Emperor Geese at Cinder River Lagoon, Alaska Peninsula During Fall Staging and Migration - 1987

by

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ABSTRACT

The migration of emperor geese (*Chen canagica*) was monitored in Cinder River Lagoon, Alaska Peninsula in early fall 1987. Peak abundance of geese occurred on 4 October with 11,090 estimated in the study area. Overflights of aircraft $\leq$150 m with flushes from disturbances were 1.6 times higher than in 1986. Most disturbances were attributed to hunter, commercial, and search and rescue aircraft. Age composition varied with activity of flocks which was invariably related to stage of tide. In high tide roosts, flocks averaged 36.6 $\pm$ 3.6% (SE) young. Family groups arrived first to the lagoon feeding area, averaging 49.2 $\pm$ 2.3% young 3-4 h before low tide. Family groups ranged from means of 2.86 $\pm$ 0.18 to 4.33 $\pm$ 0.25 young. Neck collars on 23 individual geese were read 68 times, including 8.0% of the geese collared in 1987 in the Yukon Delta, Alaska. Additionally, 40% of the collars read in 1986 (N = 2) were seen in 1987. Juvenile geese tended to sleep, feed and search for food more than adults, while differences between sexes were not as apparent.

INTRODUCTION

The initial effort of this study began in 1986 (Wilk et al. 1986) as a "migration watch", of emperor geese (*Chen canagica*). The objectives were to obtain age composition ratios and read neck collars of geese so that production and migration "turnover" could be assessed. Because little detailed information was known during fall staging in Cinder River Lagoon, we expanded the scope of the studies. In 1987, assisted by biological technicians K. I. Wilk, and K. M. Sowl, we conducted intensive daily ground counts of the flocks utilizing the blue mussel (*Mytilus edulis*) beds, and high tide roosts near our field cabin during all hours of daylight. We also gathered data on disturbances of geese. Observations of neck collared geese were recorded, and activity budgets were obtained when possible. Because of the constraints of time on writing these results, an exhaustive analysis and discussion was not possible. Therefore, some results presented are subject to further interpretation, after data are more carefully analyzed.

STUDY AREA

The study area focused on the western spit near the outlet of the lagoon (Fig. 1). Observations of population composition were limited to an area within the view of binoculars and spotting scopes (300-400 m), which included some of the highest concentrations of emperors during feeding and roosting. In early October, a count from the eastern spit of the lagoon was also made (Fig. 1). A description of the lagoon and associated flora and fauna are found in the 1986 report.

METHODS

Weather information was collected 3 time each day, at sunrise, mid-day (between 1200 and 1430 hrs) and sunset.

Abundance counts were conducted from the study spit, to include the entire lagoon which could be seen through 10 x 40 binoculars or variable power spotting scopes. Based on a comparison of ground-air estimates in 1986, 70% of the geese in the lagoon may be observed during low tide from the study spit.

We systematically classified adult- and juvenile-plumaged geese in the lagoon and/or adjacent roosts during daylight every 2 hours. The effort was allocated to sample composition of flocks in even hours in relation to the low tide on one day and odd hours the next. Adult-plumaged birds showed complete white on the head and back of neck and had bright orange legs. Juvenile-plumaged birds displayed varying degrees of gray on their heads and showed dull orange on their legs and feet. These general criteria were suitable for distinguishing categories even though plumage differences exist (Palmer 1976, Bellrose 1980). Late in the counting period, we were particularly cautious about classification as a larger proportion of young had developed light gray to dull white heads as plumage changes evolved.

Based on observations in 1986, samples of percent young were pooled by time blocks in relation to activity of flocks. Samples were then used to estimate the mean percent young for each period of flock activity. The periods included 3 to 4 h before low tide (arrival and establishment), 2 h before to 2 h after low tide (lagoon feeding), 3 to 4 h after low tide (post-feeding and departure), and 5 and 6 h after low tide and 5 h before low tide (high tide roost). Periods of flock activity are detailed in the results.

Counts of family groups were made whenever possible. Flocks of 1-2 adults accompanied by young were recorded during periods of arrival to the lagoon from the high tide roosts (feeding flights) or from the lagoon to the roosts (roosting flights). The count periods generally lasted 1.5-2.0 h.

During daylight, we recorded all aircraft ($\leq$150 m altitude) and bald eagle overflights and other disturbances in the lagoon or adjacent areas. Aircraft overflights made by goose researchers or resupply flights were not counted. Neck collars from marked geese were read when possible and related data on status were recorded. We also estimated ratios of collared:uncollared geese in flocks when possible.

We carried out activity budgets of collared individuals as often as possible within the limits of other work. We tallied goose activity every 10 ($N = 28$) or 20 ($N = 5$) seconds for periods ranging between 5.2 to 36.3 minutes. Specific behaviors were lumped into general activity categories of Bollinger and Sedinger (1985) and Gill et al. (1986), except drinking. Geese apparently intake most water while feeding in the lagoon. The general categories (followed by specific behaviors we tallied) included alert (general/extreme alert, looking); resting/sleeping; locomotion (walking, swimming, flying); feeding (digging, dabbling, dipping, upending or picking at ground); maintenance (preening, scratching, stretching, wing flapping, collar tugging and related movements); and, intra-specific interactions (aggressive or submissive actions).

To determine if there were any differences in the composition of young in the population among periods of flock activity, I used the Kruskal-Wallis nonparametric analysis of variance (K-W ANOVA) by ranks for samples of unequal size. To determine which period(s) accounted for significant difference(s), I used a modified Tukey-type nonparametric multiple comparisons test using the Q statistic for samples of unequal size. I also used K-W ANOVA to determine if there were any differences in age composition among all hours of the tide cycle. A nonparametric Mann-Whitney U-test was used to compare mean percent young between periods of activity between years, and to compare activity budgets. I used a chi-square goodness-of-fit test to determine if the 1987 adult:juvenile ratios of neck collared geese seen in Cinder conformed to the ratio collared in the Yukon Delta (YK-D) in August 1987. Nonparametric tests followed Zar (1984) and were used because assumption(s) underlying parametric analyses were not met.

RESULTS

Weather, Migration and Phenology

Average weather conditions in 1987 were similar to those of 1986 (Table 1, Fig. 2), however, temperature extremes were less variable and October was less cloudy. The coldest temperature was 2.2 C (36 F) (in the morning of 4 October). In 1986, temperatures of $\leq$2.2 C were reached 4 times with lows of 0 C recorded twice. In 1986, freezing temperatures at Cinder appeared associated with in- and outmigrations of geese (Fig. 2). In 1987, this relationship was not apparent with temperatures less extreme, even though peak abundance of geese with a subsequent drop in numbers appeared to have occurred on the same days as 1986 (Fig. 2).

