collared fox were located during aerial and ground surveys using a Telonics model TR-2/TS-1 receiver and Telonics model RA-2A directional H antennas. Aerial surveys from a Cessna 185 or 206 were conducted along 3, 23 km east/west transects (coast, bluff, and mid-study area) at altitudes of 200-500 m. Locations were plotted on 1:63,000 USGS quad maps. Ground surveys were conducted from the bluff, high pingos, and from 2, 4 m wooden towers located near Camp Lake and Kokechik West. The antenna was held aloft by 1 observer, while the second observer monitored the receiver. Date, time, frequency number, and the azimuth to the signal were recorded. When fox were located near towers, visual observations were made using a Bausch and Lomb 15-60X spotting scope.

Den sites identified in previous years (Anthony et al.1987) were visited to determine their current status. Unmapped dens were also investigated and mapped. Active dens were observed from towers or natural vantage points to document behavior of adults and kits.

Small Mammal Abundance

Small mammal capture rates were used to calculate indices of abundance. Two, 135 m transects were randomly located in each of 5 geobotanical zones described by Eisenhauer and Kirkpatrick (1977): upland tundra, tall sedge marsh, lowland pingos, grass flats, and tidal sedge marsh. Ten stations were located at 15 m intervals. Two snap traps baited with peanut butter were placed 2 m apart and perpendicular to the transect direction at each station. Traps were checked daily for 3 days during 3 trapping periods (31 May-3 June, 28 June-1 July, and 25-28 July) to monitor temporal changes in abundance. Transects were relocated for each 3 day period to prevent overtrapping of local areas. Species, sex, and age (juvenile vs. adult) of captured animals were recorded.

RESULTS

Weather Conditions

Weather conditions were monitored daily from 25 May to 3 August, except for 13-16 June and 8-16 July. Mean low and high temperatures increased monthly throughout the study period (Figure 3). No freezing temperatures were recorded. Precipitation occurred on 28 days and totalled 1.8 cm. June accounted for 83% (1.5 cm) of total precipitation. Wind direction was evenly distributed by compass quadrant and was generally <10 km/hr.

Break-up Sequence

Break-up on the study area occurred prior to the arrival of field personnel. On 23 May, there was <5% ice cover on large lakes (≥10 ha). No ice remained on lakes by 25 May, however, snowbanks persisted along the bluff until 10 July and in the Askinuk Mountains through the departure of the field crew on 3 August.

Nest Surveys

A total of 444 goose nests were found on validation plots (n = 243) and primary plots (n = 201)(Tables 2-5). An additional 170 goose nests were found outside of these study plots. Six neck-banded geese (3 cacklers and 3 emperors) were observed, of which 5 were known to have nested (Table 6).

Nest Location

Validation and primary plots were located within 3 habitat types: short sedge meadow, grass-sedge meadow, and low pingo. Brant nests were found in tidal areas with short sedge meadow and grass-sedge meadow. Peninsulas were most often chosen for nest sites followed by islands and shorelines (Table 7). Cacklers nested most frequently on islands and peninsulas in grass-sedge meadows (Table 8). Emperors rarely nested on islands and nest sites were almost evenly divided between shorelines and peninsulas in grass-sedge meadows (Table 9). Additional nest sites were located on low pingos or in grass meadows. Whitefront nest site preference could not be established due to small sample size (n = 12)(Table 10). Whitefront nests were most frequently located on pingos in grass-sedge and pingo communities.

Nesting Chronology

Nesting chronology was determined from 184 nests: 57 brant, 50 cacklers, 71 emperors, and 6 whitefronts (Table 11). Whitefronts were excluded from interspecific comparisons due to small sample size. Emperor geese initiated nesting (14 May) and incubation

(20 May) first. Cacklers and brant followed 1 and 2 days later, respectively. Emperors, cacklers, and brant initiated nests over a period of 25, 18, and 15 days, respectively. Peak hatch periods were distinct for all 3 species (Table 12). Emperors had the earliest peak hatch (16-20 June), followed by cacklers (19-21 June) and brant (19-22 June). Conversely, brant had the first clutch to hatch (12 June), followed 1 day by emperors and 2 days by cacklers.

Clutch Size

Incomplete clutch sizes were determined for 396 nests (Tables 13-16). Modal clutch size was 4, 4, and 5 eggs for brant, whitefronts, and cacklers, respectively. Clutch sizes of 4, 5, and 6 eggs were of equal frequency for emperors. Brant had the smallest average clutch size ($\bar{x}$ = 3.2), cacklers and whitefronts were intermediate ($\bar{x}$ = 4.4 and 4.4, respectively), and emperors had the largest ($\bar{x}$ = 5.3)(Tables 13-16). Average clutch size for brant on islands and other locations ($\bar{x}$ = 3.4, n = 17)contained more eggs than peninsulas ($\bar{x}$ = 3.2, n = 68) and shorelines ($\bar{x}$ = 2.9, n = 34)(Tables 17-23). Cackler clutch size was largest on islands ($\bar{x}$ = 4.8, n = 56) and other ($\bar{x}$ = 4.3, n = 9) nest sites followed by peninsulas ($\bar{x}$ = 4.0, n = 34) and shorelines ($\bar{x}$ = 3.6, n = 17)(Tables 24-34). Emperor clutch sizes were equal on peninsulas ($\bar{x}$ = 5.9, n = 28) and other sites ($\bar{x}$ = 5.9, n = 36)(Tables 35-46). Emperor nests on shorelines ($\bar{x}$ = 5.2, n = 32), peninsulas ($\bar{x}$ = 5.1, n = 28), and islands ($\bar{x}$ = 4.0, n = 6) contained fewer eggs. Eleven of 12 whitefront nests were located on other sites. These nests averaged more eggs (4.5) than the single nest found on a peninsula (3)(Tables 47-50).

Nest Success

<u>General</u>. Overall nest success for brant, cacklers, emperors and whitefronts was 55% (n = 222), 61% (n = 165), 83% (n = 148), and 95% (n = 19), respectively (Tables 2-5).

<u>Nest Location</u>. Brant nests on islands and other sites had the highest success rates (Table 51). For cacklers, shoreline and island nest sites were the most successful locations (Table 52). Both emperors and whitefronts were generally successful at all nest site locations (Tables 53-54). For emperors, the highest value occurred at other nest sites. Although this was also the case for whitefronts, the validity of this claim is questioned since only 1 of 12 nests located was not classified as other.

<u>Clutch Size</u>. In general, nesting success for all 4 species decreased as clutch size decreased (Tables 55-58).

Nest Depredation

Total depredation was recorded for 38% of 432 nests, excluding incidental nests (Tables 59-62). Observed or suspected predators were recorded at 69 nests, with the remaining nests (n = 95) depredated by unknown predators. Arctic or red fox depredation was suspected at 41 nests. Additionally, mammals were suspected of being the primary predator on brant nests (79% of known depredation, n=39). The remaining depredation was caused by parasitic jaegars (S. parasiticus). Although glaucous gulls (L. hyperboreus) hunted goslings after hatch, they were not observed eating eggs during laying or incubation. Avian predators caused the majority of depredation at cackler and emperor nests (60% and 78%, respectively). One whitefront nest was depredated by an unknown predator.

Human Disturbance

Nest depredation by parasitic jaegars was documented in 25 instances when field personnel disturbed nesting geese. However, in a number of additional cases, field personnel chased jaegars away before depredation occurred. Nest abandonment was directly attributed to visitation by field personnel in 2 cases. Nest visitation schedules exhibited no clear pattern of impact on nesting success. Nevertheless, nest success for brant and cacklers was higher in primary plots than in validation plots (67% vs. 34% and 72% vs. 48%, respectively). In addition, the lowest success rates for brant and cacklers occurred in the only plots visited during nest initiation (425 and 25, respectively)(Tables 2-5).

Aircraft Disturbance

Low flying aircraft were observed over the study area on 2 occasions. The first instance occurred on 23 May when nesting geese were flushed by a military helicopter flying at an altitude of 30-60 m. The second incident occurred on 3 June when geese were disturbed by a small fixed-wing aircraft flying at an altitude of 30-45 m. An unknown amount of disturbance occurred on 16 July when 2 single-engine planes circled Kokechik Bay at an altitude of 30-90 m.

Subsistence Activities

Subsistence activities occurred infrequently after establishment of the field camp on 23 May. On 24 May, 4 people spent 1 hour in a brant colony collecting eggs and shooting waterfowl, including at least 1 brant. On 26 May, 5 people were observed collecting eggs at the same location. Neither egging incident occurred in a study plot.

Brood Surveys

Between 16 June and 28 July, 501 Class I and 238 Class II broods were observed (Tables 63-66). Additionally, 11 Class III broods (4 brant and 7 cackler) were observed between 11-27 July. Emperors had the largest Class I mean brood size ($\bar{x}$ = 4.5, n = 23) and cacklers had the largest Class II mean brood size ($\bar{x}$ = 4.1, n = 18). Brant had the smallest Class I and II mean brood sizes ($\bar{x}$ = 2.8, n = 75 and $\bar{x}$ = 2.8, n = 39, respectively). Intraspecific comparisons of Class I and II mean brood sizes were similar for brant and cacklers. However, emperor Class II broods were 0.9 goslings less the Class I broods. As expected, large broods (>4 goslings) made up a smaller proportion of Class II broods compared to Class I broods of brant (13% vs. 8%) and emperors (52% vs. 25%). However, it improved for cacklers (40% vs. 50%). Brant and emperor broods concentrated on coastal mudflats and in short sedge meadows. Cackler broods, on the other hand, were often observed in grass-sedge meadows, lowland pingos and tidal sedge meadows.

