PROGRESS REPORT:

Staging of Emperor Geese along the Alaska Peninsula - Spring 1989

by

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Key Words: Alaska Peninsula, behavior, Bristol Bay, Alaska, *Anser canagica*, Cinder River, collar observations, distribution, emperor goose, geese, mark/recapture, migration, Nelson Lagoon, productivity, waterfowl.

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ABSTRACT

In 1989, the Alaska Fish and Wildlife Research Center began the second year of a study evaluating annual and seasonal mortality of emperor geese and their use of estuaries during migration. Neck-collared and radio-tagged geese were observed from two study sites along the Alaska Peninsula, where a large proportion of the population concentrates during spring and fall.

At Cinder River, the staging population peaked with approximately 9000 geese during the second half of April. Geese using Nelson Lagoon were too widely dispersed to count from the ground, but an aerial survey on 5 May showed 12,049 using the area. Geese from the two study sites comprised 36.3% of the total spring count during the 5 May 1989 survey. Distribution of geese using both lagoons varied with tidal fluctuations. At Cinder River, areas used in the spring differed markedly from those used in the fall.

One of eleven radios applied to emperor geese in the previous summer was detected during two aerial surveys. Signals from the solar-powered collar radios were recieved within a range of 3 km using a hand-held "H" antenna.

The total number of collars identified in spring was less than one third of the total seen during the previous fall. This number should decrease proportionately with the population due to overwintering mortality. Limited access to geese and poor weather conditions reduced observer efficiency compared to that of the fall. The low ratio of marked to unmarked geese may reflect collar loss, disproportionate juvenile mortality, collar-induced mortality, or use of lagoons by different cohorts in spring. Further investigation will focus on quantifying the impact of each of these variables.

INTRODUCTION

Emperor geese are a northern Pacific Flyway species, with 80 to 90% of the population remaining within Alaska throughout the year. This Alaskan contingent nests along the coastal fringe of the Yukon-Kuskokwim Delta; the remainder of the population nests on the eastern coast of Siberia (King and Lensink 1971). Both groups overwinter in small, scattered flocks along the Aleutian Island chain (Eisenhauer and Kirkpatrick 1977).

Spring surveys of geese migrating along the Alaska Peninsula reveal a decline from approximately 150,000 counted in 1971 (King and Lensink 1971) to current levels, which have fluctuated around 50,000 since 1986 (King and Dau, unpubl. data). Little is known regarding the timing and cause of this mortality. Human impacts, such as environmental contamination and hunting pressure, are poorly understood. Low survival rates and low productive rates are believed to contribute to this decline (Petersen and Gill 1982, Petersen 1985).

In 1988, the Alaska Fish and Wildlife Research Center initiated a six-year study of neck-collared emperor geese to examine mortality, behavior, and migration routes. Objectives of this research include:

1) estimating annual and seasonal rates of survivorship, and comparing estimates among sexes and age groups;
2) developing population indices based on aerial surveys, age ratios, and mark/resighting data;
3) documenting movement of individuals among lagoons along the migration route, and fidelity to specific lagoons from year to year; and
4) understanding behavior with respect to tide cycle, season, habitat availability, and age distribution.

Analysis of mark/resighting data provides a means of evaluating current estimates of survival and production (e.g., Lensink 1988, King and Dau 1987). Investigation of mortality factors affecting emperor geese during the breeding season may enhance our understanding of population declines observed in other species also nesting on the Yukon Kuskokwim Delta.

BACKGROUND

Population levels of emperor geese were monitored over the past decade with aerial surveys conducted during spring and fall migration (King and Dau 1987, King and Eldridge 1988). In order to provide an index of annual production, production estimates have been made each year at Izembek Lagoon beginning in 1966 and sporatically at Nelson Lagoon (Petersen and Bill 1982). To provide an annual production indes for the entire population, age ration are being estimated from aerial photographs taken along the entire peninsula in fall (Petersen and Gill 1982, Butler et al. 1989).

From 1982 to 1987, U. S. Fish and Wildlife Service biologists collared 1331 molting emperor geese on the Yukon Delta National Wildlife Refuge (NWR). At Kokechik Bay, Petersen (1987a) collared an additional 100 adult females and monitored these birds on the nesting grounds from 1982 to 1987. In the fall of 1986 and 1987, Wilk et al. (1987) recorded observations of collared geese while monitoring migration at Cinder River.

In 1988, 800 geese were collared from 6 locations on the Yukon Delta NWR. Captured birds represented family groups, including 431 juveniles from known natal areas. Simulations using the computer programs SURVIV and RELEASE (Burnham et al. 1987) revealed that at least 800 marked geese should be released each year in order to obtain survivorship estimates with 80% confidence limits. These simulations assumed a 20% resighting rate, derived from observations of nest-trapped geese on the Yukon Delta (Petersen 1987b).

Radio packages were applied to one adult male and ten adult females captured during banding drives in 1988. Five of these were solar-powered radios affixed to plastic neck collars. The remaining six were backpack radios attached with PVC-coated wire harnesses. These frequencies were monitored during aerial surveys in the fall of 1988 and spring of 1989.

STUDY AREA

Aerial surveys for radio-transmittered geese encompassed 550 km of the northern shore of the Alaska Peninsula from King Salmon to Cold Bay. This coastline includes seven major bays used by emperor geese during spring and fall staging (Figure 1).

Study sites were established at two staging areas, Cinder River and Nelson Lagoon. Approximately 625 km southwest of Anchorage, Cinder River (57°27'N, 158°07'W) empties into a shallow lagoon as it drains into Bristol Bay (Figure 2). Both sides of the lagoon mouth and the west shore consist of sand and sand cobble, while extensive mudflats occupy the south end and the east shore. A deep channel bisects the lagoon from the southwest end to the mouth. Outside the lagoon, the Bristol Bay coast consists of sandy dunes interrupted by numerous tidal sloughs.

At Cinder River, the dune area adjacent to the lagoon shore is dominated by beach rye grass (Elymus arenarius). The area inland of the lagoon is composed of numerous lakes and upland tundra, characterized by crowberry (Empetrum nigrum), sphagnum (Sphagnum spp.), cow parsnip (Heracleum lanatum), and low-bush cranberry (Vaccinium vitus-idaea).

Nelson Lagoon (56°00'N, 161°10'W) lies along the northcentral Alaska Peninsula approximately 875 km southwest of Anchorage. The study area includes eight islands and the surrounding mixed mud and sandflats (Figure 3). The island and lagoon shoreline is composed of sand and sand cobble; the dominant vegetation is beach rye grass. The area inland of the lagoon resembles that of Cinder River. Gill and Jorgenson (1979) describe the study area in detail.

METHODS

Four observers monitored marked birds during spring migration, with two persons at Cinder River (20 April to 13 May) and two at Nelson Lagoon (20 April to 18 May). Observations of emperor geese were conducted opportunistically in order to maximize collar observations. Flocks were observed from wooden blinds or approached by foot along the mudflats and shoreline roosting areas. We recorded time, tide stage, location, behavior, general flock activity, and total flock size at the beginning of each observation. The flock was then scanned repeatedly for collars with a Questar telescope. After reading collars, we scanned the flock again to obtain a ratio of marked to unmarked geese among those birds with necks and heads fully exposed. A final scan was conducted to record presence or absence of tarsus bands, including only geese with both legs exposed during the scan. Birds were re-examined for neck collars after a tarsus band was observed.