The crowberry (*Empetrum nigrum*) crop appeared light and patchy in 1987. In 1986, a relatively abundant crop occurred in the uplands of the study spit. Although emperor droppings containing berry residue and stain were common in 1986, few were seen in 1987.

Abundance, Distribution and Disturbances

Upon arrival to the lagoon, 3,187 geese were tallied in an overflight with a low-wing aircraft. Although daily estimates of abundance varied, a peak of 11,090 geese was reached on 4 October (Fig. 2). On 3 October, when the aircraft of the primary survey team passed over the lagoon (1218-1230 hrs), 9,144 emperors were tallied (M. Hogan, pers. commun.). Our ground count in the study area, from the NE spit revealed 6,690 geese, which was 73% of the total tallied by the aerial survey team. On 10 October, I estimated 4,140 emperors on the final ground count. On 13 October, W. I. Butler and M. R. Petersen (pers. commun.) estimated 10,000 - 12,000 emperors in the lagoon on an overflight. On 21 October, no geese were seen in the lagoon, but an estimated 300 were seen in an area of freshwater ponds between Cinder and Ugashik Bay (J. P. Payne, pers. commun.). Butler and Petersen noted that some geese were present on the study spit and west beach on 25 October, and on 27 October, estimated 5,000 geese on the beaches along both spits of the lagoon outlet.

The general distribution of geese in and around the lagoon followed a predictable pattern, although disturbances regularly disrupted activities. During feeding, distribution was invariably linked to levels of water and availability of food (Figs. 3-5). As tide ebbed, geese followed the water line. At low tide, the highest concentrations occurred near the outlet of the lagoon. After feeding, many geese migrated to roosts at high tide, beyond view of the study area. By early October, geese were common along the near beach on both sides of the study spit. The patterns of activity were not different from observations in 1986.

In 1987, overflights of aircraft <150 m and flushes from disturbance were

Bald eagles that we recorded flushed geese 100% of the time. In October, eagle disturbances were twice as common as September, but the average size of flushed flocks was 70% smaller.

Red foxes (Vulpes vulpes), and falcons ([Falco peregrinus] and [F. rusticolus]) occurred in close proximity to geese without incident. On 25 September, a brown bear (Ursus arctos) was observed laying in the lagoon at low tide, within 20 m of geese. When the bear walked along the shoreline near feeding geese, many were wary, but few flushed.

Age Composition

Activity of flocks was wholly dependent upon the stage of tide which controlled the timing of feeding and roosting flights to the mussel beds. Activity of flocks was classified into 4 periods,

Period 1, arrival and establishment, 4 to 3 h before low tide, characterized by the first arrival of geese to the lagoon with the first availability of food, followed by the establishment of flocks in feeding areas. The earliest arrivals were family groups, followed by flocks of adult-plumaged geese. As the build-up progressed, family and other social groups became less discernable as they mixed. The first arrivals occurred closest to the shorelines, moving into the lagoon as the tide ebbed and fresh beds of mussels and other intertebrates were exposed. In terms of goose abundance and behavior, a highly variable and active period. General goose behavior ranged from resting to feeding. Variation in timing was related to level of high tide.

Period 2, lagoon feeding, between -2 and 2 h of low tide, inclusive, when geese were established in the lagoon. The pattern of distribution was influenced in part, by the water line in relation to food availability. Least variable period in terms of overall abundance and behavior. Goose behavior was characterized by feeding.

Period 3, post-feeding and departure, 3 and 4 h after low tide, a period when geese began leaving feeding areas. Geese drifted with the flow of tide, and staged along near shorelines of the lagoon spits, then departed for high tide roosts. Some remained on exposed shoals until the shoals were inundated with the tide, at which time geese flew to distant or near shore roosts. This period was also characterized by a general "regrouping" or separation of family and other social groups from the massive feeding flock, gathering along the beach near our field camp and other shorelines. Behavior was variable, but adults were most alert at this time, in anticipation of departure. This was a period of transition between feeding and roosting, also influenced by the level of tide.

Period 4, high tide roost, included 5 and 6 h after low tide, and 5 h before low tide. Geese rested, slept, preened or grazed on near beach or along Bristol Bay shore. Timing of departure from roosts varied with level of tide and was delayed when the highest tides occurred.

In 1987, the size of flocks from periods of activity from which percent young samples were taken averaged between 635 ± 77 (SE) and 948 ± 167 geese (range = 120-2,438), compared with 629 ± 164 to 1,011 ± 90 geese (range = 101-1,855) in 1986 (Appendix 4). The size of samples was limited by visibility which was influenced by weather and proximity of geese to the study spit. Individual motivation was also a factor. The estimated mean percent young in flocks in 1987 was statistically higher during the arrival period than in roosts at high tide (Table 3). Percentages in 1987 were higher in all activity periods than in 1986, but they were statistically higher only at low tide (Table 4). Percent young was not different ($P > 0.10$) among the 12 hours of the tide cycle. We did not detect differential migration reflected in changes in age composition.

Young with Single and Paired Adults

In 1987, the sizes of groups of young with 1 or 2 adults averaged between 2.86 ± 0.18 (SE) (N = 65, 9 October) and 4.33 ± 0.25 (N = 54, 24 September) young (N = 10 samples). In 1986, for samples >30 groups, the daily means ranged between between 3.13 ± 0.28 and 3.88 ± 0.21 young (N = 7 samples).

Geese with Neck Collars

In 1987, 23 neck collars of individual geese were read 68 times (Appendix 1). A total of 109 neck collars were seen, including those for which codes could not be read. Individual neck-collars were read between 1 and 8 times. Juvenile female 2C1, seen at Cinder on 27 September, was also seen at Hook Lagoon (15 km SW of Cinder) on 18 October (R. E. Gill, Jr., pers. commun.). 2C1 was the only goose seen at Hook (N = 6) that was also recorded at Cinder.

Two individuals observed in the study area in 1987 were also observed there in 1986, representing 40% of the neck collars read in all of 1986 (see Wilk et al. [1986]). One of the birds, female A87 was banded in 1982. Three other individuals, females 8P6, 6E9, and P41 were banded in 1982 (Kokechik Bay), 1983 (Azun River), and 1984 (Newtok), respectively (Appendix 2). All other observations were of geese banded in 1986 and 1987.