Fox Ecology

Three arctic and 2 red fox were captured in April by M. Anthony (AFWRC). Two arctic fox were recaptures from an earlier study (Anthony et al. 1987). Old radios were removed and new ones attached. The third arctic fox and both red fox were new captures and all were fitted with radio transmitters. Two arctic fox and 1 red fox with active transmitters from a previous study were not captured (Anthony et al. 1987). In addition a pair of red fox were captured in April south of the bluff. The male was marked with blue paint and released. Unfortunately its mate had to be euthanized due to a serious trapping injury. Between 7-17 July, 49 arctic fox (12 adults and 37 kits) were captured. Radio transmitters and ear-tags were placed on 5 adults. Thirteen kits were marked with ear-tags and colored markers. Of the remaining adults, 1 female died from trapping injuries, 2 were not marked and 4 were recaptures with active transmitters. One kit was destroyed after sustaining a broken foreleg from a leghold trap set with 2 springs. Eight of the 13 kits were captured with remote-controlled traps at 2 den sites. The remaining 5 kits were caught in leghold traps.

Radio collared fox were located less frequently than expected. Ground surveys located only 3 of 12 animals during the field season (Table 67). Aerial surveys on 14 June and 1, 28 July located 4 (n = 7), 5 (n = 7),and 11 (n = 12 animals, respectively. One red fox (164.664 Mhz) remained south of the bluff all summer, and one arctic fox (164.675 Mhz) was last located in February 1988. An additional radio collar (164.624 Mhz), which had been chewed off, was retrieved south of the bluff on 29 July. Total number of locations were insufficient to delineate arctic and red fox territories.

Den Use

Of 63 den sites, 41 were found in previous years, and 22 were discovered in 1988. Arctic fox were observed at 9 dens and red fox at 1 (Fig. 4). An additional 4 dens showed signs of activity (i.e. strong scent, fresh digging, or remains of prey) but no fox were observed. The red fox apparently abandoned its den after it was discovered on 6 June. Six of the dens used by arctic fox were natal dens.

Fox Productivity

During 52 hours of den observation, 6 breeding pairs with at ≥37 kits were seen (Table 68). Trapping at the tower den and den 20 interrupted normal fox behavior and made observing these animals difficult. As a result, actual kit numbers at these 2 dens were probably greater then observed. Arctic fox families at dens 575 and 20 relocated their dens following disturbance by field personnel.

Small Mammal Abundance

A total of 127 small mammals were trapped during 1,670 trap-nights (7.6 captures/100 trap-nights)(Table 69). With the exception of 1 brown lemming (Lemmus trimucronatus), all mammals captured were tundra voles (Microtus oeconomus). Capture rates indicate increasing abundance from the bay south to the bluff. Juvenile rate of capture increased monthly and reflected a high recruitment of young during the month of June. Total rate of capture increased each month, demonstrating either an increase in microtine abundance and/or activity. Missing and displaced traps were most frequent in lowland pingos (3.53 traps/100 trap-nights) and grass flats (2.35 traps/100 trap-nights).

DISCUSSION

Nesting Chronology

When compared with nesting chronologies from previous years (Petersen 1987), 1988 appeared to be an early year (Table 70).

Clutch Size

Although average clutch sizes for brant and whitefronts were consistent with previous years, those for cacklers and emperors were the lowest in recent years (Table 71). This may reflect the fact that field personnel were not able to collect data until after incubation began. Thus, eggs that were depredated during nest initiation may not have been present during the initial visit. As reported by Petersen (1987), clutch size did not show any consistent variation between nest sites.

Nest Success

Relative comparisons of nesting success between years indicate that brant, emperors and whitefronts had good nest success in 1988, while cacklers experienced an average year (Table 72). Both cacklers and emperors were more successful in 1982-1983 and less successful in 1985-1986. Island nests continued to be highly successful for both brant and cacklers (Tables 51-52).

Nest Depredation

Nest depredation was difficult to evaluate because it was rarely possible to determine the predator responsible. Petersen (1987) recorded a high incidence of fox depredation (55.7%) and a low incidence of avian depredation (8.7%). Scanlon and Jarvis (1984) attributed the majority of depredation to fox, with the remaining depredation caused by avian predators. The low percentage of nest loss in 1988 attributed to fox depredation (10%, n = 431) probably reflected the fact that fox left few clues at the nest to determine their identity. Therefore, the incidence of fox depredation was likely higher than recorded.

Brood Surveys

Due to a misunderstanding by field personnel in 1988 over the correct procedure to estimate brood size, reported values overestimated production because broods in which all goslings had been lost were not counted. This situation reinforced the need for a more systematic approach to brood surveys.

Fox Ecology

Due to equipment and personnel constraints, fox movements were not documented as closely as desired. With limited data, we presume that the 6 pairs producing kits probably maintained territories which centered on the natal dens. Two pair of these dens (Dens 613 and 575, Den 20 and the Tower Den) were 1.2 and 1.0 km apart, respectively. Additional fox may have occupied the area immediately east of Camp Lake, where 2 active dens were found but no fox observed.

Small Mammal Abundance

High productivity of arctic fox in 1988 may be related to small mammal abundance. According to Anthony et al. (1987), small mammal numbers declined substantially from 1985 to 1986. The overall capture rate in 1988 (7.6/100 trap-nights) was twice that recorded in 1986 (3.6/100 trap-nights), but well below the 1985 rate (21.1/100 trap-nights) and may indicate that rodent populations are on the rebound from low levels in recent years. Snap traps baited with peanut butter may have targeted the predominant species and biased species composition data. Capture rates for 1988 would probably be slightly higher than reported because of the large number of traps that were displaced or disappeared. Animals in these traps may have been depredated by mammalian and avian predators.

MANAGEMENT RECOMMENDATIONS

Logistics

If both goose and fox studies are continued at Kokechik Bay, a minimum of 4 biological technicians are required to accomplish the field work. Two should be located in the eastern portion of the study area (Camp Lake) and 2 in the western portion (Kokechik West). With this arrangement, personnel at Camp Lake would concentrate on goose work, while personnel at Kokechik West would concentrate on fox studies. Despite separate camp locations, cooperation between personnel would be coordinated in order to complete all aspects of the study (i.e. some goose plots should be maintained at Kokechik West, and fox work needs to be expanded east of Camp Lake.

Nest Surveys

Nest surveys should follow the strategy developed by Garrett et al. (1983). Survey plots should be distributed east-west along the coastal plain, and several plots should be located near both Camp Lake and Kokechik West field camps. Random plots selected for the delta-wide goose survey can be incorporated in the Kokechik Bay survey. In order to allow comparisons with previous years' data, plots established by Eisenhauer (1976) and Petersen (1987) should be surveyed. Additional plots can be established as time permits.

Nesting Chronology

Although nesting chronology can be determined by back-dating (using float angles of eggs or hatch date), methods described by Garrett and Wege (1985) are preferred. Central to this methodology is documenting egg-laying sequences for individual nests. However, the magnitude of nest depredation caused by the presence of field personnel during egg-laying needs to be reconciled with the importance of these data. Float angles were useful to evaluate the progress of incubation, and a sample of eggs should be floated throughout incubation.

Waterfowl Productivity

Measuring productivity is facilitated by the collection of complete clutch size data which allows documenting egg loss rate during egg-laying and incubation. To increase our understanding of goose productivity and nest depredation, a continuing analysis of the causes of egg loss and nest failure is required.

Human Disturbance

Nest initiation and hatch are critical periods in the breeding cycle of geese. Minimizing disturbances during these times is imperative. Continuing to monitor the impact of the presence of field personnel on nest depredation will assure this is accomplished. Additionally, areas with high concentrations of jaegars should be annually identified and avoided to minimize their depredation of nests.

Brood Surveys

Brood surveys need to be expanded to document gosling loss. To accurately count broods and to minimize disturbance, 2 towers with blinds should be erected in the coastal zone. One blind should be erected north of Camp Lake, and a second located near the mouth of the Kokechik River. Documentation of habitat use by broods should be initiated.

Fox Movements

Aerial surveys should be flown monthly throughout the winter to document fox movements. Additionally, an aerial survey at the start of the field season would provide field personnel with current information on fox locations and status of radio transmitters. Tower surveys can be effective but they require additional personnel, time, and equipment designed for triangulation. Continuing to delineate fox territories in relation to changes in annual abundance and productivity of fox, waterfowl and small mammals will contribute to our understanding of the ecology at Kokechik Bay.

Trapping and marking efforts should continue for both adults and kits so that the fox population on the study area contains marked individuals. This will provide additional data on mortality rates, longevity, and dispersal. Remote-controlled kit trapping is most effective during July and August when kits first venture out of their dens.

Den Use

An annually updated map of den locations at Kokechik Bay needs to be maintained. All dens should be visited annually to determine activity.

Fox Productivity

Fox productivity should be measured annually. Additional time observing dens is required to obtain accurate counts of kit numbers at each den. To reduce disturbance, litter size should be determined before kits are trapped and marked. Generally, dens located in low and high pingos can be observed from nearby pingos, while surveillance from tower blinds is more efficient in flat terrain with limited cover.

Small Mammal Abundance

Snap-trap lines provide an index to the abundance of small mammals. However, live-trapping along a grid pattern would provide needed information (e.g. home range, longevity, etc.) to better understand the dynamics of these populations. Live-traps might capture other small mammals that escape snap-traps (especially shrews). Used in conjunction with snap-traps, the effectiveness of live-traps can be determined by alternating snap-trap lines and live-trap lines in each vegetation zone. Pit traps with lead-in fencing may provide the most accurate species composition and abundance data, but the logistics of their deployment is difficult and may not allow efficient utilization of time.

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Table 1. Description of study plots at Kokechik Bay, 1988.

Plot	Strategy[a]	No. of Visits	Plot Type	Habitat Type(s)[b]
1	Validation	4	Transect[c]	Grass-sedge meadow
2	Validation	4	Transect[c]	Grass-sedge meadow/low pingo
25	Validation	5	Study	Grass-sedge meadow
26	Validation	5	Study	Low pingo/grass-sedge meadow
32	Primary	2	Random[d]	Short sedge meadow/ grass-sedge meadow
362	Primary	2	Random[d]	Grass-sedge meadow/low pingo
415	Primary	2	Random[d]	Low pingo/grass-sedge meadow
425	Validation	5	Random[d]	Grass-sedge meadow
492	Primary	2	Random[d]	Short sedge meadow/ grass-sedge meadow
512	Primary	2	Random[d]	Grass-sedge meadow
539	Primary	3	Random[d]	Grass-sedge meadow
542	Primary	2	Random[d]	Low pingo

[a] Strategies developed by Garrett et al. (1983).