A remote radio-receiving station was established on the south side of the Cinder River lagoon mouth (Figure 2). The 11 frequencies applied to emperor geese were continuously monitored from 21 April through 12 May using a receiver controlled by a data collection computer. We erected two 4-element Yagi antennas, 45° apart, directed north and east towards the lagoon mouth at approximately 22 m above mean lower low water. Two solar collar radios were placed 1.5 km southwest of the remote station to serve as beacons. This system was checked weekly for power, RF gain adjustments, and presence of radios in the area.

At Nelson Lagoon, researchers scanned for emperor goose frequencies with an ATS receiver and portable hand-held "H" antenna. Telemetry hikes were conducted daily on the mudflats around Cannery Island during low tide and whenever researchers visited other islands within the study area. Transmitter range was tested at Nelson Lagoon by placing two solar collar radios at camp and noting signals on receivers hand-carried to known distances.

We recorded temperature, wind speed, and wind direction three times daily at both sites. Maximum and minimum temperatures and precipitation were taken each morning.

Goodness-of-fit tests were employed to compare observed to expected age ratios among marked geese (a=0.05) using the likelihood ratio estimate (G^2 - Sokal and Rohlf 1981). Weighted averages for percentages of marked individuals and juveniles were calculated with 95% confidence intervals following Cochran (1963). Capture histories of marked geese were compiled with dBase data management system and an initial estimate of survivorship was attempted using the program JOLLY (Pollack et al. 1985, Brownie et al. 1986).

RESULTS

Weather

The spring of 1989 was wet, cold, and windy along the Alaska Peninsula (Table 1). Winds remained below 10 kmh for only 4 days during the 21 day observation period at Cinder River and for 5 of 26 days at Nelson Lagoon. Strong winds (over 30 kmh) generally originated from the southeast at Cinder River. In comparison, winds above 30 kmh at Nelson Lagoon were from the south, southeast, and southwest (Figure 4). Daily temperature fluctuations (Figure

5) as well as cloud cover and average precipitation (Table 1) were similar at both study sites. Cinder River recorded higher wind speeds while Nelson Lagoon experienced more total rainfall (Table 1).

Collar Sightings

In the spring of 1989, 47 unique collars were sighted from the combined efforts at Nelson Lagoon and Cinder River. Thirty-seven of the 47 collars seen (78.7%) were applied in 1988. Observations from both sites accounted for only 4.6% of all geese collared in 1988 (Table 2). In contrast, observations from the previous fall accounted for 19.6% of the geese collared in 1988 (Cantor et al. 1989).

Only ten of the 47 collars seen (21.3%) were from geese banded prior to 1988 (Table 2). Five of these ten birds were seen for the first time at Nelson Lagoon. The remaining five birds were observed at Cinder River; two of these had been observed previously at Cinder River during fall migration. One goose, collared in 1984, had lost its collar and was identified by tarsus band only.

Among the 37 collars observed from the 1988 banding effort, 21.6% were juveniles when banded (Table 3). This proportion is significantly lower than that of juveniles originally released at the banding site ($G^2=16.9$, $p<.05$).

At Cinder River, 112 observations yielded 24 unique collar sightings. Fifteen of these collars (62.5%) were also seen at Cinder River the previous fall (Table 4). A total of 77 collar readings included multiple sightings for 14 collars. Assuming these 14 collared geese remained within the lagoon between first and last sighting, a maximum of 12 collared geese were confirmed present in the lagoon on 26 April (Figure 6a). Four geese were seen over a span of 13 days. The majority of collars (79.2%) were read before 3 May, reflecting a major outmigration observed on that date.

At Nelson Lagoon, 23 collars were read from 217 discrete observations. Four of these collars (1.7%) had been sighted at Cinder River in the previous fall (Table 4). A total of 118 collar readings included multiple sightings for 13 individuals. The maximum number of collared geese known to be using Nelson Lagoon at one time was 9 on 3 and 13 May (Figure 6b). Two individuals were sighted over a span of 13 days.

The ratio of marked to unmarked geese at Cinder River did not differ significantly from those at Nelson Lagoon; consequently, the two data sets were combined. We thus obtained a total sample of 160 flocks, including 44,219 individual geese. Marked geese constituted 0.167 ± .041% of the sample, or one per 597.6 ± 146.7 birds examined. The proportion of marked birds observed this spring was significantly lower than that recorded during the previous fall migration. Cantor et al. (1989) found marked geese comprised 0.69 ± .09% of the population in the fall.

Radio-telemetry

Of the 11 radios applied to emperor geese in the summer of 1988, only 6 were detected during the subsequent fall migration (Cantor et al. 1989). During two spring surveys over the northern shore of the Alaska Peninsula, a single frequency was detected along the migration route. The frequency 167.633 was heard in the Seal Islands area on 23 April (C. Dau, Izembek NWR, unpubl. data). However, this signal was not observed during a second flight conducted on 5 May (R. King, unpubl. data). The same signal had been heard repeatedly at Seal Islands during the previous fall migration. This solar-powered radio was affixed to a neck-collar and applied to an adult female in the summer of 1988 (Cantor et al. 1989).

Experiments with hand-held receivers at Nelson Lagoon showed an approximate receiving range of 3 km, using solar-powered radios identical to those applied to geese in 1988. No transmittered geese were recorded from the ground at Cinder River or Nelson Lagoon during the spring of 1989.

Population

Daily ground censuses were hindered by the widely dispersed distribution of geese at both Cinder River and Nelson Lagoon. However, aerial surveys provided population estimates which correlated well with numbers and distributions observed from the ground (Table 5).

An aerial survey of Cinder River showed approximately 9000 geese in the lagoon when researchers arrived on 20 April. Ground observations indicated a drop in numbers on 30 April. This decrease was confirmed on 5 May, when 4,512 were counted in the lagoon during the spring survey (R. King, unpubl. data). On 11 May, at least 2000 geese remained in the area. By 13 May, only one flock of 800 was counted from the air when observers left Cinder River.

At Cinder River, peak migration occurred at least ten days prior to the peak in 1988. In 1988, the highest counts of 10,000 to 13,000 geese at Cinder River occurred during the first week of May (Cantor et al. 1988).

At Nelson Lagoon, 11,022 geese were counted during the aerial survey of 5 May. An additional 1,027 geese were counted at Port Moller and Mud Bay (R. King, unpubl. data).

This year, geese using Cinder River comprised 9.9% of the total spring survey count (Table 5). Aerial surveys conducted over the past eight years recorded from 5.4 to 15.0% of the total population in Cinder River during spring migration (excepting the late migration of 1982). In comparison, geese observed at Nelson Lagoon contributed 26.4% of the total survey count. This proportion has ranged from 16.1 to 59.6% each spring since 1981.

Distribution

Goose behavior was strongly related to tide height and resultant changes in habitat availability, both during spring and fall migration. During both seasons, geese fed in the exposed mudflats during low tide, moving to shoreline roost sites as these areas became submerged. However, feeding and roosting sites differed markedly from spring to fall at Cinder River (Figures 7 and 8).