We read 18 neck collars (8.0%) from the 225 emperors (adult = 65, juvenile = 160) collared in the Yukon Delta (Y-KD) (Old Chevak area) in August, 1987. These represented 12.3% (N = 8) of the adults and 6.3% (N = 10) of the juveniles. These collars represented 78.3% of the collars read in 1987. The ratio of neck collars on adults:juveniles we observed was not statistically different ($P > 0.10$) from the ratio banded in Y-KD in 1987. However, based on percentages, about 78.1% of the expected number of juveniles were seen, and 53.8% more adults were seen than expected.

Ratios of collared to uncollared geese in flocks were similar in September and October, with an overall ratio of 1:366 (Table 5). Multiplying this ratio times the total number of marked birds seen produced an estimate of 8,421 geese for the study area.

Behavior

Activity budgets of 20 individuals (87% of all neck collars read) were recorded 33 times for a total of 13.9 h of observation (Appendix 3). Due to small sizes of samples, comparisons were lumped into groups of adults and juveniles, and males and females in beach roosts or lagoon (Tables 6-7). On average, geese spent the majority of time feeding in the lagoon and resting in roosts. Juveniles fed more, were more active, and less alert than adults during feeding. Juveniles slept more in beach roosts. Statistically, none of the comparisons between adults and juveniles were significantly different ($P > 0.20$). Males rested/slept or did maintenance activities in roosts, and actively fed about half the time while in the lagoon. Females engaged in significantly more locomotion behavior ($P < 0.05$), as none of the males studied displayed this activity in beach roosts. In beach roosts, geese were observed grazing on oysterleaf (Mertensia maritima), while in swales, or along streamsides, which emperors often shared with cackling Canada geese (Branta canadensis minima), alkali grass (Puccinellia spp.) was grazed. Although males appeared to sleep more in beach roosts, the differences were not statistically significant ($P > 0.10$). All other comparisons between male/female behaviors were not different ($P > 0.20$).

Neck collars did not appear to alter feeding activities, although geese were seen tugging at the base of collars when performing maintenance activities. On one occasion, adult male 2C4 was observed tugging at his collar for 50.5% of the 16.8 min. he was studied.

DISCUSSION

Abundance, Distribution and Disturbances

In 1986 and 1987, peak abundance appeared to have occurred on the same day, followed by a marked outmigration after the first week of October. In 1986, the estimate from ground count was 71% of the aerial survey. Assuming estimates from the ground ranged between 70 and 75% of the geese present, then at peak abundance, the number of emperors at Cinder may comprise between 22% and 30% of the population indexed in the aerial survey in fall. The large numbers of geese seen by Butler and Petersen in 1987 suggested a possible immigration of geese and protracted stay at Cinder after our departure. This may be attributed to the moderate conditions in September and October in the YK-D and Alaska Peninsula, as the migration of cackling Canada geese in the Alaska Peninsula was later than previous years, as well. The counts of abundance over the final days occurred after low tide, therefore large flocks could have also been concealed from view. We had learned from the trip to the NE spit that the optimal period for counting geese from the ground was 1-2 h prior to low tide because later, the shoals tended to conceal geese.

A search and rescue operation in September, commercial aircraft, and the brown bear hunting season which began on 1 October, extending beyond the period of study, indeed influenced the local distribution of geese due to flushes of flocks. Aircraft with hunters regularly staged on the study spit, and were commonly observed perturbing geese in the lagoon and outlying areas. By early October, $\geq$4,000 geese occurred in Hook Lagoon (Gill, pers. commun.). Thus, large numbers of geese could have been displaced prematurely when disturbances flushed them.

Behavior

While activity of flocks was categorized into beach roost and lagoon feeding, behavior was more variable following feeding flights and prior to roosting flights (Fig. 6). Petersen (1983) quantified emperor goose abundance in relation to the tide cycle, and clearly showed the periods of highest variability in abundance of flocks in the feeding areas occurred 4 and 3 h before low tide and 3 and 4 h after low tide.

Samples of activity budgets were small for the periods of overlap (Fig. 6), and only adults were sampled (N = 4). We found that the mean percent of feeding, resting, maintenance, locomotion and alert behavior was 20.7 ± 19.0% (SE), 18.0 ± 18.0%, 18.0 ± 12.0%, 22.1 ± 12.8%, and 21.4 ± 8.2%, respectively. There was no agressive/submissive interaction. These 4 behaviors were approximately equally allocated, clearly different from behavior in the lagoon at low tide or in roosts at high tide.

In the lagoon, young geese fed and actively searched for food more than adults. Family groups, which arrived earlier than flocks of geese without young may due so to gain an early advantage. The nutritional need of families may be greater due to the demand of brood rearing on the parents, and growth and development on young, which is undoubtedly magnified during migration. Adults being more experienced, may have a competetive advantage over young when feeding in mixed flocks and may delay feeding flights until mussel beds are more exposed.

Age Composition

The mean percentage of young in roosts at high tide, which was lowest in both years, may be the best estimate of overall composition in Cinder Lagoon-certainly the most conservative. Geese were relatively inactive, more closely grouped, and were generally easiest to count. At low tide, relatively few geese were in view from our vantage. Those present were primarily scattered family groups feeding away from the highest concentrations that occurred several hundred meters from our vantage.

The percent young in roosts ranged from 17.3 to 67.3% for 17 samples and was the most variable of any period of activity. Disturbances previously described were factors that influenced the distribution and subsequent composition of these flocks. In September, few flocks roosted on the study spit near the cabin, but large flocks were common in October. Early in October tides were also highest and geese remained in beach roosts longer prior to feeding flights because food was unavailable.

The fact that geese with neck collars were regularly resighted in both roosting and feeding areas strengthens the supposition that use of the near lagoon by the same family groups had occurred, and that some geese used the same areas for the duration of their stay at Cinder. Additionally, the only neck collar read from the NE spit, female OC8, was not seen in the study area.

One flock sampled from the NE spit 1 h before low tide was comprised of 23.6% young (N = 666). At low tide, 2 flocks had 35.6% (N = 818) and 30.2% (N = 1,484) young. These percentages were lower than 44.3% and 42.1% for 1 h before, and low tide, respectively - the overall means obtained at Cinder.

More counts from other locations in the lagoon are necessary to verify meaningful differences between locations.

