# Autumn staging of Cackling Canada Geese on the Alaska Peninsula

JAMES S. SEDINGER and KAREN S. BOLLINGER

## Introduction

Knowledge of the biology of breeding and wintering geese has increased dramatically during the last two decades. Until recently our understanding of events occurring on premigration staging areas lagged behind that for breeding birds. This is undoubtedly because geese often stop only briefly at staging areas which are usually quite remote. However, recent studies on spring staging areas showed that geese foraged in a manner that increased protein and energy intake (Ydenberg and Prins 1981; McLandress and Raveling 1981) while Ebbinge *et al.* (1982) demonstrated that spring weight gain on staging areas influenced subsequent reproductive success in Dark-bellied Brent Geese *Branta bernicla bernicla*. In the autumn Lesser Snow Geese *Anser caerulescens caerulescens* also selected foods high in nutrient content (Prevett *et al.* 1979; Thomas and Prevett 1980) and juveniles did not have sufficient lipid reserves to complete autumn migration until after staging on the James Bay coast (Wypkema and Ankney 1979).

**Figure 1. Locations of breeding, autumn staging and wintering areas of Cackling Canada Geese.**

Cackling Canada Geese *Branta canadensis minima*, the smallest subspecies of Canada Geese, nest on the coastal fringe of the Yukon-Kuskokwim Delta and winter primarily in the Central Valley of California (Figure 1). In October they leave the Delta and fly directly to the north side of the Alaska Peninsula where they remain for up to three weeks. In most years Cackling Geese fly nonstop from the Alaska Peninsula to the Klamath Basin (2,800 km) on the Oregon-California border in late October (Nelson and Hansen 1959). A direct flight was confirmed in 1984 by observation of a marked individual on the Alaska Peninsula and resighting of the same individual in the Klamath Basin 3 days later (H. McCollum pers. comm.). Since 1980 a significant fraction of the Cackling Goose population has begun wintering in the Willamette Valley of western Oregon (J.C. Bartonek unpub. 1986) reducing the length of the autumn migratory flight by ca. 450 km.

Recent declines in numbers of Cackling Geese (O'Neill 1979; Raveling 1984) have stimulated interest in their biology during all phases of the annual cycle. Autumn staging is likely to be especially important for these geese because of the energetic consequences of their small size and the long overwater migration they undertake. This report concerns the behaviour of Cackling Geese staging at Ugashik Bay on the Alaska Peninsula during autumn. The importance of premigratory staging for this population in view of the energetic cost of autumn migration, as evidenced by weight loss during the flight to California, is also discussed. Detailed accounts of migration chronology in relation to weather patterns and annual variation in the energetic cost of migration are currently under preparation by personnel of the Alaska Fish and Wildlife Research Center, U.S. Fish and Wildlife Service.

Wildfowl 38 (1987): 13–18

## Study Area

Virtually the entire population of Cackling Geese is present on the Alaska Peninsula in October and is restricted to two areas, Ugashik Bay and the mouth of the Cinder River (R. Gill pers. comm.). All observations were made at Ugashik Bay where Cackling Geese used two principal areas. The first was a 10 km$^2$ peninsula formed by a bend in the Ugashik River as it entered Ugashik Bay (Area A, Figure 2). This area consisted of a tall (1 m) graminoid community interspersed with shallow (10–30 cm deep) brackish ponds. Pond shores had a shallow gradient that supported stands of *Hippuris tetraphlla*, *Spergularia canadensis*, and *Puccinellia phryganodes*. *Triglochin palustris* occurred sporadically in this habitat. Geese also used an extensive tidal mudflat (Area B, Figure 2) which contained pure stands of *H. tetraphylla* and *P. phryganodes*, and occasionally used unvegetated mudflats along the river bank and exposed bars in Ugashik Bay.

## Methods

Observations were begun on 7th and 5th October in 1983 and 1984, respectively, and finished on 16th and 20th October in the two years. Behaviours of geese were classified as: foraging, drinking, locomotion (walking, swimming and flying), maintenance (preening and bathing), alert, resting and aggressive interactions (chasing and fleeing). In 1984 time spent in these behaviours by individual geese using inland ponds (the only area that could be consistently observed) was estimated by recording their activities at 1 minute intervals for periods ranging from 10 to 180 minutes ($\bar{X}=$ 46 minutes). The percentage of time spent in each behaviour for a given observation period was estimated to be the proportion of 1 minute samples on which each behaviour was recorded. Proportions of time spent in each behaviour during a single observation period thus provided a single data point for statistical anlysis. In 1983 a continuous record was kept of behaviours