[b] Habitat types described by Jackson (1981).

[c] Transects established for aerial surveys of nesting brant (M. Anthony pers. comm.).

[d] Random plots were part of the refuge-wide goose productivity study (Stehn 1986).

Table 2. Production data for black brant at Kokechik Bay, 1988.

	Plot Number								
	Validation Plots				Primary Plots				
	1	2	25	425	362	492	512	Incidental	Total
Mean "Incomplete" Clutch Size	3.8	3.2	3.1	3.2	2.8	3.4	2.9	3.4	3.2
n	11	6	29	35	5	68	14	32	168
Mean Clutch at End of Incubation	3.8	2.8	2.5	3.1	2.8	3.4	2.9	3.3	3.2
n	9	6	13	12	5	65	13	26	149
Mean Egg Loss for Nests Losing Eggs	2.5	1.7	2.7	2.8	-	2.1	1.9	2.4	2.5
n	4	3	22	34	-	18	11	8	100
Mean Clutch Hatched	3.2	2.8	2.7	2.7	2.8	3.3	2.7	3.5	3.2
n	9	5	11	7	5	55	7	23	122
Mean Goslings Hatched/ Nesting Pair	2.2	2.3	0.9	0.5	2.8	2.5	0.9	2.4	1.7
Nests - Status Determined	12	6	33	42	5	74	21	29	222
Successful Nests (%)	75	83	33	17	100	74	33	79	55
Nests Abandoned (%)	0	0	0	0	0	0	0	-	0
Total Nests Found	13	6	33	44	5	74	21	33	229
Nests/km^2	265	122	407	136	15	229	65	-	177

Table 3. Production data for cackling Canada geese at Kokechik Bay, 1988.

	Plot Number												
	Validation Plots					Primary Plots							
	1	2	25	26	425	32	362	415	492	512	539	Incidental	Total
Mean Incomplete Clutch Size	3.5	3.8	3.9	4.8	4.7	5.8	3.6	5.5	4.2	4.5	4.2	3.8	4.2
n	2	10	19	19	11	6	8	4	13	2	21	61	176
Mean Clutch at End of Incubation	3.0	4.3	4.6	4.5	4.7	5.2	3.8	5.5	3.7	4.5	3.6	4.1	4.2
n	1	7	7	15	10	5	4	4	12	2	15	40	122
Mean Egg Loss for Nests Losing Eggs	4.0	2.0	3.6	3.4	2.1	3.3	3.5	1.0	2.9	-	2.6	2.1	2.7
n	1	3	12	14	8	3	4	2	7	0	14	25	93
Mean Clutch Hatched	3.0	4.1	5.0	4.5	4.7	5.8	3.8	5.0	4.1	4.5	3.5	4.1	4.2
n	1	7	6	11	6	4	4	3	8	2	13	36	101
Mean Goslings Hatched/ Nesting Pair	1.5	2.9	1.4	2.2	2.2	3.3	1.7	3.8	2.5	4.5	2.1	2.4	2.3
Nests - Status Determined	2	9	20	22	11	6	9	3	13	2	20	49	166
Successful Nests (%)	50	78	30	50	55	67	44	100	62	100	65	73	61
Nests Abandoned (%)	0	0	0	5	0	0	0	0	0	0	5	-	2
Total Nests Found	2	10	21	22	13	7	9	4	13	2	22	61	186
Nests/km^2	40	224	260	143	40	22	28	12	40	6	68	-	80

Table 4. Production data for emperor geese at Kokechik Bay, 1988.

	Plot Number													
	Validation Plots					Primary Plots								
	1	2	25	26	425	32	362	415	492	512	539	542	Incidental	Total
Mean Incomplete Clutch Size	4.2	3.0	4.6	5.4	5.5	5.4	6.4	4.0	5.8	6.7	5.0	5.8	5.0	5.2
n	4	1	7	54	2	5	5	1	5	3	7	8	62	164
Mean Clutch at End of Incubation	3.8	3.0	5.5	4.6	3.0	6.4	6.4	4.0	6.2	6.0	5.3	5.7	4.4	5.5
n	4	1	4	49	1	5	5	1	4	3	6	7	18	125
Mean Egg Loss for Nests Losing Eggs	2.0	-	3.0	2.3	4.0	3.0	3.0	2.0	2.3	2.0	1.3	6.0	1.3	2.2
n	1	0	5	24	2	2	3	1	3	1	3	1	12	67
Mean Clutch Hatched	3.8	3.0	4.2	4.9	3.0	6.0	5.8	2.0	5.5	6.0	5.2	5.7	4.6	4.9
n	4	1	4	48	1	5	4	1	4	3	6	7	34	122
Mean Goslings Hatched/ Nesting Pair	3.8	3.0	2.1	4.1	1.5	5.0	4.6	0.7	4.4	4.5	4.4	5.0	2.5	3.4
Nests - Status Determined	4	1	8	58	2	6	5	3	5	4	7	8	37	148
Successful Nest (%)	100	100	50	83	50	83	80	33	80	75	86	88	92	83
Nests Abandoned (%)	0	0	0	0	0	0	0	0	0	0	0	0	-	0
Total Nests Found	4	1	8	58	2	6	5	3	5	4	7	8	62	173
Nests/km^2	82	20	99	376	6	19	15	9	15	12	22	25	-	58

Table 5. Production data for Pacific greater white-fronted geese at Kokechik Bay, 1988.

	Plot Number					
	Validation Plot	Primary Plots				
	26	32	362	542	Incidental	Total
Mean Incomplete Clutch Size	4.5	5.5	3.5	4.0	4.4	4.4
n	6	2	2	2	14	26
Mean Clutch at End of Incubation	3.8	5.0	5.0	4.0	3.8	4.0
n	6	2	1	2	8	19
Mean Egg Loss for Nests Losing Eggs	1.5	1.0	2.0	-	1.5	1.5
n	4	1	1	0	2	8
Mean Clutch Hatched	3.5	5.0	5.0	4.0	3.5	3.8
n	6	2	1	1	8	18
Mean Goslings Hatched/ Nesting Pair	3.5	5.0	5.0	2.0	2.0	2.6
Nests - Status Determined	6	2	2	1	8	19
Successful Nest (%)	100	100	50	100	100	95
Nests Abandoned (%)	0	0	0	0	0	0
Total Nests Found	6	2	2	2	14	26
Nests/km^2	39	6	6	6	-	14

Table 6. Neck-banded geese observed at Kokechik Bay, 1988.

Neck-band	Species	Plot Number	Nest Location	Clutch Size	Outcome of Clutch
0A8	Emperor	26	Peninsula	5	Hatched
02A	Emperor	425	Peninsula	5	Hatched[a]
3J0	Cackler	X			
61J	Emperor	26	Peninsula	6	Hatched
8A2	Cackler	492	Island	4	Hatched
	Cackler	X	Meadow	4	Unknown

[a] Three of 5 eggs hatched (remaining 2 depredated).

Table 7. Nest site locations for black brant at Kokechik Bay, 1988.

Plot	Nest Location				Total
	Island	Peninsula	Shoreline	Other[a]	
Validation					
1	4	7	1	1	13
2	2	4	0	0	6
25	14	16	3	0	33
425	8	24	12	0	44
Subtotal	28	51	16	1	96
Primary					
362	5	0	0	0	5
492	13	21	22	18	74
512	7	9	5	0	21
Subtotal	25	30	27	18	100
Total	53	81	43	19	196

[a] Other includes grass meadow (n=18) and sloughbank (n=1).

Table 8. Nest site locations for cackling Canada geese at Kokechik Bay, 1988.

Plot	Nest Location: Island	Peninsula	Shoreline	Other[a]	Total
Validation					
1	1	1	0	0	2
2	3	6	1	0	10
25	9	10	1	1	21
26	9	3	4	6	22
425	11	1	1	0	13
Subtotal	33	21	8	7	68
Primary					
32	5	2	0	0	7
362	2	4	3	0	9
415	4	0	0	0	4
492	7	3	2	1	13
512	1	1	0	0	2
539	7	9	4	2	22
Subtotal	26	19	9	3	57
Total	59	40	17	10	125

[a] Other includes grass meadows (n=5), sloughbanks (n=2), and pingos (n=3).

Table 9. Nest site locations for emperor geese at Kokechik Bay, 1988.

Plot	Nest Location: Island	Peninsula	Shoreline	Other[a]	Total
Validation					
1	1	1	2	0	4
2	0	0	0	1	1
25	2	1	1	4	8
26	2	18	16	22	58
425	0	1	1	0	2
Subtotal	5	21	20	27	73
Primary					
32	1	1	2	2	6
362	0	1	1	3	5
415	0	2	1	0	3
492	0	2	3	0	5
512	0	1	1	2	4
539	0	1	4	2	7
542	0	2	1	5	8
Subtotal	1	10	13	14	38
Total	6	31	33	41	111

[a] Other includes grass meadows (n=14), sloughbanks (n=8), and pingos (n=19).

Table 10. Nest site locations for Pacific greater white-fronted geese at Kokechik Bay, 1988.

Plot	Nest Location				Total
	Island	Peninsula	Shoreline	Other[a]	
Validation					
26	0	1	0	5	6
Subtotal	0	1	0	5	6
Primary					
32	0	0	0	2	2
362	0	0	0	2	2
542	0	0	0	2	2
Subtotal	0	0	0	6	6
Total	0	1	0	11	12

[a] Other includes grass meadow (n=2), sloughbank (n=1), and pingo (n=8).

Table 11. Nesting chronology[a] for black brant, cackling Canada geese, emperor geese, and Pacific greater white-fronted geese at Kokechik Bay, 1988.