At Cinder River, habitat use correlated well with previous observations during spring migration. Geese roosted exclusively on mudflats and tundra ponds on the south and east shores of the lagoon. In contrast, fall roost sites occurred at the tide line on sandy beaches of Bristol Bay, within 4 km of the lagoon mouth. Feeding geese were more dispersed in spring than in fall, and appeared to be eating a variety of invertebrates in addition to blue mussels (Mytilus edulis). In fall, feeding was restricted to mussel beds within 1 km of the mouth (Cantor et al. 1989).

Geese were observed preening and roosting on island shores at Nelson Lagoon. As the tide dropped, geese moved on to lagoon mud and sandflats to feed, following the tideline south towards channels with exposed mussel beds. Geese returned to roosting sites as the tide rose and covered feeding areas (Figure 9).

DISCUSSION

Weather conditions along the Alaska Peninsula resembled those experienced in the previous spring. Peak arrival of geese at Cinder River was 10 days earlier than in 1988. In contrast, late winter storms coupled with low temperatures on the Yukon-Kuskokwim Delta delayed goose migration and nesting chronology in 1989 (Perry 1989). This suggests that weather conditions in the Aleutian Islands influences migration to staging areas on the Alaska Peninsula, while weather on the staging grounds and nesting areas affects timing of migration to nesting areas.

The total spring count for emperor geese in 1989 was 60% of the previous fall count (R. King, unpubl. data). Since 1981, surveys dropped below this level only in one year (King and Dau 1987 - Table 5). The Pacific Flyway Council relies on spring surveys to monitor emperor goose population levels, as "birds are more concentrated during a shorter time period than during the more protracted fall migration" (Hogan et al. 1988:3). Management decisions are currently based on a running three-year average of spring surveys. Hunting is prohibited when the three-year average drops below 60,000. Spring counts have remained below this threshold since 1985. The current three-year average is barely a third of the management goal of 150,000 geese.

The total number of collars observed at both camps this spring was less than one third of the total from Cinder River alone last fall. With no production since the previous observation period, we would expect the total number of collars in the population to decrease proportionately with the population. The dramatic difference between fall and spring surveys suggests the possibility that severe overwintering mortality occurred this year.

The number of collars observed was further reduced by the fact that observer efficiency was lower in spring than in fall. Spring roosting sites were inaccessible, and feeding areas were widespread, limiting the effectiveness of wooden observation blinds. The frequency of spring storms and severe heat waves further impeded our efforts. However, the low proportion of marked geese in the population suggests that additional factors played a role in decreasing collar sightings. The ratio of marked to unmarked geese would be affected by collar loss, disproportionate juvenile mortality, changes in goose distribution, and collar-induced mortality.

The extent of collar loss has not been quantified in emperor geese, but may represent an important parameter in mark/recapture models (Kremers 1988, Arnason and Mills 1981, Nelson et al. 1980). Collars may slip off shortly after application or break after an extended period of wear. In Canada geese (Branta canadensis), the effect of collar loss on neckband studies can be "severe" over the course of several years (Zicus and Pace 1986). The rate of collar loss for emperor geese needs to be quantified through continued examination of tarsus bands.

Since an equal number of marked juveniles and adults were released in 1988, disproportionate juvenile mortality would reduce the proportion of marked geese in the population. In fact, the decreasing proportion of juveniles in the marked population indicates that mortality is significantly higher in juveniles than in adults. This is not unreasonable; Barry (1984) reports juvenile mortality rates as high as 74% in snow geese (Anser caerulescens).

The proportion of collared birds in our sample may also be affected if different cohorts of the population use the lagoon in spring and fall. Evidence from collar returns suggests that fidelity to specific staging areas from fall to spring is high, but not absolute. Continued monitoring of radio-collared geese will enhance our understanding of the turnover rates and site fidelity of geese staging along the Alaska Peninsula.

Finally, the possibility of collar-induced mortality must be addressed. Given the remoteness of emperor goose habitat throughout its range, major collar-induced mortality may occur undetected. Anckney (1975) reported higher starvation rates among neck-banded lesser snow geese; however, Raveling (1976) disputed this finding on the basis of biases in sampling strategy. For Canada geese, Craven (1979:271) found "no evidence...that neckbands cause physical damage or impairment...other than an icing problem". Furthermore, he reported that icing only occurred at temperatures at or below -17°C. Emperor geese would rarely encounter temperatures this low on the wintering grounds along the Aleutian Island chain (Naval Oceanography Command Attachment 1986). This winter, researchers from Dutch Harbor to Shemya repeatedly observed nine collared geese under a variety of conditions. No evidence of neckband icing was discovered (Byrd 1989).

Preliminary attempts to assess survivorship rates based on collar sightings produced unacceptable confidence limits. Although limited data are available from releases prior to 1988, only a single survivorship period has elapsed since the release of 800 collared geese in 1988. As the study progresses, we hope to achieve a resighting rate sufficient to decrease these confidence limits. It is encouraging that a 36.3% of all geese counted on the spring survey occurred within the two study sites; with additional turnover as migration proceeds, perhaps as many as 50% of the population are accessible at some time during migration.

In an assessment of survival rates for Pacific Flyway geese, Lensink (1988) estimated annual survivorship based on age ratios and census results. He determined that an annual survival rate of at least 75% is necessary to sustain a stable emperor goose population. The overall population decline, coupled with the wide descrepancy between fall and spring survey counts, suggests that survivorship falls well below this threshold level.

The low return rate of radio-transmittered geese may be due to technical failure of the radios or mortality of transmittered geese. As the solar collars have an expected life of three years, we may detect these frequencies in future surveys.

Tide height strongly affectes goose distribution and behavior in spring and fall (Petersen 1983). Feeding primarily occurs during low tide, when mudflats are exposed. At Cinder River, changes in feeding distribution from spring to fall probably reflected differences in growth and distribution of mussel beds. Changes in food availability may also account for seasonal variation in goose distribution during high tide, if roost sites were selected for proximity to food resources.

RECOMMENDATIONS

1. Continue monitoring migration from both Cinder River and Nelson Lagoon. Increase observer efficiency with the use of wooden observation blinds and towers. Improve access to geese on Nelson Lagoon by moving camp from Cannery Island to the mainland on the south shore of the lagoon and/or the Kudobin Islands. Increase the number of personnel stationed at Nelson Lagoon to three.

2. Continue assessments of survivorship rates based on capture histories of neck-collared birds.

3. Evaluate the possibility of collar-induced mortality by examining recapture rates of geese trapped for banding. The recapture rate of geese with metal leg-bands only will be compared with that of neck-collared geese.

4. Evaluate the rate of collar loss with continued sampling for presence of tarsus bands. Whenever conditions allow, marked to unmarked ratios will be obtained from sampling legs and necks during separate scans.

5. Establish four remote radio receiving stations along the Alaska Peninsula: one at Cinder River, two at Nelson Lagoon, and one at Seal Islands.