Estimates of percent young from Izembek and Cinder River lagoons from aerial photos in September and October 1987 showed a higher proportion of young than in 1986 (C. P. Dau, W. I. Butler, pers. commun.). Data we obtained at Cinder revealed proportions of young ranging from 0.2 to 3.1% higher in all periods of flock activity (Table 4). The dynamics of age composition in relation to tide cycle is clear. Intensive ground sampling from several strategic locations in Cinder Lagoon would help resolve the problem of estimation of productivity where the overall distribution of age components in the population is still poorly understood.

CONCLUSIONS

Cinder River Lagoon is a vital staging area for emperor geese in spring and fall because of the high abundance and availability of blue mussel as the most important food source. Age composition estimates and behavior are influenced by the cycle of the tide, as family groups are the first to arrive to the feeding areas. Geese appear to use the same feeding areas on a fairly regular basis but more observations are necessary. Aircraft is the primary disturbance on geese, which affects distribution patterns and foraging activity. Assessment of productivity from the ground might best be accomplished using simultaneous counts from strategic locations. Human activities which threaten the integrity of the marine environment at Cinder and other estuaries along Bristol Bay, threaten the population of emperor geese and associated species.

RECOMMENDATIONS

YES 1. Composition counts should be carried out at Cinder in spring (2-3 days) to assess overwinter mortality and read neck collars to determine if individuals use the same staging areas as fall.

YES 2. In fall, studies should continue, to include a simultaneous sampling from 2 or 3 strategic locations in the lagoon, using similar methods. The study period should also be extended into mid-October.

? 3. Rocket nets could be used to capture, collar and band emperor geese in the staging area, enabling investigators to better understand the distribution and habitat use of emperor geese in Cinder.

? 4. Radio telemetry should be used for geese fitted with transmitters, to gain a better understanding of local movements in Cinder during staging, and to learn about migration patterns and their timing.

RED 5. Studies of behavior, habitat use and food of emperor geese in several other major lagoons in the Alaska Peninsula should be carried out to evaluate their importance and identify potential human impacts to each.

6. Aircraft and hunting disturbance should be further monitored and future management actions should be oriented to reducing them if possible.

NO 7. Law enforcement patrols in spring and fall should become routine in major staging areas of emperor geese in the absence of investigators. We noticed less hunting in 1987 when our presence was known from the start, than in 1986, when hunters were not aware of our study.

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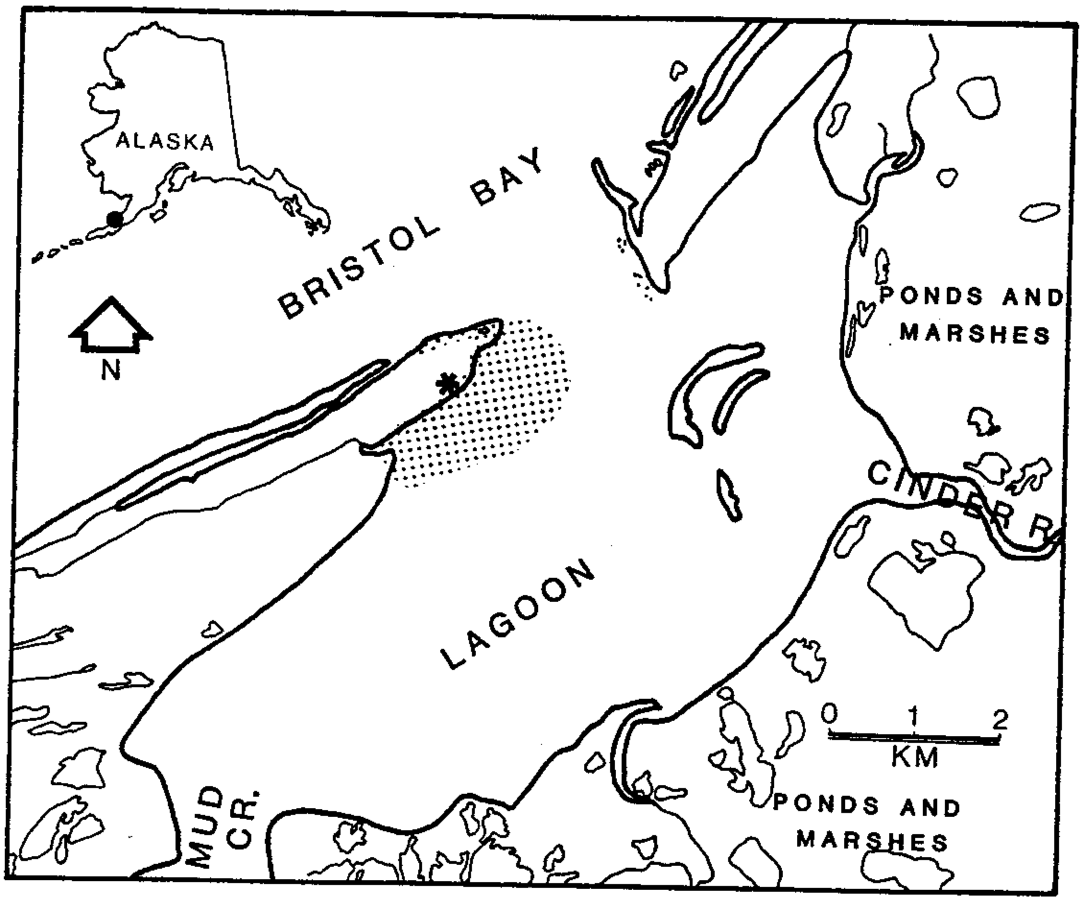

Figure 1. Study area of emperor goose studies in Cinder River Lagoon. Stippling shows locations where flocks were sampled.