Event	Brant (n=57)	Cacklers (n=50)	Emperors (n=71)	Whitefronts (n=6)
Nest Initiation	16 May	15 May	14 May	15 May
Peak Nest Initiation[b]	25-28 May	20-22 May	17-21 May	17-27 May
Icubation Initiation	22 May	21 May	20 May	19 May
Peak of Icubation Initiation[c]	28-31 May	25-27 May	23-27 May	21 May-1 June
First Clutch to Hatch	12 June	15 June	13 June	18 June
Peak Hatch	19-22 June	19-21 June	16-20 June	21-24 June

[a] Dates determined by backdating based on egg-laying sequence, float angle, or observed hatch date.

[b] Dates determined by backdating from the peak initiation of incubation based on the mean clutch size (see Tables 2-5).

[c] Backdating from hatch dates was based on incubation periods which were assumed to be 23, 26, 24, and 26 days for brant, cacklers, emperors, and whitefronts, respectively.

Table 12. Hatch dates for black brant, cackling Canada geese, emperor geese and Pacific greater white-fronted geese at Kokechik Bay, 1988.

Species Method	Julian Day																												Total
	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	
Brant																													
Observed[a]		2	3	2				4	5	2		1	2																21
Visit[b]							2[d]	9[d]		3	8							4											26
Float[c]	6								1			1												1				1[e]	10
Total	6		2	3	2		2	9	5	8	10	1	1	2				4						1				1	57
Cackling Canada Geese																													
Observed[a]								7	4	1	3	2	1																18
Visit[b]								8[d]	5[d]	2[d]	3							1											19
Float[c]				4			2[e]								2[e]			4[e]		1									13
Total				4			2	8	12	6	4	3	2	1	2			5		1									50
Emperor Geese																													
Observed[a]				1					3	2	2	,3	2											1					14
Visit[b]								7[d]	32[d]	2[d]														1[e]					42
Float[c]		2	2		8								2			1													15
Total		2	2		9			7	32	5	2	2	5	2		1								2					71
White-fronted Geese																													
Observed[a]						1																							1

[a] Refers to those nests which contained pipping eggs or goslings.
[b] Refers to nests in which hatch occurred between 2 consecutive visits. The median date was selected as the hatch date.
[c] Refers to nests in which eggs were floated to determine a range of hatch dates.. The median date was selected as the hatch date.
[d] Eggs hatched on or before this date.
[e] Nest depredated before hatch.

Table 13. Frequency of clutch size from incomplete clutches for black brant at Kokechik Bay, 1988.

Clutch Size	Plot Type/Number								
	Validation				Primary				
	1	2	25	425	362	492	512	Incidental	Total
Unknown[a]	2	0	4	9	0	7	7	0	29
1	0	1	4	2	1	6	3	3	20
2	0	1	8	14	1	9	4	2	39
3	3	1	5	5	1	15	3	13	46
4	7	2	6	7	2	31	1	8	64
5	1	1	6	5	0	6	2	6	27
6	0	0	0	1	0	0	1	0	2
7	0	0	0	1	0	0	0	1	2
Total	13	6	33	44	5	74	21	33	229

[a] Depredation occurred prior to first visit.

Table 14. Frequency of clutch size from incomplete clutches for cackling Canada geese at Kokechik Bay, 1988.

Clutch Size	Plot Type/Number												
	Validation					Primary							
	1	2	25	26	425	32	362	415	492	512	539	Incidental	Total
Unknown[a]	0	0	2	3	2	1	1	0	0	0	1	0	10
1	0	1	2	1	0	0	0	0	0	0	2	4	10
2	0	0	2	2	1	0	2	0	1	0	0	5	13
3	1	2	4	1	1	0	2	0	3	0	3	16	33
4	1	4	4	2	1	0	1	0	5	1	8	12	39
5	0	3	3	6	5	2	3	2	2	1	3	14	44
6	0	1	3	5	3	3	0	2	2	0	5	7	31
7	0	0	1	1	0	1	0	0	0	0	0	2	5
8	0	0	0	1	0	0	0	0	0	0	0	0	1
Total	2	11	21	22	13	7	9	4	13	2	22	60	186

[a] Depredation occurred prior to first visit.

Table 15. Frequency of clutch size from incomplete clutches for emperor geese at Kokechik Bay, 1988.

Clutch Size	Plot Type/Number													
	Validation					Primary								
	1	2	25	26	425	32	362	415	492	512	539	542	Incidental	Total
Unknown[a]	0	0	0	2	0	0	0	1	0	1	0	0	0	4
1	0	0	1	1	0	0	0	0	0	0	0	0	1	3
2	0	0	0	1	0	0	0	0	0	0	1	0	2	4
3	2	1	1	4	0	1	0	0	0	0	0	0	6	15
4	0	0	1	7	0	1	1	1	2	1	2	1	20	37
5	1	0	1	13	1	1	1	0	0	0	1	2	13	34
6	1	0	2	15	1	0	1	0	1	0	1	3	6	31
7	0	0	1	12	0	1	0	0	1	0	2	2	6	25
8	0	0	0	1	0	1	1	0	1	2	0	0	7	13
9	0	0	0	0	0	0	1	0	0	0	0	0	1	2
Total	4	1	7	56	2	5	5	2	5	4	7	8	62	168

[a] Depredation occurred prior to first visit.

Table 16. Frequency of clutch size from incomplete clutches for Pacific greater white-fronted geese at Kokechik Bay, 1988.

Clutch Size	Plot Type/Number					
	Validation	Primary				
	26	32	362	542	Incidental	Total
2	0	0	1	0	0	1
3	1	1	0	0	5	7
4	2	0	0	2	4	8
5	2	0	1	0	2	5
6	1	0	0	0	1	2
7	0	0	0	0	2	2
8	0	1	0	0	0	1
Total	6	2	2	2	14	26

Table 17. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 1 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	1	0	1	2
1	0	0	0	0	0
2	0	0	0	0	0
3	0	2	1	0	3
4	3	4	0	0	7
5	1	0	0	0	1
Total	4	7	1	1	13
Mean	4.3	3.7	3.0	-	3.8
S.D.	0.5	0.5	0	-	0.6

[a] Data do not include incidental nests.

Table 18. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 2 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	1	0	0	1
2	0	1	0	0	1
3	0	1	0	0	1
4	1	1	0	0	2
5	1	0	0	0	1
Total	2	4	0	0	6
Mean	4.5	2.5	-	-	3.2
S.D.	0.7	1.3	-	-	1.5

[a] Data do not include incidental nests.

Table 19. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 25 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	2	2	0	0	4
1	1	1	2	0	4
2	2	5	1	0	8
3	5	0	0	0	5
4	2	4	0	0	6
5	2	4	0	0	6
Total	14	16	3	0	33
Mean	3.2	3.4	1.3	-	3.1
S.D.	1.2	1.4	0.6	-	1.4

[a] Data do not include incidental nests.

Table 20. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 362 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	1	0	0	0	1
2	1	0	0	0	1
3	1	0	0	0	1
4	2	0	0	0	2
Total	5	0	0	0	5
Mean	2.8	-	-	-	2.8

[a] Data do not include incidental nests.

Table 21. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 425 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	1	4	4	0	9
1	0	2	0	0	2
2	3	6	5	0	14
3	1	2	2	0	5
4	2	4	1	0	7
5	0	5	0	0	5
6	1	0	0	0	1
7	0	1	0	0	1
Total	8	24	12	0	44
Mean	3.3	3.4	2.5	-	3.2
S.D.	1.5	1.6	0.8	-	1.5

a Data do not include incidental nests.

Table 22. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 492 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	4	2	1	7
1	1	2	1	2	6
2	1	2	4	2	9
3	7	4	1	3	15
4	3	7	13	8	31
5	1	2	1	2	6
Total	13	21	22	18	74
Mean	3.2	3.3	3.4	3.4	3.3
S.D.	1.0	1.2	1.0	1.2	1.1

[a] Data do not include incidental nests.

Table 23. Frequency of clutch size for incomplete clutches by nest location for black brant in plot 512 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	2	2	3	0	7
1	0	2	1	0	3
2	1	2	1	0	4
3	1	2	0	0	3
4	0	1	0	0	1
5	2	0	0	0	2
6	1	0	0	0	1
Total	7	9	5	0	21
Mean	4.2	2.3	1.5	-	2.9
S.D.	1.6	1.1	0.7	-	1.6

[a] Data do not include incidental nests.

Table 24. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 1 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	1	0	0	1
4	1	0	0	0	1
Total	1	1	0	0	2
Mean	4.0	3.0	-	-	3.5
S.D.	0	0	-	-	0.7

[a] Data do not include incidental nests.

Table 25. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 2 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	1	0	0	0	1
2	0	0	0	0	0
3	0	2	0	0	2
4	1	2	1	0	4
5	1	2	0	0	3
6	0	0	1	0	1
Total	3	6	2	0	11
Mean	3.3	4.0	5.0	-	4.0
S.D.	2.1	0.9	1.4	-	1.3

[a] Data do not include incidental nests.

Table 26. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 25 at Kokechik Bay, 1988[a].

Clutch Size	Nest Location				Total
	Island	Peninsula	Shoreline	Other	
Unknown	0	2	0	0	2
1	1	1	0	0	2
2	0	2	0	0	2
3	1	2	0	1	4
4	2	1	1	0	4
5	2	1	0	0	3
6	2	1	0	0	3
7	1	0	0	0	1
Total	9	10	1	1	21
Mean	4.6	3.2	4.0	3.0	3.9
S.D.	1.8	1.7	0	0	1.7

a Data do not include incidental nests.

Table 27. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 26 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	2	0	1	3
1	0	0	0	1	1
2	0	0	1	1	2
3	0	0	1	0	1
4	1	0	1	0	2
5	5	0	1	0	6
6	2	1	0	2	5
7	1	0	0	0	1
8	0	0	0	1	1
Total	9	3	4	6	22
Mean	5.3	6.0	3.5	4.6	4.8
S.D.	0.9	0	1.3	3.0	1.8

[a] Data do not include incidental nests.

Table 28. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 32 at Kokechik Bay, 1988[a].

Clutch Size	Nest Location				Total
	Island	Peninsula	Shoreline	Other	
Unknown	1	0	0	0	1
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	2	0	0	0	2
6	1	2	0	0	3
7	1	0	0	0	1
Total	5	2	0	0	7
Mean	5.8	6.0	-	-	5.8
S.D.	1.0	-	-	-	0.8

[a] Data do not include incidental nests.