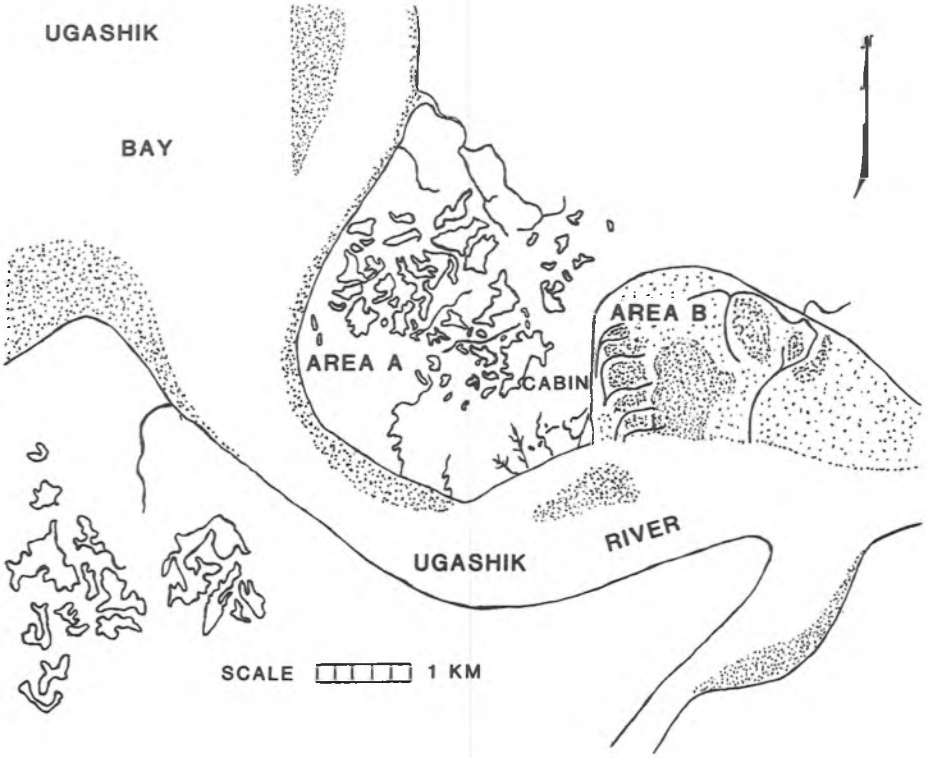

Figure 2. Ugashik Bay autumn staging area of Cackling Canada Geese.

of focal individuals except that behaviours of less than 1 minute duration were not recorded. Because of the potential bias associated with this method results from 1983 were not subjected to statistical analysis. The number of aggressive interactions during an observation period, in which a focal individual was involved, were counted and the role of the focal individual (aggressor or displaced bird) was noted (1984 only).

Individuals were selected for observation from among geese wearing plastic neckbands with alpha-numeric codes that allowed individual recognition, and consequently identification of age and sex. Neckbands were applied on the breeding grounds by personnel of the U.S. Fish and Wildlife Service, and in California by personnel of the California Department of Fish and Game and the University of California, Davis, as part of a study examining survival. Sex was determined during banding by cloacal examination. Geese were assigned to one of three age categories for analysis of behavioural data: adults, at least 27 months old; second-year, 15 months old; and hatching-year, 3 months old at the time of the study.

Weights of Cackling Geese at Ugashik Bay were obtained from birds shot by hunters in 1980 and 1983. Weights of geese from 1980 were provided by R. Sellers, Alaska Dept. of Fish and Game, while KSB weighed geese in 1983. Hunter-killed geese were classified as either hatching-year (3 months old) or after-hatching-year (>15 months old).

Comparison between sexes of the percentage of time spent in different behaviours by adults and hatching-year birds was made using t-tests. Sample sizes of second-year birds were not sufficient for this analysis. These analyses did not indicate significant differences in behaviour between sexes so data were pooled and a 1-way ANOVA was performed to examine differences in behaviour among age classes. Behavioural data were collected from some individuals on more than one occasion. Since data collected from the same individual on different occasions may not have provided independent samples, data from individuals were nested within age classes in the ANOVA. This analysis produces a $\chi^2$ statistic resulting from a maximum-likelihood test of the hypothesis that there was no variation in behaviour due to age (Dixon 1983).