6. Collect geese for stomach analysis, in conjunction with the sampling of invertebrates within feeding areas. Develop map of mudflat habitat zones and sample use by geese within these zones. Identify sub-areas within the study area for spring and fall aerial surveys to obtain counts of geese within specific areas of the lagoon.

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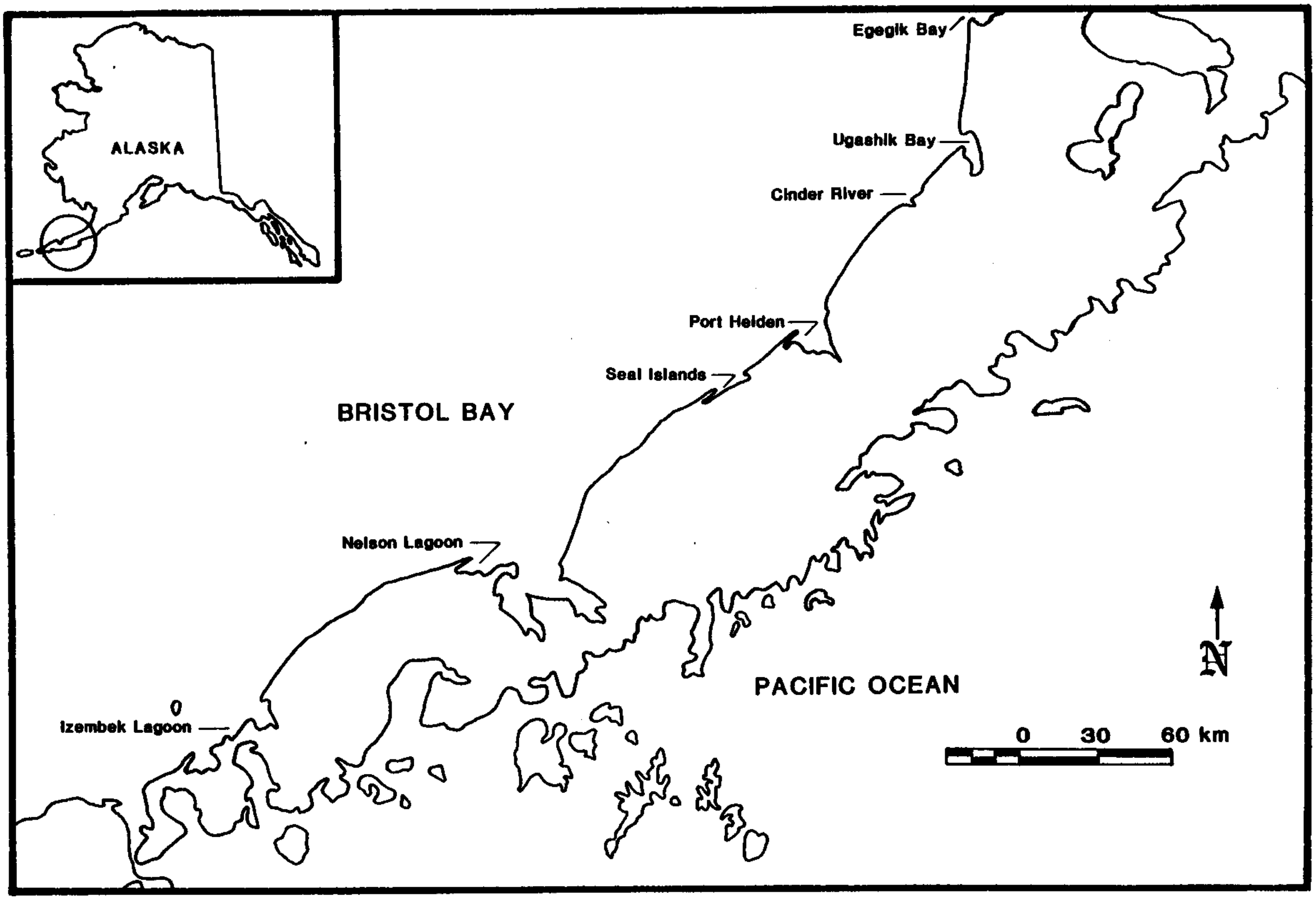


Figure 1. Area surveyed for emperor geese along the north shore of the Alaska Peninsula, Alaska.

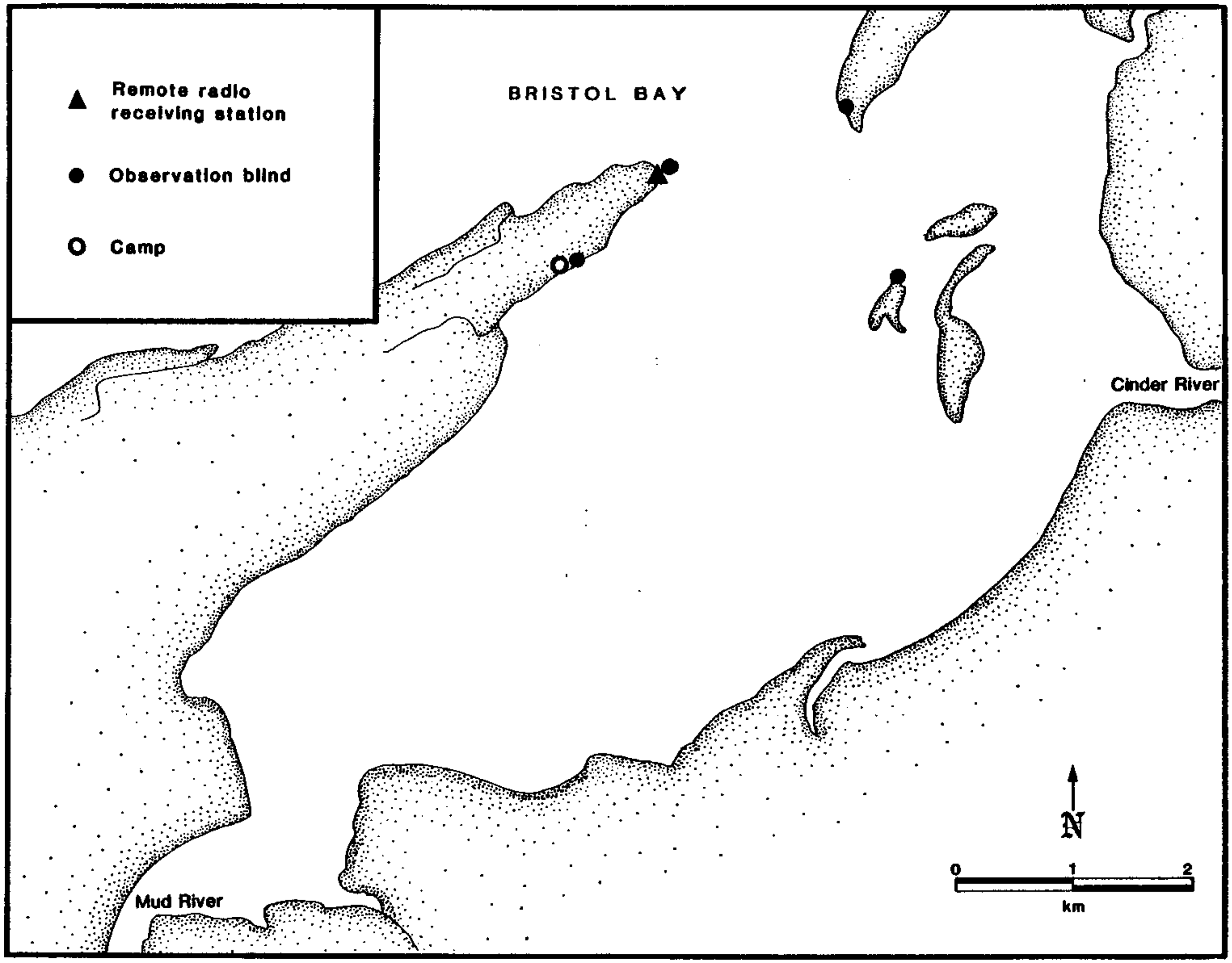


Figure 2. Cinder River study area on the Alaska Peninsula, Alaska.