Table 29. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 362 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	1	0	0	1
1	0	0	0	0	0
2	1	1	0	0	2
3	0	0	2	0	2
4	0	1	0	0	1
5	1	1	1	0	3
Total	2	4	3	0	9
Mean	3.5	3.7	3.7	-	3.6
S.D.	2.1	1.5	1.2	-	1.3

[a] Data do not include incidental nests.

Table 30. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 415 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	2	0	0	0	2
6	2	0	0	0	2
Total	4	0	0	0	4
Mean	5.5	-	-	-	5.5
S.D.	0.6	-	-	-	0.6

a Data do not include incidental nests.

Table 31. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 425 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	2	0	0	0	2
1	0	0	0	0	0
2	1	0	0	0	1
3	0	1	0	0	1
4	1	0	0	0	1
5	4	0	1	0	5
6	3	0	0	0	3
Total	11	1	1	0	13
Mean	4.9	3.0	5.0	-	4.7
S.D.	1.3	0	0	-	1.3

[a] Data do not include incidental nests.

Table 32. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 492 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	1	0	1
3	1	1	1	0	3
4	2	2	0	1	5
5	2	0	0	0	2
6	2	0	0	0	2
Total	7	3	2	1	13
Mean	4.7	3.7	2.5	4.0	4.1

[a] Data do not include incidental nests.

Table 33. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 512 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	1	0	0	1
5	1	0	0	0	1
Total	1	1	0	0	2
Mean	5.0	4.0	-	-	4.5
S.D.	0	0	-	-	0.7

[a] Data do not include incidental nests.

Table 34. Frequency of clutch size for incomplete clutches by nest location for cackling Canada geese in plot 539 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	1	0	0	1
1	1	0	1	0	2
2	0	0	0	0	0
3	0	2	1	0	3
4	3	2	2	1	8
5	0	2	0	1	3
6	3	2	0	0	5
Total	7	9	4	2	22
Mean	4.4	4.5	3.0	-	4.2
S.D.	1.8	1.2	1.4	-	1.5

[a] Data do not include incidental nests.

Table 35. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 1 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	1	1	0	0	2
4	0	0	0	0	0
5	0	0	1	0	1
6	0	0	1	0	1
Total	1	1	2	0	4
Mean	3.0	3.0	5.5	-	4.2
S.D.	0	0	0.7	-	1.5

[a] Data do not include incidental nests.

Table 36. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 2 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	1	1
Total	0	0	0	1	1
Mean	-	-	-	3.0	3.0
S.D.	-	-	-	0	0

[a] Data do not include incidental nests.

Table 37. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 25 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	1	0	0	0	1
2	0	0	0	0	0
3	0	1	0	0	1
4	0	0	0	1	1
5	0	0	1	0	1
6	1	0	0	1	2
7	0	0	0	1	1
Total	2	1	1	3	7
Mean	3.5	3.0	5.0	5.7	4.6
S.D.	3.5	0	0	1.5	2.1

[a] Data do not include incidental nests.

Table 38. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 26 at Kokechik Bay, 1988[a].

Clutch Size	Nest Location: Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	2	2
1	0	0	0	1	1
2	0	1	0	0	1
3	0	2	1	1	4
4	1	1	3	2	7
5	1	8	3	1	13
6	0	2	6	8	15
7	0	3	3	6	12
8	0	1	0	0	1
Total	2	18	16	21	56
Mean	4.50	5.2	5.4	5.6	5.4

[a] Data do not inlclude incidental nests.

Table 39. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 32 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	1	0	1
4	0	0	0	1	1
5	1	0	0	0	1
6	0	0	0	0	0
7	0	0	0	1	1
8	0	0	1	0	1
Total	1	0	2	2	5
Mean	5.0	-	5.5	5.5	5.4
S.D.	0	-	3.5	2.1	2.1

[a] Data do not include incidental nests.

Table 40. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 362 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	1	0	1
5	0	1	0	0	1
6	0	0	0	1	1
7	0	0	0	0	0
8	0	0	0	1	1
9	0	0	0	1	1
Total	0	1	1	3	5
Mean	-	5.0	4.0	7.7	6.4
S.D.	-	0	0	1.5	2.1

[a] Data do not include incidental nests.

Table 41. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 415 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	1	0	0	1
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	1	0	0	1
Total	0	2	0	0	2
Mean	-	4.0	-	-	4.0
S.D.	-	0	-	-	0

[a] Data do not inlcude incidental nests.

Table 42. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 425 at Kokechik Bay, 1988[a].

Clutch Size	Nest Location: Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	1	0	0	1
6	0	0	1	0	1
Total	0	1	1	0	2
Mean	-	5.0	6.0	-	5.5
S.D.	-	0	0	-	0.7

[a] Data do not include incidental nests.

Table 43. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 492 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	1	1	0	2
5	0	0	0	0	0
6	0	0	1	0	1
7	0	0	1	0	1
8	0	1	0	0	1
Total	0	2	3	0	5
Mean	-	6.0	5.7	-	5.8
S.D.	-	2.8	1.5	-	1.8

[a] Data do not include incidental nests.

Table 44. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 512 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	1	1
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	1	0	1
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	1	0	1	2
Total	0	1	1	2	4
Mean	-	8.0	4.0	8.0	6.7
S.D.	-	0	0	0	2.3

[a] Data do not include incidental nests.

Table 45. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 539 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	1	0	1
3	0	0	0	0	0
4	0	0	2	0	2
5	0	0	0	1	1
6	0	1	0	0	1
7	0	0	1	1	2
Total	0	1	4	2	7
Mean	-	6.0	4.2	6.0	5.0
S.D.	-	0	2.1	1.4	1.8

[a] Data do not include incidental nests.

Table 46. Frequency of clutch size for incomplete clutches by nest location for emperor geese in plot 542 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	1	0	0	1
5	0	0	1	1	2
6	0	1	0	2	3
7	0	0	0	2	2
Total	0	2	1	5	8
Mean	-	5.0	5.0	6.2	5.8
S.D.	-	1.4	0	0.8	1.0

[a] Data do not include incidental nests.

Table 47. Frequency of clutch size for incomplete clutches by nest location for Pacific greater white-fronted geese in plot 26 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	1	0	0	1
4	0	0	0	2	2
5	0	0	0	2	2
6	0	0	0	1	1
Total	0	1	0	5	6
Mean	-	3.0	-	4.8	4.5

[a] Data do not include incidental nests.

Table 48. Frequency of clutch size for incomplete clutches by nest location for Pacific greater white-fronted geese in plot 32 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	1	1
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	1	1
Total	0	0	0	2	2
Mean	-	-	-	5.5	5.5
S.D.	-	-	-	3.5	3.5

[a] Data do not include incidental nests.

Table 49. Frequency of clutch size for incomplete clutches by nest location for Pacific greater white-fronted geese in plot 362 at Kokechik Bay, 1988[a].

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	1	1
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	1	1
Total	0	0	0	2	2
Mean	-	-	-	3.5	3.5
S.D.	-	-	-	2.1	2.1

[a] Data do not include incidental nests.

Table 50. Frequency of clutch size for incomplete clutches by nest location for Pacific greater white-fronted geese in plot 542 at Kokechik Bay, 1988[a] .

	Nest Location				
Clutch Size	Island	Peninsula	Shoreline	Other	Total
Unknown	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	2	2
Total	0	0	0	2	2
Mean	-	-	-	4.0	4.0
S.D.	-	-	-	0	0

[a] Data do not include incidental nests.

Table 51. Percent nesting success by nest location for black brant at Kokechik Bay, 1988[a].

	Nest Location							
	Island		Peninsula		Shoreline		Other	
Plot No.	%	n	%	n	%	n	%	n
Validation								
1	75	4	83	6	100	1	0	1
2	100	2	75	4				
25	50	14	25	16	0	3		
425	38	8	18	22	0	12		
Primary								
362	100	5						
492	69	13	62	21	82	22	83	18
512	57	7	22	9	20	5		
Total	62	53	40	78	47	43	79	19

[a] Data do not include incidental nests.

Table 52. Percent nesting success by nest location for cackling Canada geese at Kokechik Bay, 1988[a].

	Nest Location							
	Island		Peninsula		Shoreline		Other	
Plot No.	%	n	%	n	%	n	%	n
Validation								
1	0	1	100	1				
2	33	3	100	5	100	1		
25	50	8	20	10	0	1	0	1
26	44	9	33	3	50	4	67	6
425	56	9	0	1	100	1		
Primary								
32	75	4	50	2				
362	100	2	0	4	67	3		
415	100	3						
492	71	7	67	3	50	2	0	1
512	100	1	100	1				
539	83	6	62	8	50	4	50	2
Total	62	53	47	38	56	16	50	10

[a] Data do not include incidental nests.

Table 53. Percent nesting success by nest location for emperor geese at Kokechik Bay, 1988[a].

	Nest Location							
	Island		Peninsula		Shoreline		Other	
Plot No.	%	n	%	n	%	n	%	n
Validation								
1	100	1	100	1	100	2		
2							100	1
25	50	2	0	1	0	1	100	4
26	50	2	83	18	94	16	86	22
425			100	1	0	1		
Primary								
32	100	1	100	1	100	2	50	2
362			100	1	0	1	100	3
415			50	2	0	1		
492			100	2	67	3		
512			100	1	100	1	50	2
539			100	1	75	4	100	2
542			50	2	100	1	100	5
Total	67	6	81	31	79	33	88	41

[a] Data do not include incidental nests.

Table 54. Percent nesting success by nest location for Pacific greater white-fronted geese at Kokechik Bay, 1988[a].

	Nest Location							
	Island		Peninsula		Shoreline		Other	
Plot No.	%	n	%	n	%	n	%	n
Validation								
26			100	1			100	5
Primary								
32							100	2
362							50	2
542							100	1
Total			100	1			90	10

[a] Data do not include incidental nests.

Table 55. Hatching success of incomplete clutches for black brant at Kokechik Bay, 1988.