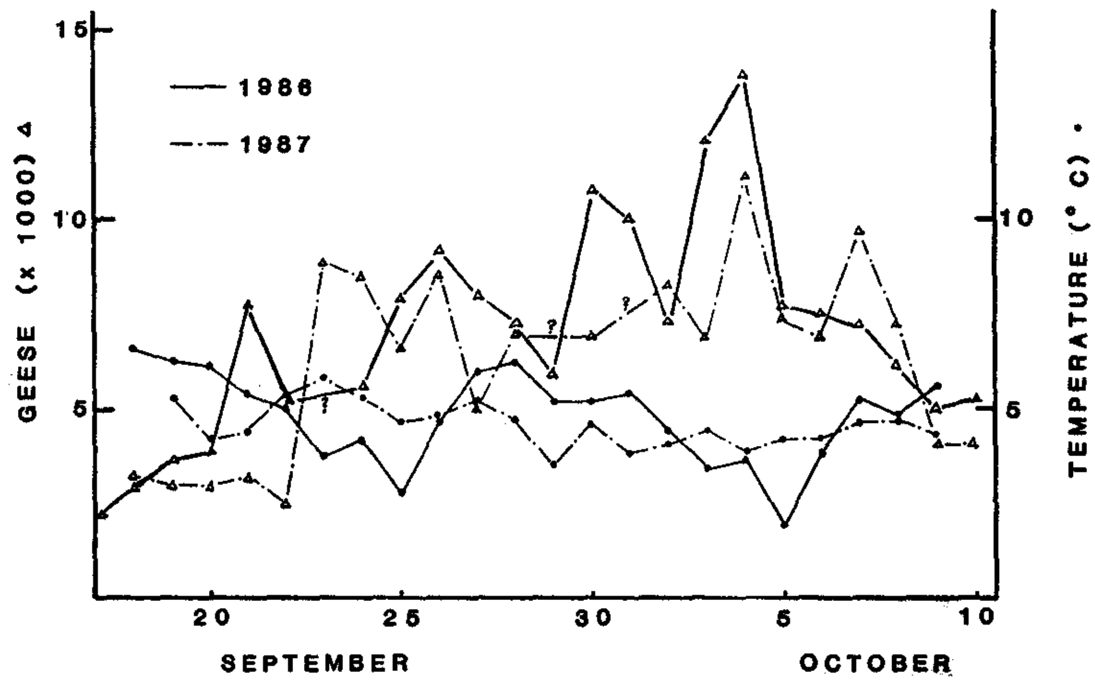

Figure 2. Mean daily temperatures and goose abundance in Cinder River Lagoon study area.

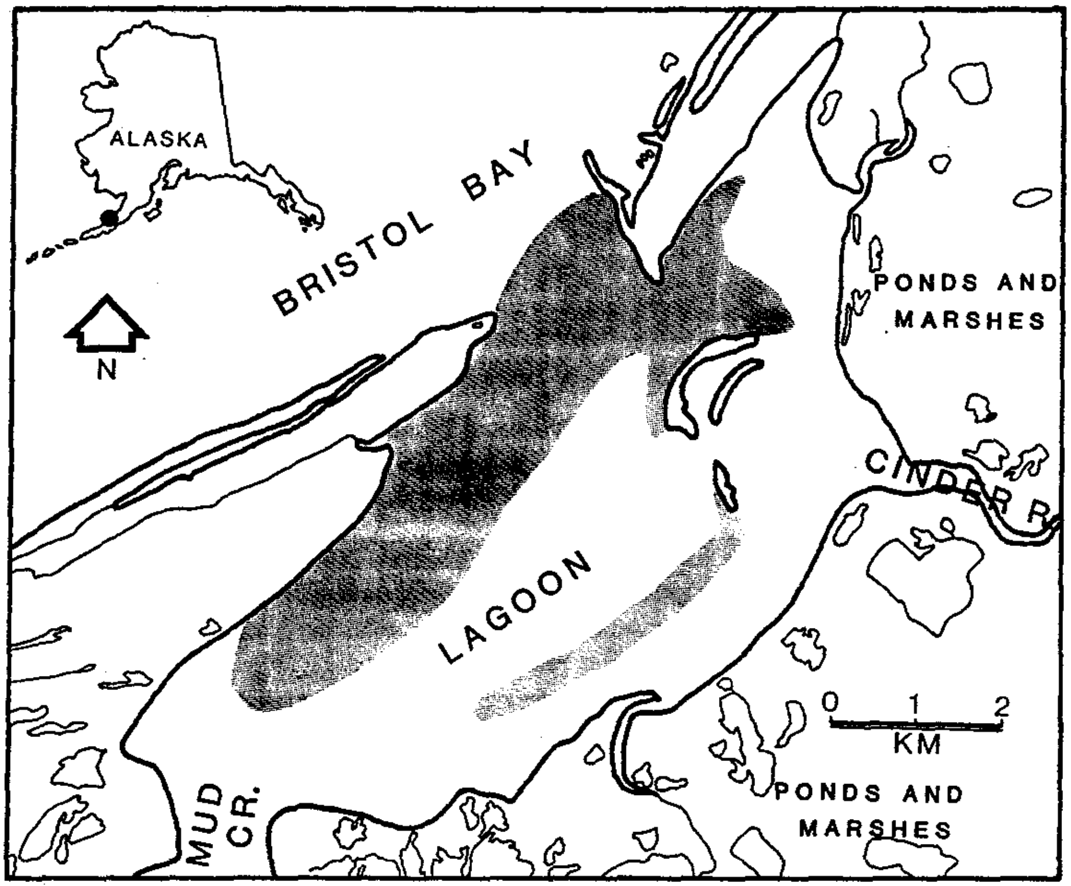

Figure 3. General distribution (gray) of emperor geese during arrival and establishment in Cinder River Lagoon approximately 3-4 h before low tide.