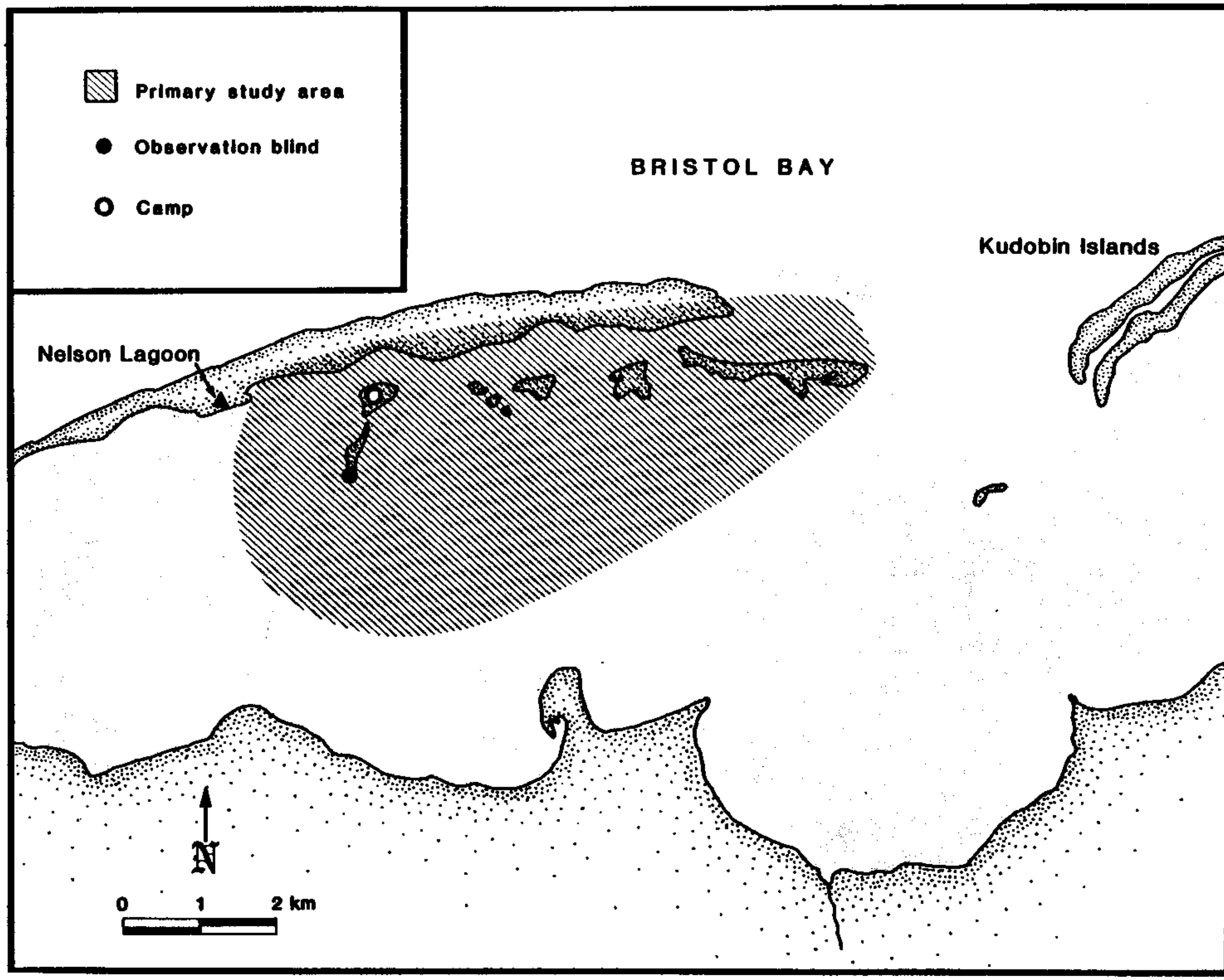
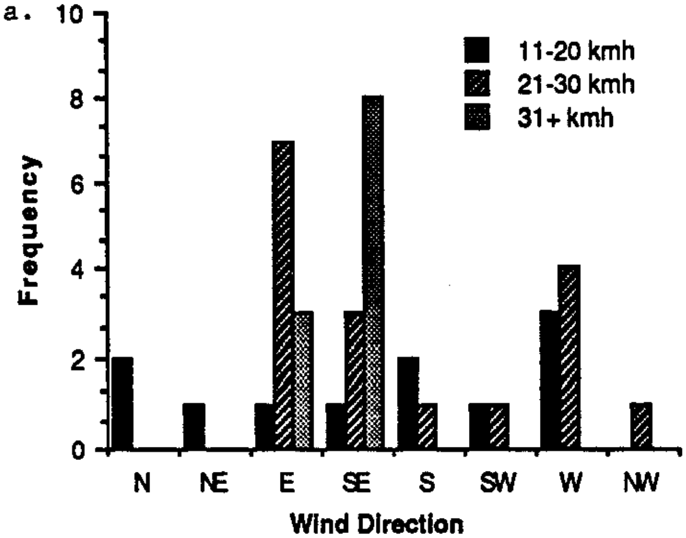


Figure 3. Nelson Lagoon study area on the Alaska Peninsula, Alaska.

a.



b.