	Clutch													
	1		2		3		4		5		6		7	
Plot No.	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Validation														
1					100	2	86	7	100	1				
2	0	1	100	1	100	1	100	2	100	1				
25	0	4	25	8	60	5	67	6	33	6				
425	0	2	0	12	40	5	43	7	0	5	100	1	100	1
Primary														
362	100	1	100	1	100	1	100	2						
492	33	6	78	9	88	16	90	30	83	6				
512	0	3	75	4	33	3	0	1	50	2	100	1		
Incidental	50	2	100	2	80	10	71	7	100	4			100	1
Total	21	19	43	37	71	45	79	62	58	26	100	2	100	2

Table 56. Hatching success of incomplete clutches for cackling Canada geese at Kokechik Bay, 1988.

	Clutch															
	1		2		3		4		5		6		7		8	
Plot No.	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Validation																
1					100	1	0	1								
2	0	1			100	1	75	4	100	3						
25	0	2	0	2	25	4	25	4	67	3	33	3	100	1		
26	0	1	50	2	0	1	50	2	67	6	80	5	0	1	100	1
425			0	1	0	1			75	4	100	3				
Primary																
32									100	1	67	3	100	1		
362			50	2	50	2	0	1	67	3						
415									100	1	100	2				
492			0	1	67	3	40	5	100	2	100	2				
512							100	1	100	1						
539	0	1			100	3	50	8	100	2	80	5				
Incidental	0	4	67	3	64	14	75	8	100	12	83	6	100	2		
Total	0	9	36	11	60	30	63	34	87	38	79	29	80	5	100	1

Table 57. Hatching success of incomplete clutches for emperor geese at Kokechik Bay, 1988.

	Clutch																	
	1		2		3		4		5		6		7		8		9	
Plot No.	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Validation																		
1					100	2			100	1	100	1						
2					100	1												
25	0	1			0	1	100	1	0	1	100	2	100	1				
26	0	1	100	1	100	4	86	7	77	13	93	15	100	12	100	1		
425									100	1	0	1						
Primary																		
32					100	1	0	1	100	1			100	2	100	1		
362							0	1	100	1	100	1			100	1	100	1
415							100	1										
492							50	2			100	1	100	1	100	1		
512							100	1							100	2		
539			0	1			100	2	100	1	100	1	100	2				
542							100	1	100	2	67	3	100	2				
Incidental			100	1	60	5	100	12	100	8	100	2	100	3	100	5	100	1
Total	0	2	67	3	79	14	86	29	86	29	89	27	100	22	100	11	100	2

Table 58. Hatching success of incomplete clutches for Pacific greater white-fronted geese at Kokechik Bay, 1988.

	Clutch															
	1		2		3		4		5		6		7		8	
Plot No.	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Validation																
26					100	1	100	2	100	2	100	1				
Primary																
32					100	1									100	1
362			0	1					100	1						
542							100	1								
Incidental					100	4	100	2	100	2						
Total			0	1	100	6	100	5	100	5	100	1			100	1

Table 59. Percent avian, mammalian, and unknown depredation by nest location for black brant at Kokechik Bay, 1988[a].

	Nest Location											
	Island				Peninsula				Other			
Plot No.	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown
Validation												
1	4	25	0	0	6	0	0	17	2	0	0	50
2	2	0	0	0	4	0	0	25				
25	14	0	21	29	16	12	31	31	3	0	33	67
425	8	12	0	50	22	0	64	18	12	8	67	25
Primary												
362	5	0	0	0								
492	13	0	0	31	21	0	0	38	40	5	0	12
512	7	0	0	43	9	0	0	78	5	20	0	60
Total	53	4	6	28	78	3	24	32	62	6	15	21

[a] Data do not include incidental nests.

Table 60. Percent avian, mammalian, and unknown depredation by nest location for cackling Canada geese at Kokechik Bay, 1988[a].

	Nest Location											
	Island				Peninsula				Other			
Plot No.	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown
Validation												
1	1	100	0	0	1	0	0	0				
2	3	0	0	67	5	0	0	0	1	0	0	0
25	8	12	12	25	10	10	40	30	2	50	50	0
26	9	0	0	56	3	0	33	33	10	0	0	40
425	9	11	0	33	1	0	0	100	1	0	0	0
Primary												
32	4	0	0	25	2	0	0	50				
362	2	0	0	0	4	25	25	50	3	33	0	0
415	3	0	0	0								
492	7	14	0	14	3	33	0	0	3	33	0	33
512	1	0	0	0	1	0	0	0				
539	6	0	0	17	8	12	0	25	6	0	0	33
Total	53	8	2	28	38	11	16	26	26	12	4	27

[a] Data do not include incidental nests.

Table 61. Percent avian, mammalian, and unknown depredation by nest location for emperor geese at Kokechik Bay, 1988[a].

	Nest Location											
	Island				Peninsula				Other			
Plot No.	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown
Validation												
1	1	0	0	0	1	0	0	0	2	0	0	0
2									1	0	0	0
25	2	0	50	0	1	0	100	0	5	20	0	0
26	2	0	0	50	18	11	0	6	38	3	0	8
425					1	0	0	0	1	100	0	0
Primary												
32	1	0	0	0	1	0	0	0	4	0	0	25
362					1	0	0	0	4	0	0	25
415					2	0	0	50	1	0	100	0
492					2	0	0	0	3	0	0	33
512					1	0	0	0	3	0	0	33
539					1	0	0	0	6	17	0	0
542					2	50	0	0	6	0	0	0
Total	6	0	17	17	31	10	3	6	74	5	1	9

[a] Data do not include incidental nests.

Table 62. Percent avian, mammalian, and unknown depredation by nest location for Pacific greater white-fronted geese at Kokechik Bay, 1988[a].

	Nest Location							
	Peninsula				Other			
Plot No.	n	Avian	Mammal	Unknown	n	Avian	Mammal	Unknown
Validation								
26	1	0	0	0	5	0	0	0
Primary								
32					2	0	0	0
362					2	0	0	50
542					1	0	0	0
Total	1	0	0	0	10	0	0	10

[a] Data do not include incidental nests.

Table 63. Weekly brood sizes for black brant at Kokechik Bay, 1988.

No. of Goslings	Week Beginning							Total
	12 June	19 June	26 June	3 July	10 July	17 July	24 July	
Class I								
1	0	0	10	7	0	0	0	17
2	0	3	9	2	1	0	0	15
3	0	0	8	11	0	1	0	20
4	0	2	6	4	1	0	0	13
5	0	1	2	3	1	0	0	7
6	0	0	1	0	0	0	0	1
7	0	0	0	2	0	0	0	2
8	0	0	0	0	0	0	0	0
Total	0	6	36	29	3	1	0	75
Mean	-	3.2	2.6	3.1	3.7	3.0	-	2.8
Class II								
1	0	0	0	0	0	9	0	9
2	0	0	0	0	0	9	0	9
3	0	0	0	0	0	7	1	8
4	0	0	0	0	1	9	0	10
5	0	0	0	0	0	2	0	2
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	36	2	39
Mean	-	-	-	-	4.0	2.6	5.0	2.8

Table 64. Weekly brood sizes for cackling Canada geese at Kokechik Bay, 1988.

No. of Goslings	Week Beginning							
	12 June	19 June	26 June	3 July	10 July	17 July	24 July	Total
Class I								
1	0	1	1	0	0	0	0	2
2	0	0	1	1	4	0	0	6
3	0	1	2	2	3	0	0	8
4	1	2	2	3	3	0	0	11
5	0	2	4	3	3	0	0	12
6	0	3	0	1	1	0	0	5
7	0	0	0	0	1	0	0	1
Total	1	9	10	10	15	0	0	45
Mean	4.0	4.4	3.7	4.1	3.8	-	-	4.0
Class II								
1	0	0	0	0	0	1	0	1
2	0	0	0	0	0	1	1	2
3	0	0	0	0	0	1	2	3
4	0	0	0	0	0	3	0	3
5	0	0	0	0	0	5	1	6
6	0	0	0	0	0	3	0	3
7	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	14	4	18
Mean	-	-	-	-	-	4.4	3.2	4.1

Table 65. Weekly brood sizes for emperor geese at Kokechik Bay, 1988.

No. of Goslings	Week Beginning							
	12 June	19 June	26 June	3 July	10 July	17 July	24 July	Total
Class I								
1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	2
3	0	4	2	1	0	1	0	8
4	0	1	0	0	0	0	0	1
5	0	1	3	2	0	0	0	6
6	0	1	0	0	1	0	0	2
7	0	1	1	0	0	0	0	2
8	0	0	2	0	0	0	0	2
Total	0	8	9	4	1	1	0	23
Mean	-	4.2	5.1	3.8	6.0	3.0	-	4.5
Class II								
1	0	0	0	0	0	1	0	1
2	0	0	0	0	0	3	0	3
3	0	0	0	0	0	3	0	3
4	0	0	0	0	0	5	0	5
5	0	0	0	0	0	2	1	3
6	0	0	0	0	0	1	0	1
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	15	1	16
Mean	-	-	-	-	-	3.5	5.0	3.6

Table 66. Weekly brood sizes for Pacific greater white-fronted geese at Kokechik Bay, 1988.

No. of Goslings	Week Beginning							
	12 June	19 June	26 June	3 July	10 July	17 July	24 July	Total
Class 1								
1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	1
3	0	0	0	0	0	0	0	0
4	1	0	0	1	0	0	0	2
5	0	0	0	1	0	0	0	1
Total	1	0	1	2	0	0	0	4
Mean	4.0	-	2.0	4.5	-	-	-	3.8

Table 67. Radio collared fox located from the ground at Kokechik Bay, 1988.