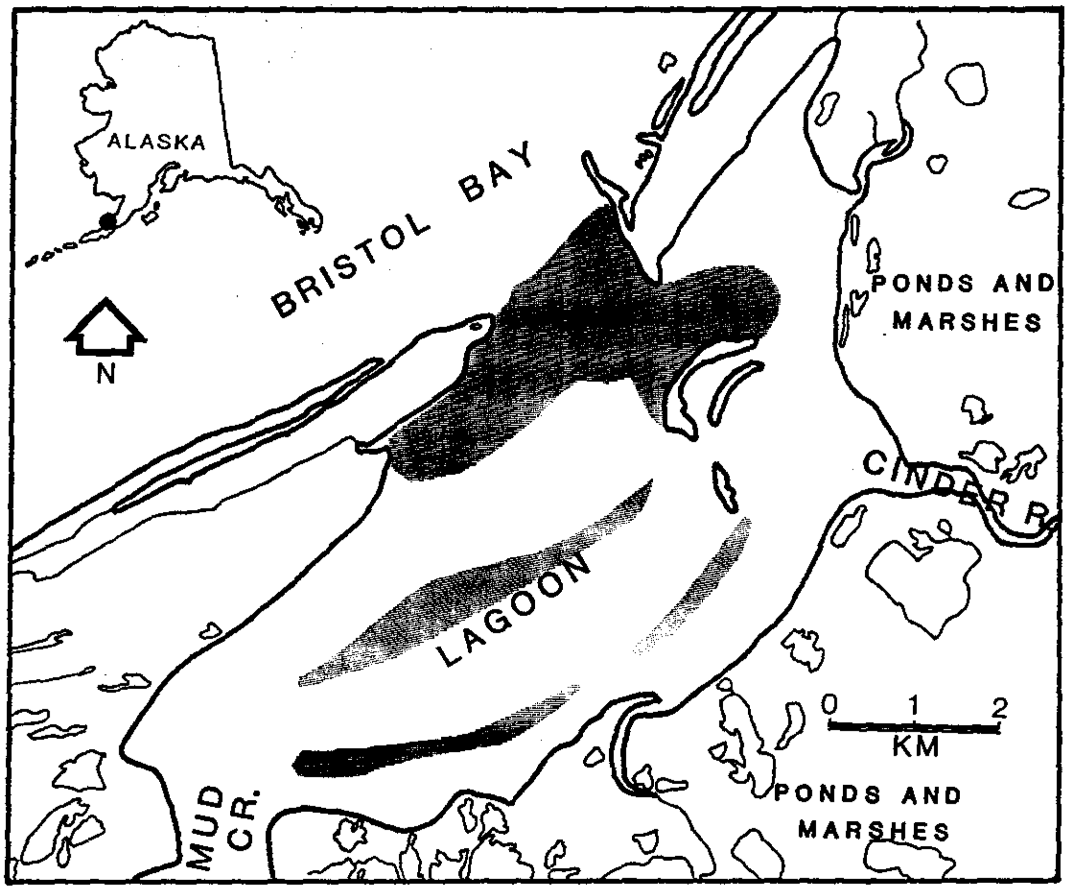

Figure 4. General distribution (gray) of emperor geese during $\pm$ 2 h of low tide in Cinder River Lagoon.

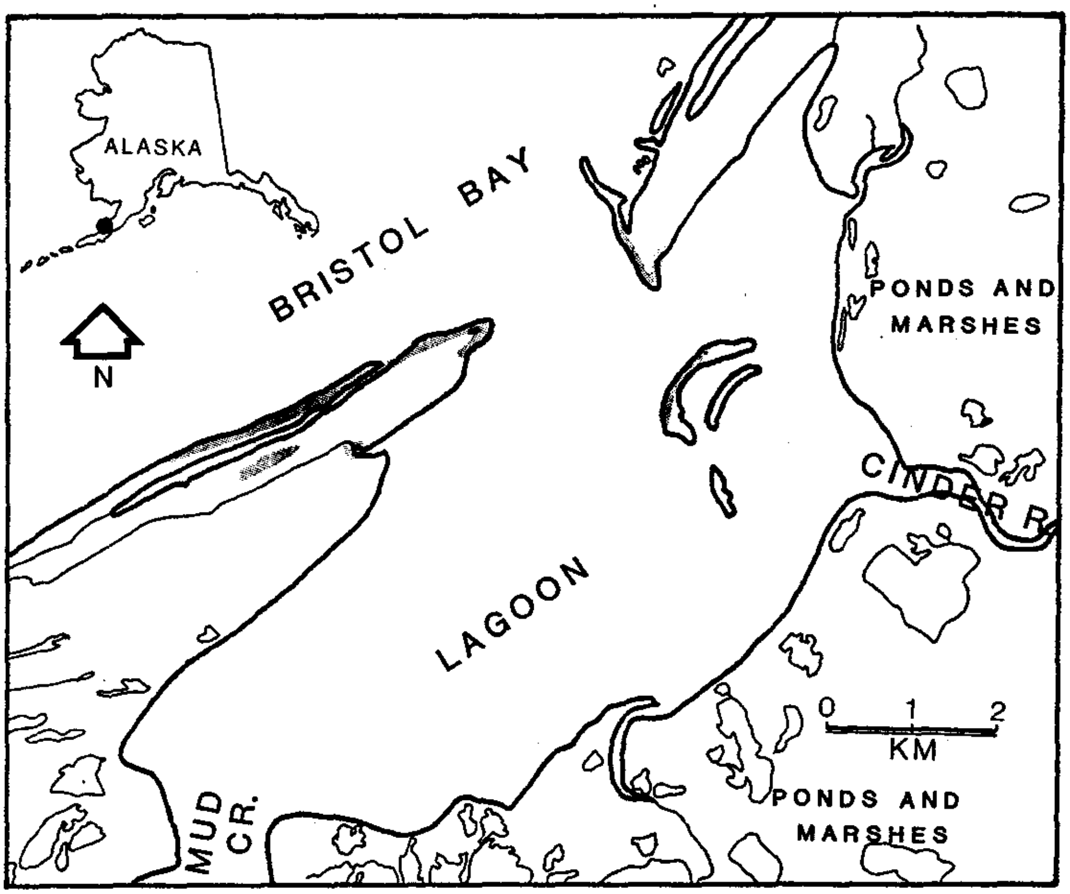

Figure 5. Observed distribution of emperor geese in Cinder River Lagoon at high tide (5-6 h after low tide and -5 h of low tide) from the western spit.

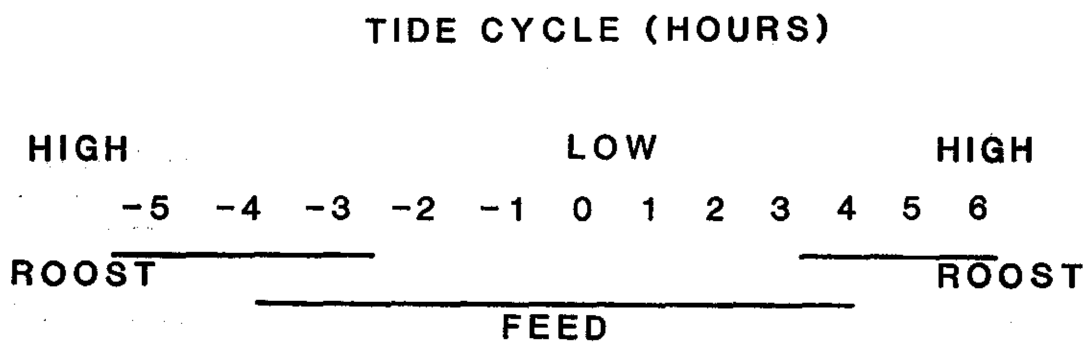

Figure 6. General flock activity of emperor geese in relation to the stage of tide.

Table 1. Summary of weather conditions, Cinder River Lagoon, Alaska, 18 September - 10 October 1986 and 1987.