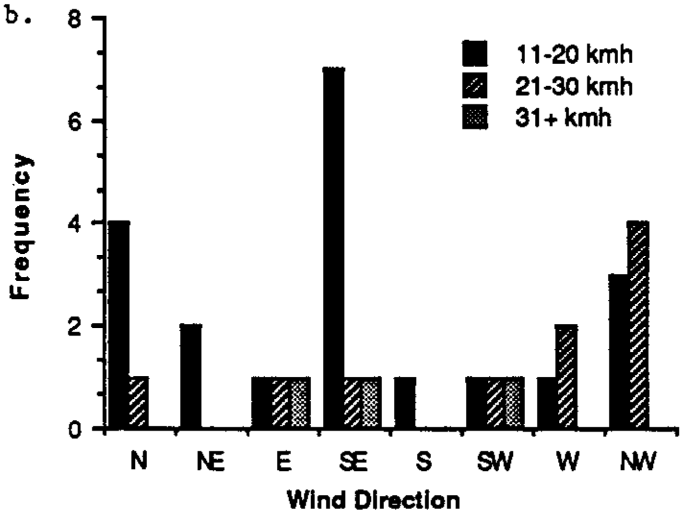
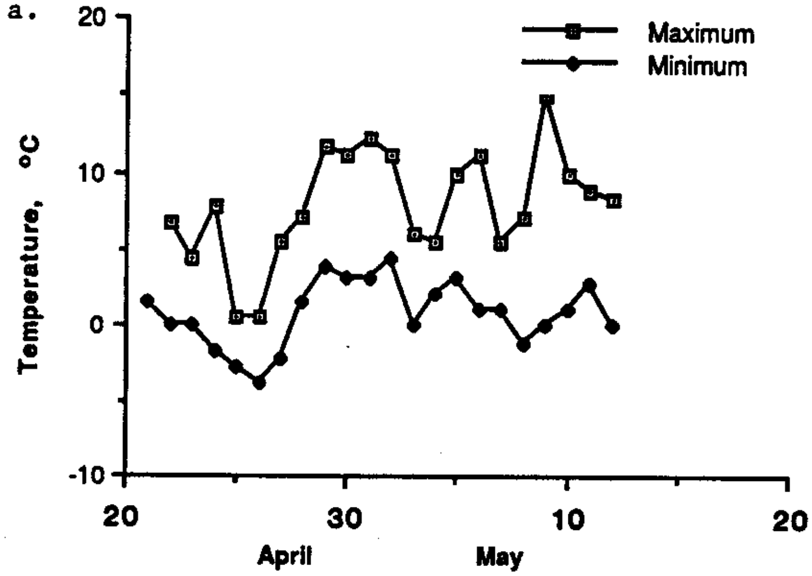


Figure 4. Wind speed and direction at the Cinder River (a) and Nelson Lagoon (b) study sites.

a.



b.

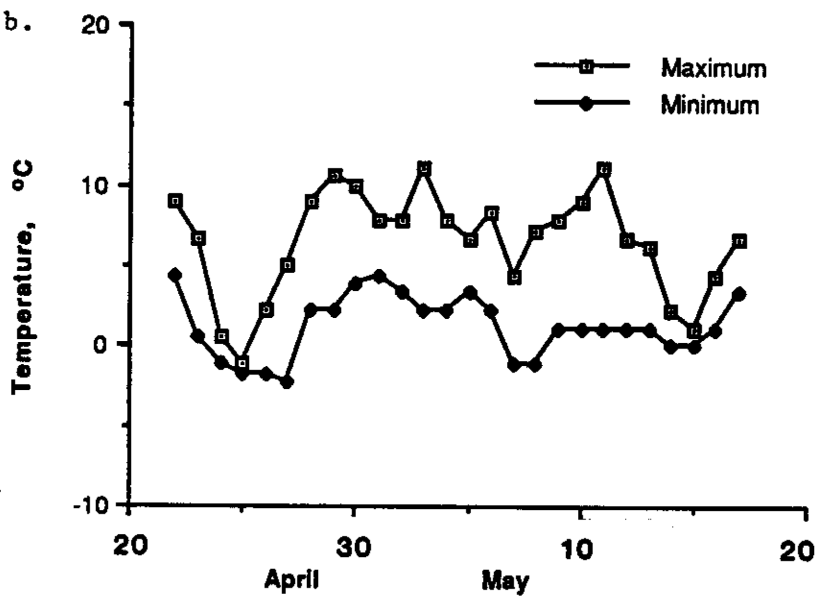
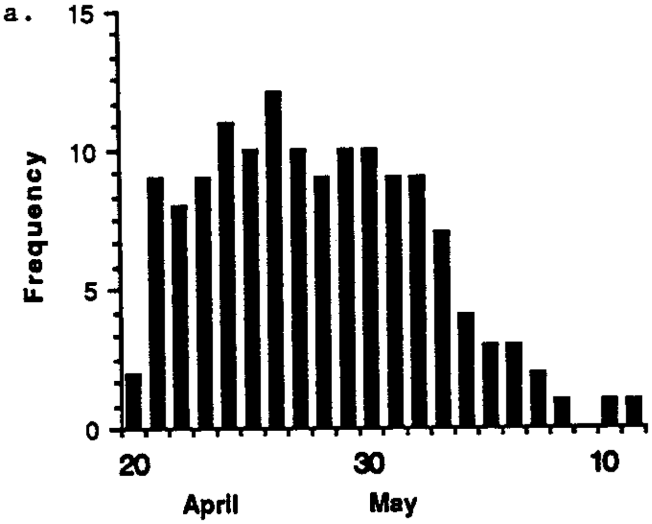


Figure 5. Maximum and minumum temperatures at the Cinder River (a) and Nelson Lagoon (b) study sites.

a.



b.

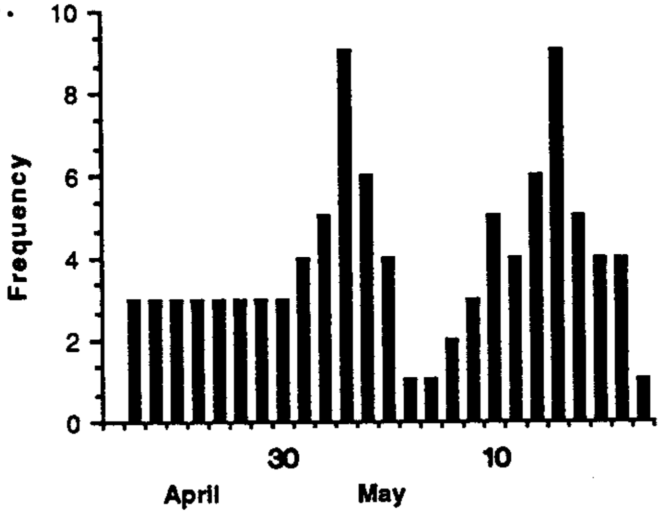


Figure 6. Numbers of confirmed collars observed daily at Cinder River (a) and at Nelson Lagoon (b).