Date	Monitoring Location	Time period of Monitoring (hrs)	Frequency Received (Mhz)
27 May	Camp Lake Tower	2200-2300	none
1 June	Bluff south of Camp Lake	2000-2020	164.439
2 June	Camp Lake	0030	164.439
5 June	Camp Lake Tower	0100-0200	none
9 June	Plot 539	1630-1650	none
10 June	Camp Lake Tower	0030-0230	none
13 June	Kokechik West Camp.	1800-1815	none
14 June	Kokechik West Camp	2200-2220	none
18 June	Camp lake Tower	0030-0230	164.439?
22 June	Camp Lake Tower	1030-1115	none
23 June	Camp Lake Tower	2230-0030	164.439
25 June	Den	1800	164.439
	Kokechik River	1900	164.439
27 June	Camp Lake Tower	2230-0050	164.439
20 July	Den	1630	164.563
21 July	Den	1630	164.439 164.599

Table 68. Arctic fox productivity at Kokechik Bay, 1988.

Map Code	Den Location	Adult Female	Adult Male	Kits
A	Kokechik River	164.599[a,b]	164.439[b]	9
B	Gull Lake	(dead)	164.563	8
C	Den 20	166.762	166.937	4[c]
D	Tower Den	166.988	unmarked	5[d]
E	Den 613	unmarked	164.611	6[e]
F	Den 575	164.714[b]	164.649[b]	5

[a] Numbers refer to the radio frequency (Mhz) of collared fox.

[b] Recaptured with an active transmitter.

[c] Three kits were ear-tagged with red flags and markers numbered 15 (male), 16 (male), and 18 (female).

[d] Four kits were ear-tagged with markers numbered 1 (female), 11 (female), 17 (female), and 174/175 (male).

[e] Five kits were ear-tagged with orange flags and markers numbered 151/152 (female), 153/154 (male), 155/156 (male), 157/160 (female), and 166/167 (female).

Table 69. Small mammals trapped in 5 geobotanical zones at Kokechik Bay, 1988.

Zone	Month[a]	Juveniles	Adults	Total	Captures/100 Trap-Nights
Tidal	May	1	1	2	2.0
Sedge	June	2	5	7	5.8
Flat	July	4	8	12	10.0
	Total	7	14	21	6.2
Grass	May	0	3	3	3.0
Meadow	June	2	2	4	3.3
	July	7	6	13	10.8
	Total	9	11	20	5.9
Low	May	4	2	6	6.0
Pingo	June	5	3	8	6.7
	July	12	2	14	11.7
	Total	21	7	28	8.2
Tall	May	0	6	6	6.0
Sedge	June	22	10	32	26.7
Marsh	July	15	2	17	14.2
	Total	37	18	55	16.2
Upland	May	0	1	1	1.0
Tundra	June	0	1	1	0.8
	July	1	0	1	1.1
	Total	1	2	3	1.1
Total	May	5	13	18	3.6
	June	31	21	52	8.7
	July	39	18	57	10.0
	Total	74	53	127	7.6

[a] Trapping dates were 31 May-3 June (May), 28 June-1 July (June), and 25-28 July (July).

Table 70. Date of first egg for black brant, cackling Canada geese, emperor geese, and Pacific greater white-fronted geese at Kokechik Bay, 1982-1988[a].

Species	1982	1983	1984	1985	1986	1988
Brant	26 May	21 May	24 May	27 May	29 May	16 May
Cacklers	29 May	18 May	20 May	26 May	23 May	15 May
Emperors	29 May	15 May	18 May	26 May	21 May	14 May
Whitefronts		21 May	24 May	26 May	25 May	15 May

[a] 1982-1986 data taken from Petersen (1987).

Table 71. Clutch sizes for black brant, cackling Canada geese, emperor geese, and Pacific greater white-fronted geese nesting at Kokechik Bay, 1982-1988[a].

	Brant		Cacklers		Emperors		Whitefronts	
Year	x	n	x	n	x	n	x	n
1982	2.7	30	4.6	45	6.1	86	3.3	3
1983	3.5	33	5.5	53	5.7	158	5.1	8
1984	3.2	52	5.5	35	5.6	91	4.1	7
1985	3.4	202	4.9	86	5.9	145	4.2	17
1986	4.1	68	4.8	49	5.7	75	4.2	16
1988	3.3	167	4.3	116	5.4	102	4.1	11

a 1982-1986 data from Petersen (1987).

Table 72. Nesting success for black brant, cackling Canada geese, emperor geese, and Pacific greater white-fronted geese at Kokechik Bay, 1982-1988[a].

Year	Brant		Cacklers		Emperors		Whitefronts	
	x	n	x	n	x	n	x	n
1982	58	33	76	55	90	86	50	2
1983	23	13	70	47	86	120	100	3
1984	8	93	47	73	60	141	57	1
1985	52	180	53	110	69	159	58	17
1986	0	110	34	104	32	174	58	19
1988	52	189	57	115	82	111	90	10

a 1982-1986 data from Petersen (1987).

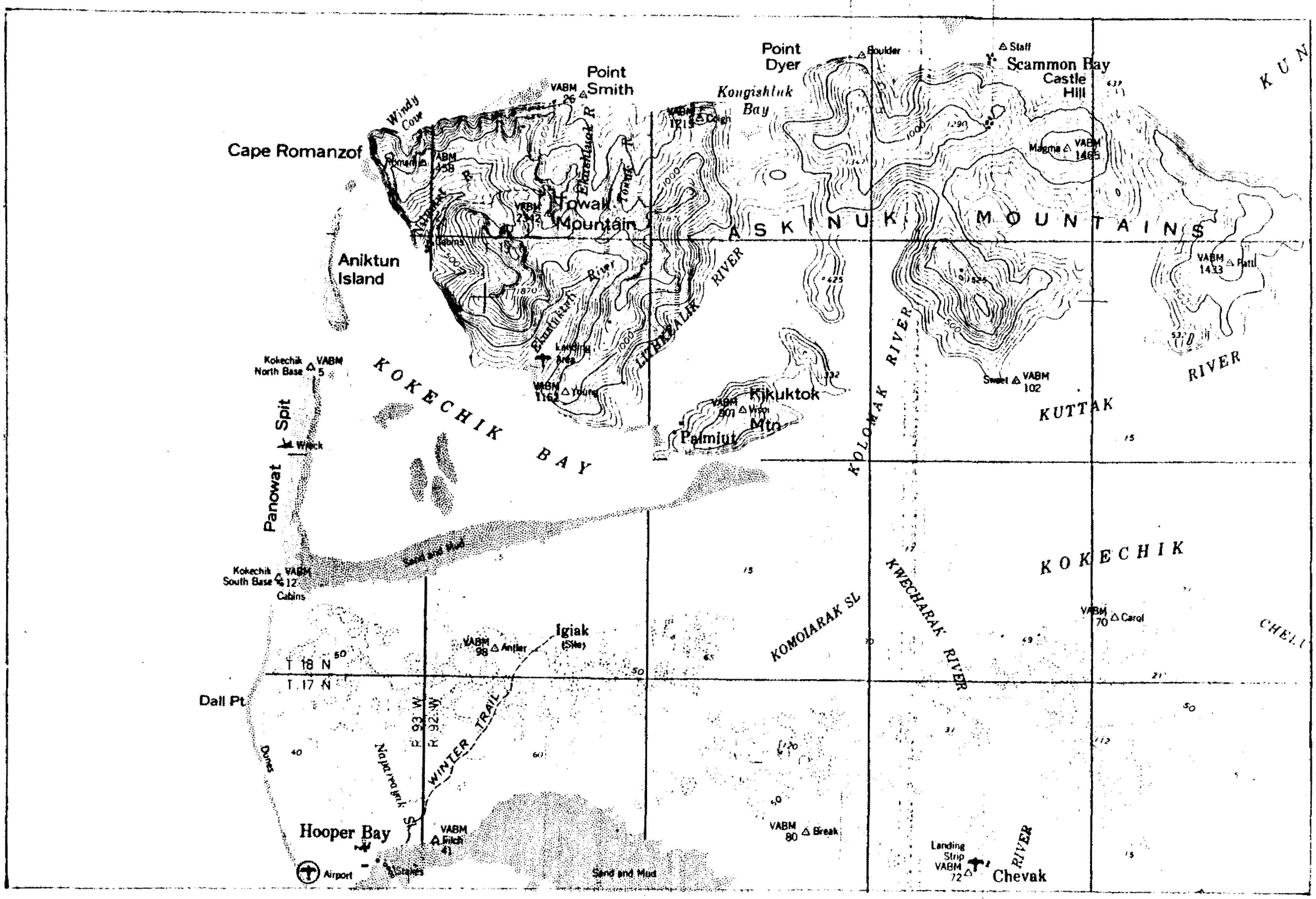

Figure 1. Overview of Kokechik Bay, Yukon Delta N. W. R., Alaska .