	Daily mean[a]			Wind direction (% of time)									Daily mean[a]			
													Rainfall			
	Temp. (C)	Cloud cover (%)	Wind (kph)	N	NE	E	SE	S	SW	W	NW	Calm	Night (mm)	Day (mm)	Barom. (mbar)	Humid. (%)
September																
1986	10.3	80	16	12	0	12	35	12	8	19	0	4	1.7	1.0	1022	86
	2.2	23	6										4.8	1.9	10	6
1987	9.6	82	18	0	0	19	19	3	6	31	17	6	1.8	2.7	1002	90
	1.3	23	14										2.8	4.9	9	6
October																
1986	8.5	74	11	0	6	17	17	0	0	22	11	28	1.2	1.1	1012	89
	2.3	32	9										1.3	1.5	7	4
1987	8.5	55	16	0	0	11	37	26	4	7	0	15	0.5	1.0	1008	92
	0.6	27	8										0.5	1.2	10	3
Totals																
1986	9.6	77	14	7	2	14	27	7	5	21	5	14	1.5	1.0	1018	87
	2.4	26	8										3.7	1.7	10	5
1987	9.2	70	17	0	0	16	27	13	5	21	10	10	1.2	2.0	1005	91
	1.2	28	11										2.2	3.8	9	5

[a]Standard deviations listed below means.

Table 2. Disturbances of emperor geese by low-flying aircraft and bald eagles in Cinder River Lagoon, Alaska, expressed as the number of times geese were seen flushed by overflights.

	No. flights ≤ 150 m		No. times geese flushed			No. geese flushed[a]		Type of aircraft[b] (%)			
	Mean daily	SD	Mean daily	SD	Percent	Mean	SD	High wing	Low wing	Heli.	Unkn.
September											
1986											
Aircraft	6.5	3.1	2.5	2.2	38.0						
1987											
Aircraft	7.9	3.3	3.6	2.8	46.1	341	619	63	33	2	2
Bald eagle	0.6	0.9	0.6	0.9	100.0	1,814	1,267				
October											
1986											
Aircraft	2.4	2.3	1.4	1.5	58.8						
1987											
Aircraft	7.3	3.2	2.9	2.8	39.4	506	1,371	77	21	0	2
Bald eagle	1.3	1.4	1.3	1.4	100.0	561	361				
Totals											
1986											
Aircraft	4.9	3.4	2.1	2.0	42.0						
1987											
Aircraft	7.7	3.2	3.3	2.7	43.2	406	984	69	28	1	2
Bald eagle	0.9	1.2	0.9	1.2	100.0	1,023	1,000				

[a] Some disturbances occurred with geese suspected of flushing but numbers unknown.
[b] High and low wing position in relation to windows; heli. = helicopter.

Table 3. Mean percent juvenile-plumaged emperor geese by periods of flock activity in relation to the tide, Cinder River Lagoon, 1987.

	Period of activity (h in relation to low tide)			
	high	low		high
	(-4, -3)	(-2 to 2)	(3, 4)	(5, 6, -5)
No. sample counts	11	25	11	17
Mean percent	49.2	43.9	43.6	36.6
SE	2.3	1.0	2.7	3.6
Similarity (joined by line)				

Table 4. Percent young (mean $\pm$ SE) of emperor geese by flock activity periods in relation to the tide in Cinder River Lagoon, Alaska Peninsula.

	Period of activity (h in relation to low tide)			
	high	low		high
	(-4, -3)	(-2 to 2)	(3, 4)	(5, 6, -5)
Percent young (mean $\pm$ SE) (N)				
1986	48.9 $\pm$ 3.5 (6)	40.8 $\pm$ 1.6 (27)	41.9 $\pm$ 5.9 (5)	36.4 $\pm$ 8.8 (4)
1987	49.2 $\pm$ 2.3 (11)	43.9 $\pm$ 0.1 (25)	43.6 $\pm$ 2.7 (11)	36.6 $\pm$ 3.6 (17)
P-value	>0.200	0.054[a]	>0.200	>0.200

[a]Statistically different.

Table 5. Ratios of emperor geese with or without neck-collars in flocks observed in Cinder River Lagoon, Alaska.

	No. flocks	No. collars	No. geese	Ratio (collared:uncollared)
September	20	34	13,055	1:384
October	18	49	17,330	1:354
Totals	38	83	30,385	1:366

Table 6. Activity budgets (percent, mean ± SE) (N) of adult and juvenile emperor geese observed at Cinder River Lagoon, September and October 1987.

Activity	Beach roost		Lagoon	
	Adults	Juveniles	Adults	Juveniles
Feed	4.1 ± 4.1 (7)	2.7 ± 2.2 (14)	53.1 ± 13.6 (9)	64.2 ± 17.2 (3)
Rest	63.4 ± 13.8	75.7 ± 7.9	8.5 ± 7.9	0.4 ± 0.3
Maintenance	20.3 ± 10.1	12.1 ± 3.3	9.3 ± 5.7	7.9 ± 6.1
Locomotion	6.3 ± 4.6	5.7 ± 3.5	14.2 ± 6.2	20.7 ± 7.2
Alert	5.6 ± 4.4	3.7 ± 3.4	15.0 ± 4.7	6.8 ± 5.3
Intra-specific	0.4 ± 0.4	0.1 ± 0.1	0	0

Table 7. Activity budgets (percent, mean ± SE) (N) of male and female emperor geese observed at Cinder River Lagoon, September and October 1987.

Activity	Beach roost		Lagoon	
	Males	Females	Males	Females
Feed	0 (6)	4.4 ± 2.7 (15)	50.5 ± 26.6 (3)	57.7 ± 12.3 (9)
Rest	89.2 ± 4.7	64.5 ± 9.0	0	8.6 ± 7.9
Maintenance	10.3 ± 4.7	16.7 ± 5.2	16.8 ± 16.9	6.3 ± 2.8
Locomotion	0	8.2 ± 3.7	14.9 ± 5.1	16.1 ± 6.4
Alert	0.6 ± 0.4	5.9 ± 3.7	17.8 ± 9.5	11.3 ± 4.2
Intra-specific	0	0.3 ± 0.2	0	0

Appendix 1. Chronology of observations of emperor geese with neck collars, Cinder River Lagoon, Alaska.[a]