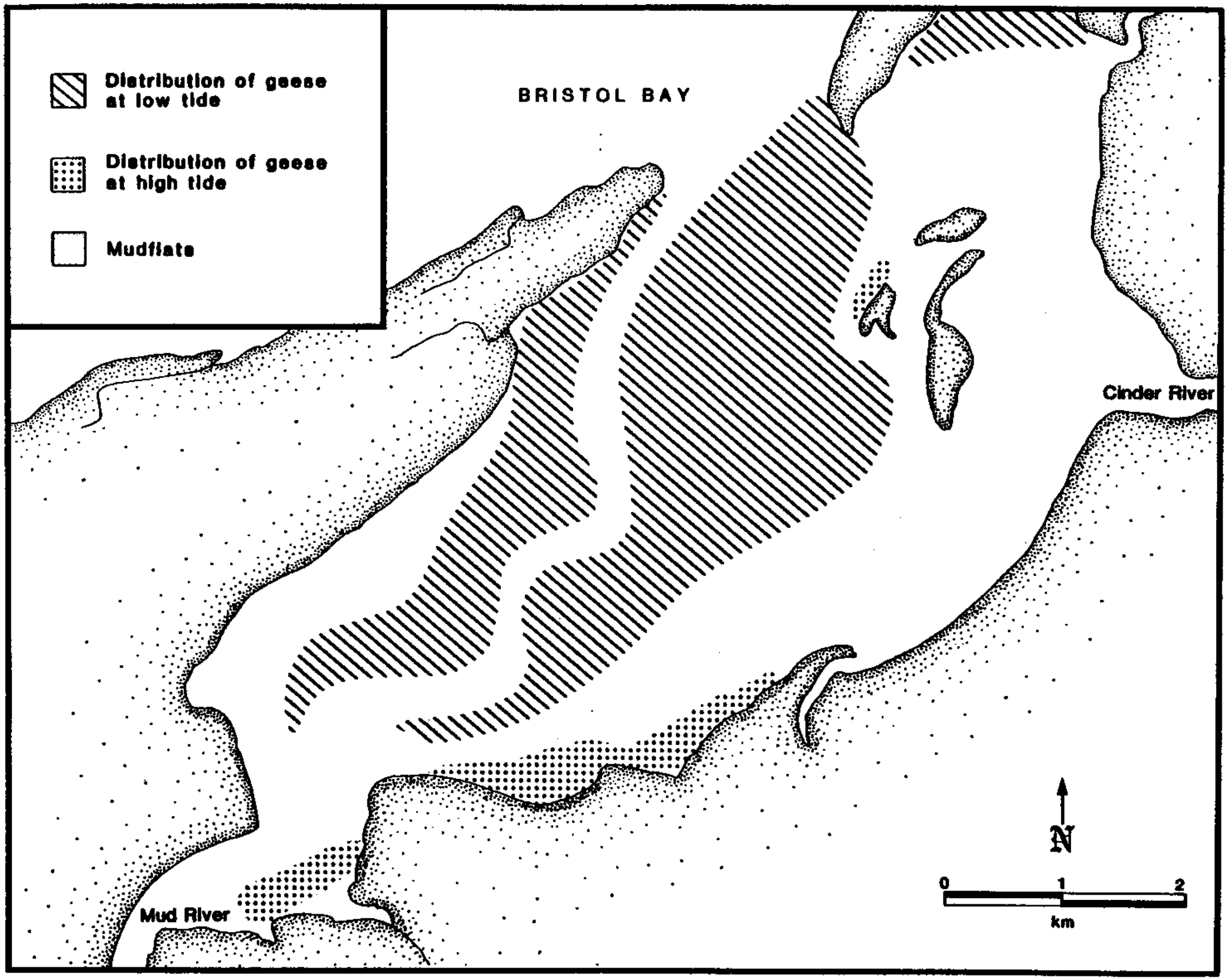


Figure 7. Spring distribution of emperor geese at Cinder River, Alaska, with respect to tide cycle.

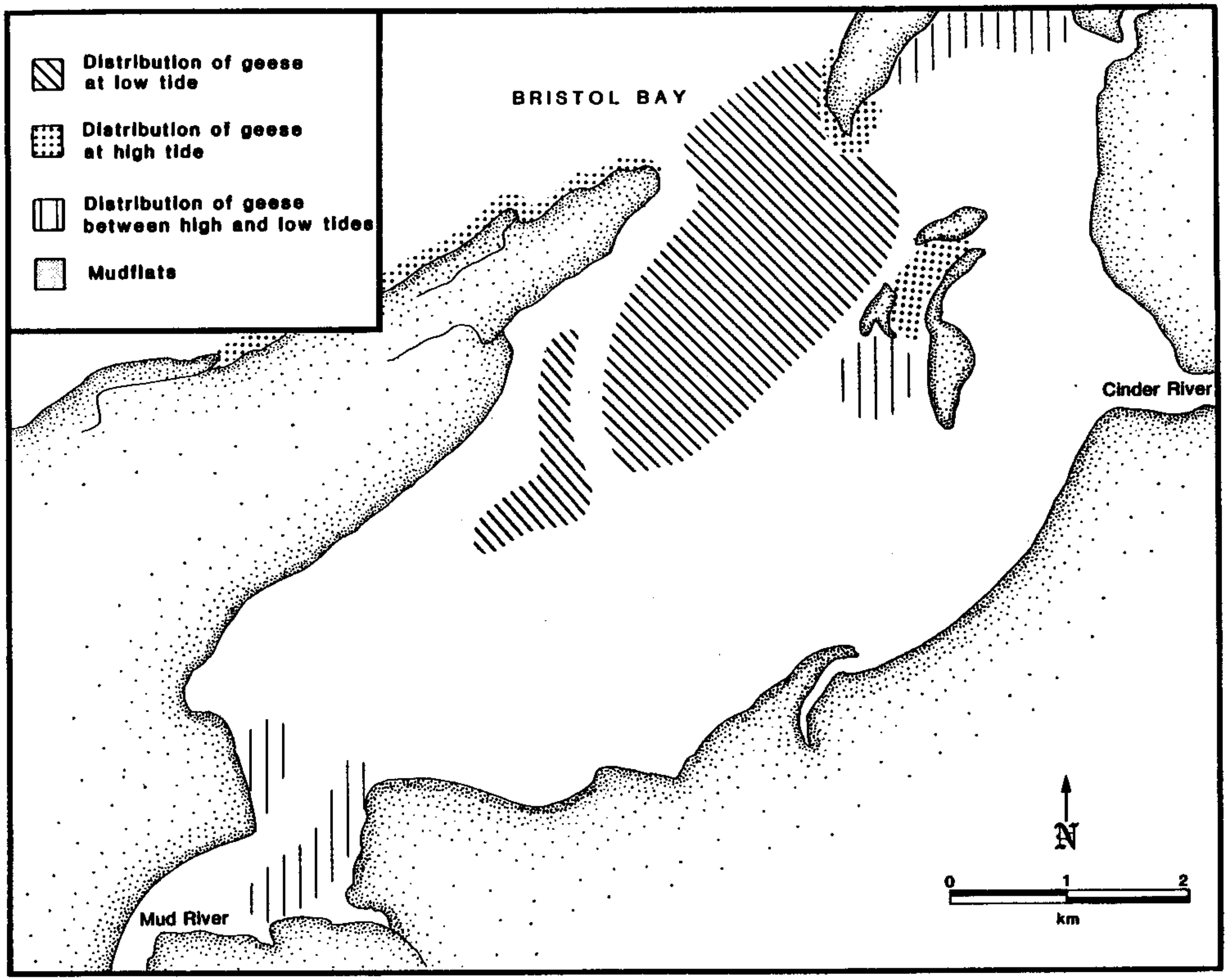


Figure 8. Fall distribution of emperor geese at Cinder River, Alaska, with respect to tide cycle.