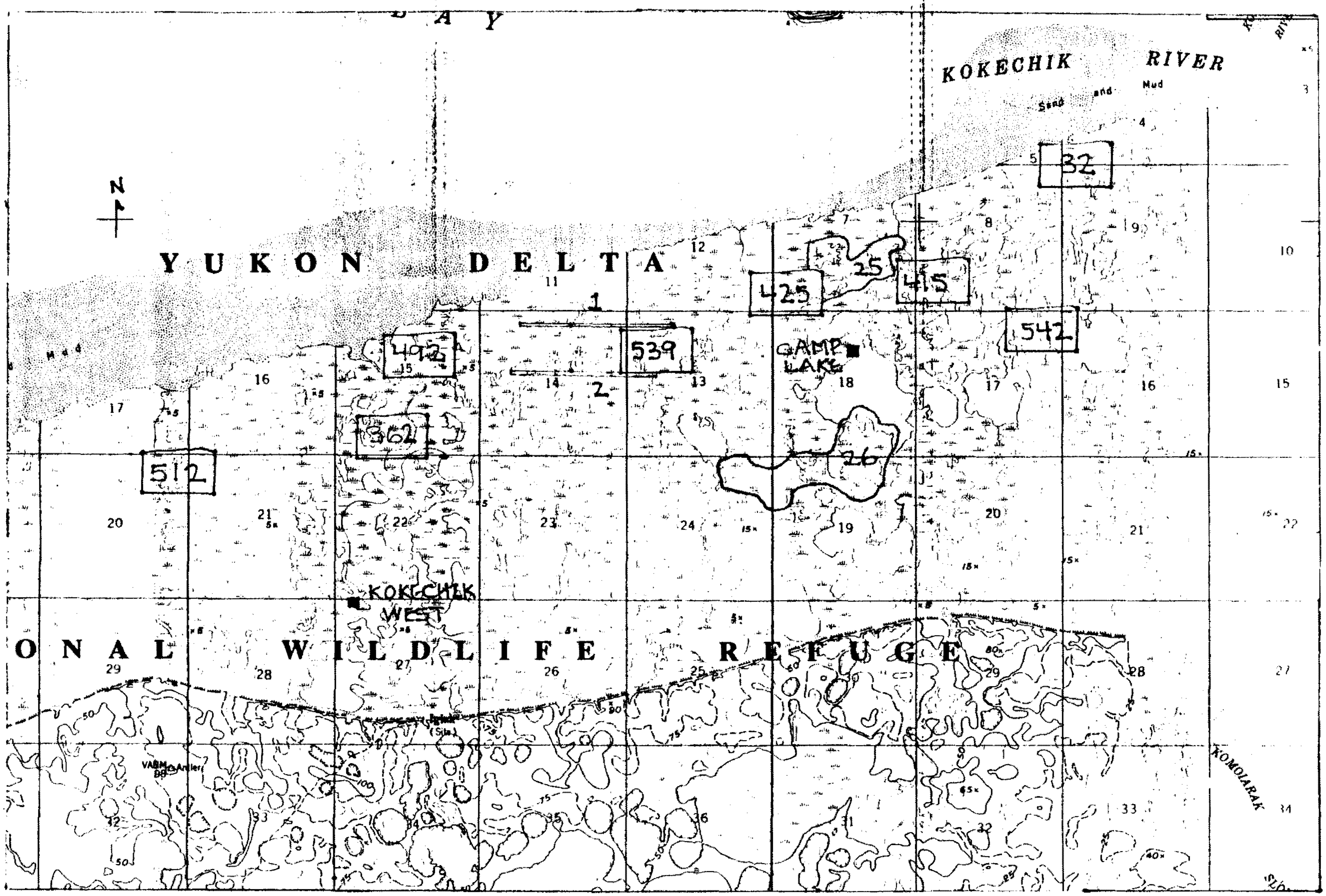

Figure 2. Study plots established at Kokechik Bay, 1988 (see Table 1 for descriptions).

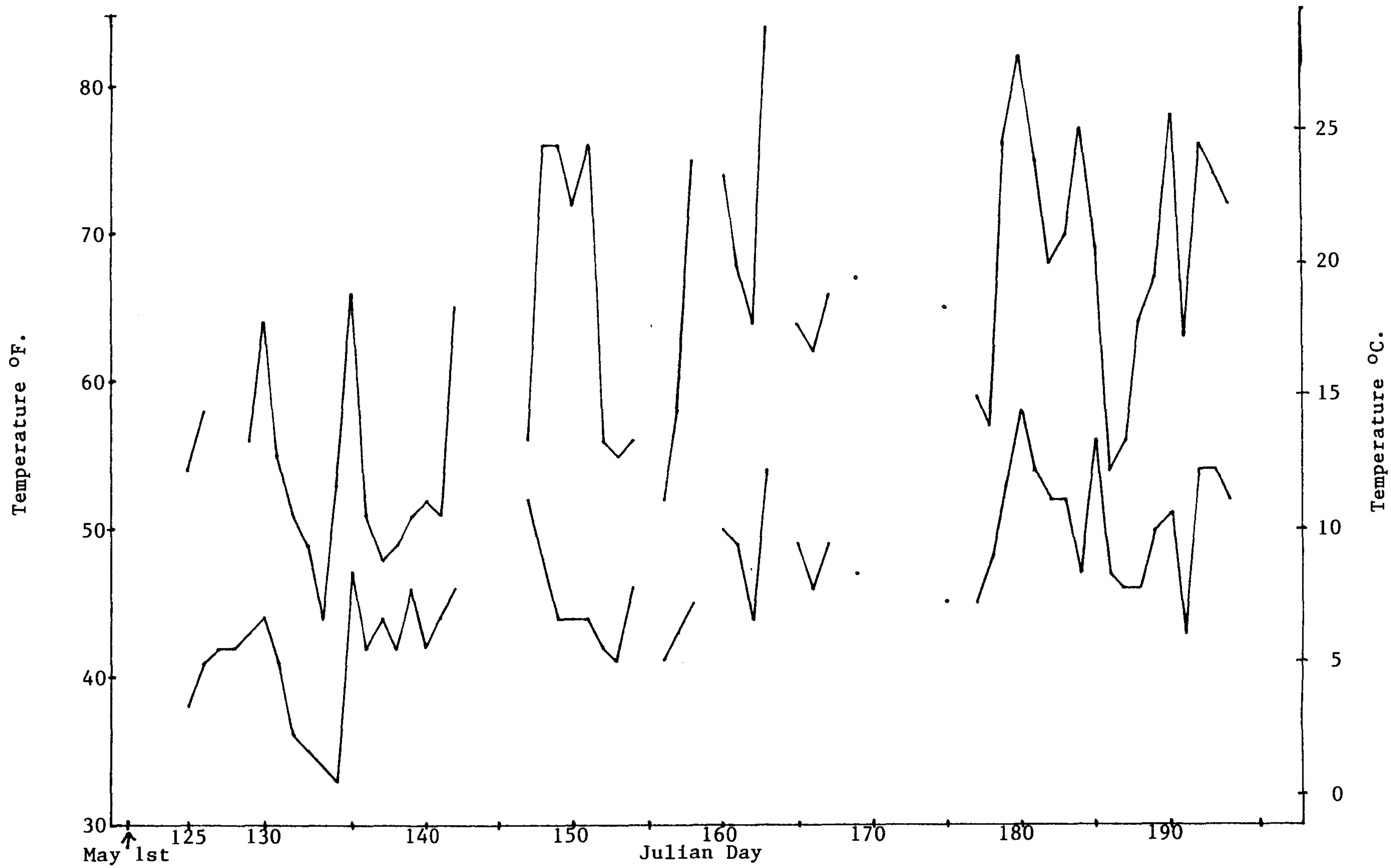

Figure 3. Daily maximum and minimum temperatures at Kokechik Bay, 1988.

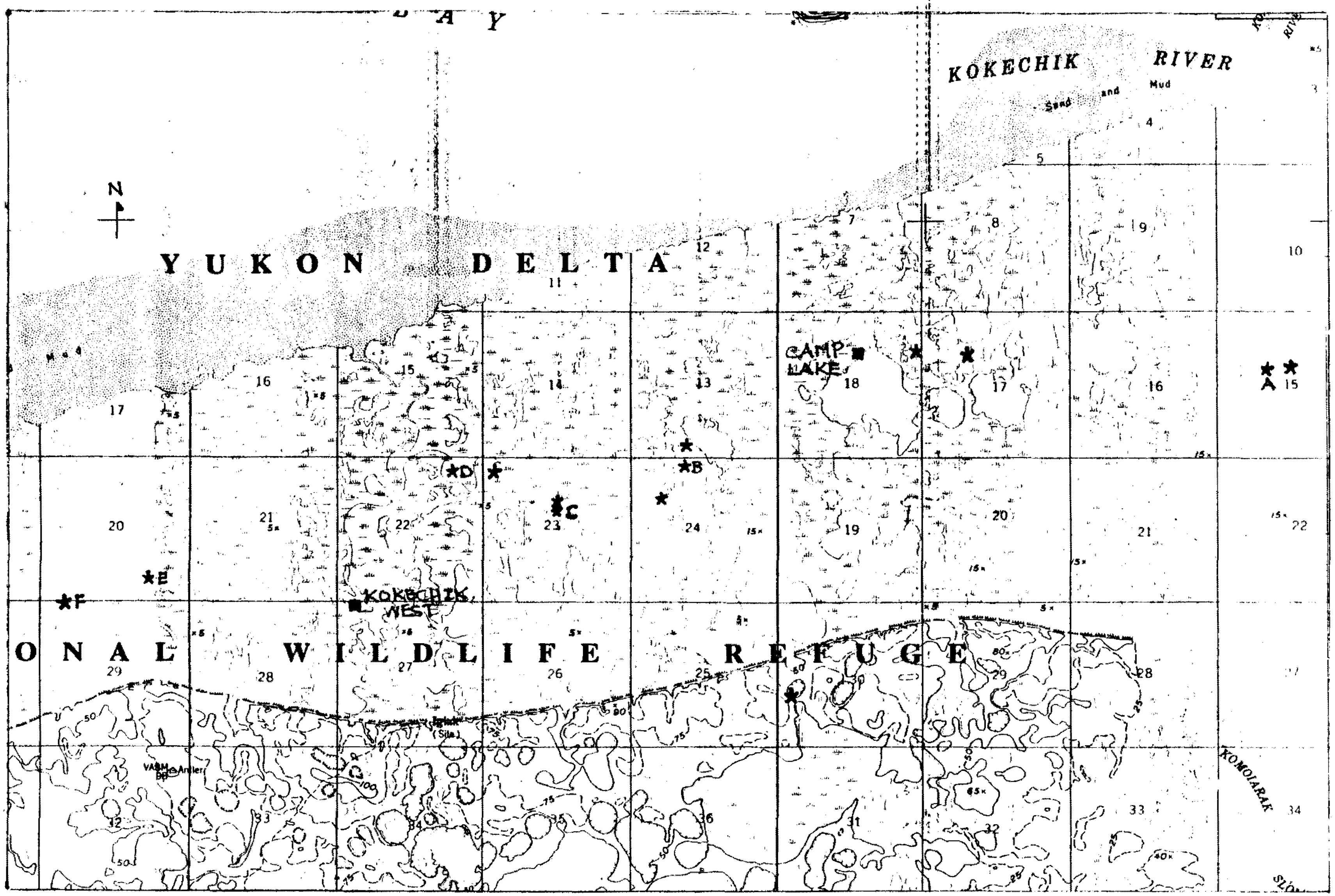

Figure 4. Dens occupied by arctic and red fox at Kokechik Bay, 1988 (refer to Table 26 for lettered dens).