Collar code	September 19	20	21	22	23	24	25	26	27	28	29	30	October 1	2	3	4	5	6	7	8	9
Adults																					
P96	x																				2
1A0		x							x	x								x	x	x	x
A87				x								x									
P81					2	x	2							x							x
9A8					2									x							x
6E9						x												x			x
P94						x						2	x					x		x	
6A1							x						x						x		x
2C4									x	x			x	x							
0C8															x						
4P1																	x				
6A4																			x		x
8P6																					x
Juveniles																					
P89				x	2	x			x	x			x					x			
3C8					x		x														
2C5							x														
2C1									x												
P57																	x				
3C0																	x		x	x	
P11																			x		x
4A8																			x		x
P34																			x		x
2C6																					x
New collars read	1	1	0	2	3	2	2	0	2	0	0	0	0	0	1	0	3	0	4	0	2
Sum collars/day	1	1	0	2	7	4	5	0	4	3	0	3	4	3	1	0	3	4	7	3	13
Cum. collars read	1	2	2	4	11	15	20	20	24	27	27	30	34	37	38	38	41	45	52	55	68
Cum. new collars	1	2	2	4	7	9	11	11	13	13	13	13	13	13	14	14	17	17	21	21	23
Unkn. codes observed	1	0	0	2	0	3	5	0	1	5	1	0	0	4	7	0	4	0	2	6	0
Cum. Unkn. codes	1	1	1	3	3	6	11	11	12	17	18	18	18	22	29	29	33	33	35	41	41
Cum. all collars	2	3	3	7	14	21	31	31	36	44	45	48	52	59	67	67	74	78	87	96	109

[a]All observations from stippled area along west spit, Figure 1, except 3 October from stippled area NE spit.

Appendix 2. Chronological summary of neck collars read from emperor geese in the Alaska Peninsula in September and October, 1987[a].

	Collar code	Time	Tarsus band number	Age-sex at banding	Year banded	Alaska location banded	Status[b]
September							
19	P96[c]	1245	887-36796	ASY-F	1987	Chevak	G
20	1AO[c]	1431	887-34845	A-F	1986	Kokechik Bay	G, F (P+3)
22	P89[c]	1430	887-36789	L-F	1987	Chevak	G, F (P+3)
	A87	1800	887-36294	A-F	1982	Kokechik Bay	G
23	3C8[c]	0840	1607-20364	L-F	1987	Chevak	G, w/P89
	P89	0840					G, w/3C8
	P89	1420					G
	P81[c]	1810	887-36781	ASY-F	1987	Chevak	G
	9A8[c]	1810	1067-20291	ASY-M	1987	Chevak	G
	9A8	2000					G
	P81	2000					G
24	6E9[c]	1910	887-35160	A-F	1983	Azun River	G, w/P89
	P89	1910					G, w/6E9
	P94[c]	2038	887-36794	ASY-F	1987	Chevak	G
	P81	2038					G, F (P+2)
25	6A1[c]	1041	1067-20252	ASY-M	1987	Chevak	G
	P81	1100					G
	2C5[c]	1100	1067-20352	L-M	1987	Chevak	G
	3C8	1110					G
	P81	1845					G, F (P+2)
27	2C1[c]	0945	1067-20496	L-F	1987	Chevak	G
	2C4[c]	1340	1067-20500	ASY-M	1987	Chevak	G, F (P+2)
	P89	1830					G, F (P+3)
	1AO	1830					G, F (P+3)
28	2C4	1130					G
	1AO	1930					G
	P89	1930					G, F (P+4)
30	A87	1020					G
	P94	1025					G
	P94	1610					G

October							
1	P94	1505					G
	2C4	1505					G
	P89	1505					G
	6A1	1505					G
2	(93E[c]	1500	887-35490	ASY-F	1984	Newtok	G)
	2C4	1715					G
	9A8	1715					G w/P81
	P81	1715					G w/9A8
3	0C8[c]	1430	1067-20214	A-F[d]	1987	Chevak	G
4	(02H[c]	1500	887-34803	ASY-F	1984	Kokechik Bay	G)
	(93E	1530					G)
	(49H[c]	1625	887-35039	SY-F	1984	Newtok	G)
	(4H6[c]	1655	887-35261	ASY-M	1983	Azun River	G)
5	4PH[c]	1010	887-35639	ASY-F	1984	Newtok	G, F (P+3)
	P57[c]	1012	887-36754	L-F	1987	Chevak	G
	3C0[c]	1030	1067-20357	L-M	1987	Chevak	G, F (P+6)
6	P89	1246					G, F (P+3)
	6E9	1700					G
	1A0	1700					G
	P94	1700					G
7	6A1	1700					G
	3C0	1700					G
	6A4[c]	1700	1067-20253	ASY-F	1987	Chevak	G, F (P+6) w/P11, 4A8, P34
	P11[c]	1700	1067-20387	L-M	1987	Chevak	(same as above)
	4A8[c]	1700	1067-20238	L-F	1987	Chevak	(same as above)
	P34[c]	1700	887-36744	L-F	1987	Chevak	(same as above)
	1A0	1700					G
	(4H6	?					G)
8	P94	1500					G
	1A0	1500					G
	3C0	1900					G
9	P96	1700					G
	1A0	1700					G, F (P+3)+ ad.
	8P6[c]	1745	887-35683	A-F	1984	Newtok	G
	9A8	1745					G

9	6A1	1745					G
	P81	1745					G
	P96						G
	4A8	1745					G
	P11	1745					G
	6A4	1745					G
	P34	1745					G
	2C6[c]	1745	1067-20353	L-M	1987	Chevak	G
	6E9	1945					G
18	(2C1	?					G)
	(6C1[c]	?	887-36111	HY-M	1987	Chevak	G)

[a]Observations in parentheses from geese recorded at Hook Lagoon (15 km SW of Cinder) by Gill (pers. commun.).
[b]G = large group or flock up to several thousand geese; F = family; (P+3) = pair plus 3 young, e.g.
[c]First recorded observation of individual.
[d]This goose was observed as an adult-plumaged bird not a juvenile as reported on banding schedule.

Appendix 3. Period of observations (minutes, mean ± SE) (N) of emperor geese for time and activity budgets.

Age	Males	Females
Juveniles	25.3 ± 5.1 (5)	28.3 ± 2.9 (12)
Adults	23.7 ± 3.9 (4)	22.5 ± 3.3 (12)

Appendix 4. Sizes of samples (N, mean ± SE) from flocks of emperor geese used to estimate age composition in Cinder River Lagoon, 1986-1987.

	Sampling period (h in relation to low tide)			
	high	low		high
	(-4,-3)	(-2 to 2)	(3, 4)	(5, 6, -5)
1986				
mean sample	900 ± 203	1,011 ± 90	629 ± 164	577 ± 172
range	149-1,517	186-1,855	125-1,075	101-1,582
1987				
mean sample	635 ± 77	775 ± 70	656 ± 132	948 ± 167
range	162-1,144	341-1,513	341-1,233	120-2,438