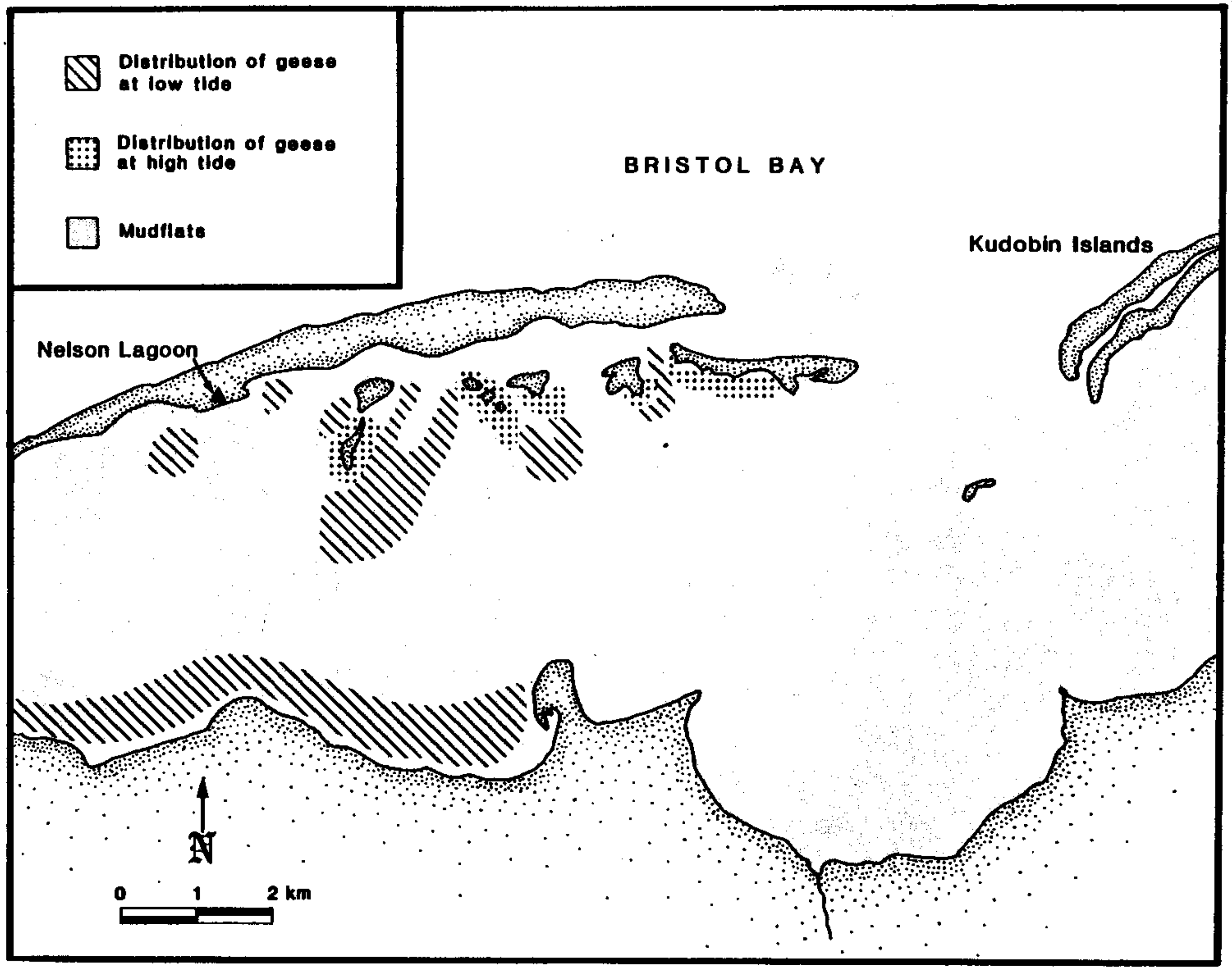


Figure 9. Spring distribution of emperor geese at Nelson Lagoon, Alaska, with respect to tide cycle.

Table 1. Weather conditions recorded along the Alaska Peninsula during the spring of 1989.

	Cinder River 21 April-12 May	Nelson Lagoon 22 April-17 May
Total observation days	21	26
Average minimum temperature	1.2°C	1.2°C
Average maximum temperature	7.6°C	6.5°C
No. of days with temperature $\leq$ 0°C	10	8
Average cloud cover	80%	85%
Total precipitation	36.8 mm	6.1 mm
Average precipitation per day	1.8 mm	2.2 mm
No. of days with precipitation	10	15
Average wind speed	18.3 kmh	9.6 kmh
No. of days with winds < 10 kmh	4	5
No. of days with winds > 30 kmh	6	3

Table 2. Numbers of collared birds released during banding drives on the Yukon-Kuskokwim Delta and subsequently observed on the Alaska Peninsula.

Year released	Total number released	Number seen in fall of 1988 (% of total)	Number seen in spring of 1989 (% of total)
1982	409	0 (0.0%)	2 (0.4%)
1983	303	1 (0.3%)	1 (0.3%)
1984	566	6 (1.1%)	3 (0.5%)
1985	18	0 (0.0%)	0 (0.0%)
1986	9	1 (11.1%)	0 (0.0%)
1987	226	3 (1.3%)	4 (1.7%)
1988	800	154 (19.3%)	37 (4.6%)
Total	2331	165 (7.1%)	47 (2.0%)

Table 3. Distribution of adults and juveniles collared, released, and subsequently observed along the Alaska Peninsula.

		Juvenile	Adult	Total
Collared and released in 1988	Male	239 (29.9%)	185 (23.1%)	424 (53.0%)
	Female	192 (24.0%)	184 (26.0%)	376 (47.0%)
	Total	431 (53.9%)	369 (46.1%)	800
Collared and released in 1988; seen in Fall 1988	Male	22 (14.3%)	50 (32.5%)	72 (46.8%)
	Female	39 (25.3%)	43 (27.9%)	82 (53.2%)
	Total	61 (39.6%)	93 (60.4%)	154
Collared and released in 1988; seen in Spring 1989	Male	7 (18.9%)	17 (46.0%)	24 (64.9%)
	Female	1 (2.7%)	12 (32.4%)	13 (35.1%)
	Total	8 (21.6%)	29 (78.4%)	37

Table 4. Collared geese observed along the Alaska Peninsula during the spring of 1989.

	Number of collars observed at Cinder River in spring 1989	Number of collars observed at Nelson Lagoon in spring 1989
Number of collars also observed at Cinder Lagoon in fall 1988	15	4
Total number of collars observed	24	23

Table 5. Emperor goose counts from aerial surveys conducted during spring migration along the Alaska Peninsula[a]

Year	Nelson Lagoon[b] (% of total)	Cinder River (% of total)	Total number geese counted	Three-year average
1989	12,049 (26.4)	4,512 (9.9)	45,712	
1988	12,240 (22.8)	7,506 (14.0)	53,784	50,384
1987	8,340 (16.1)	2,807 (5.4)	51,655	49,223
1986	14,135 (33.5)	4,645 (11.0)	42,231	50,906
1985	17,099 (29.1)	5,571 (9.5)	58,833	57,444
1984	20,375 (28.6)	10,672 (15.0)	71,217	69,735
1983	14,058 (17.8)	11,106 (14.0)	79,155	83,671
1982	60,015 (59.6)	621 (0.6)[c]	100,643	90,355
1981	23,598 (25.8)	6,329 (6.9)	91,267	

[a] King and Dau (1987 and unpubl. data)

[b] Includes Nelson Lagoon, Mud Bay, Kudobin Islands, Herendeen Bay, and Pt. Moller

[c] Low number of geese at Cinder River reflects delayed migration due to late spring break-up