## Results

Sample sizes of Cackling Geese shot by hunters were not adequate for assessment of weight gain while at Ugashik Bay. Because the samples were collected throughout the staging period, weights presented here may underestimate peak departure weights (Table 1). Nevertheless, Cackling Goose adults were at weights equal to, or exceeding pre-laying spring weights given by Raveling (1979) of 1,871 g for males, 1,890 for females; young-of-the-year were between 38% and 47% heavier than fledging weights given by Sedinger (1986), of 1,284 g for males, 1,228 for females. Ingesta were not removed from geese at Ugashik Bay, so weights of these geese were possibly slightly inflated (by about 48 g, if ingesta weight was similar to that in birds during summer, Sedinger 1986). There were no significant differences among age and sex classes in weight lost during the flight between the Alaska Peninsula and the Klamath Basin (t-test, P>0.05); Cackling Geese lost between 400–600 gm during the flight, 23–33% of the starting weight.

Foraging was the predominant activity of Cackling Geese while at Ugashik Bay in

**Table 1. Weights of Cackling Geese during autumn (X±SE)**

| | Weight (g) of geese | | | |
|---|---|---|---|---|
| Location | Imm. males | Imm. females | Adult males | Adult females |
| Ugashik Bay | 1775±78<br>(N=7) | 1804±62<br>(N=9) | 2053±39<br>(N=8) | 1912±85<br>(N=10) |
| Klamath Basin[a] | 1360±24<br>(N=13) | 1200±21<br>(N=18) | 1490±25<br>(N=26) | 1320±26<br>(N=22) |

[a] From Raveling (1978).

**Table 2. Percentage of time spent performing different behaviours (X±SE) by Cackling Geese during autumn staging, 1984, at Ugashik Bay, Alaska.**

| | | Behaviour | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age class | N[a] | Feed | Rest | Main | Drink | Alert | Loco | Aggress |
| Adult | 32<br>(46) | 53.3<br>±6.8 | 17.2<br>±5.2 | 15.5<br>±3.8 | 0.7<br>±0.5 | 6.5<br>±1.9 | 6.6<br>±1.6 | 0.2<br>±0.1 |
| Second-year | 8<br>(12) | 73.2<br>±11.9 | 8.0<br>±6.6 | 9.8<br>±5.5 | 0.0<br>±0.0 | 1.4<br>±0.9 | 6.0<br>±2.5 | 1.5<br>±1.8 |
| Hatching-year | 7<br>(9) | 83.5<br>±4.7 | 0.0<br>±0.0 | 2.7<br>±3.0 | 0.2<br>±0.2 | 3.7<br>±1.6 | 9.6<br>±3.4 | 0.4<br>±0.4 |

[a] Number of individuals sampled and total number of focal samples in parentheses.

1984 (Table 2). Males and females did not differ in behaviour but birds in the three age classes differed significantly ($\chi^2$=6.99, P<0.05) in the proportion of time devoted to feeding, with hatching-year birds spending 84% of the time feeding compared to 73 and 53% for second-year birds and adults, respectively. In 1983 hatching-year geese also spent more time feeding (98% of 5 observation periods, representing 3 individuals) than adults (68% of 13 observation periods, representing 9 individuals). The increased time devoted to feeding by hatching-year birds resulted in their spending less time resting and performing maintenance behaviours than adults or second-year geese, although these differences were not significant.

Analysis of aggressive interactions is restricted to adults owing to small sample sizes for the other age classes (Table 3).

**Table 3. Aggressive interactions of adult male and female Cackling Geese at Ugashik Bay.**

| Sex | No. times aggressor | No. times displaced | Total |
|---|---|---|---|
| Males | 22 | 7 | 29 |
| Females | 8 | 26 | 34 |
| Total | 30 | 33 | 66 |

Males and females did not differ in the number of aggressive interactions per minute: 0.06±0.02 and 0.04±0.02 interactions for the two sexes respectively (t-test, P>0.05). However, a significantly higher proportion of male interactions resulted in displacement of the nonfocal individual than was the case for females, which were usually displaced ($\chi^2$=6.41, P<0.02).

## Discussion

Autumn staging is essential for premigratory weight gain in Lesser Snow Geese; hatching-year birds did not have sufficient lipid reserves prior to autumn staging to complete autumn migration (Wypkema and Ankney 1979). It is likely that this is also true for Cackling Geese. To estimate the energy cost of the autumn migratory flight from the Alaska Peninsula to the Klamath Basin it was assumed that lipids yielded 9 kcal/g when oxidized (Ricklefs 1974). It was also assumed that flight muscles converted chemical to mechanical energy with an efficiency of 25% (Greenewalt 1975). The latter's models were used to estimate the cost of flight because their predictions were closest to estimates of energy expenditure in flying birds made using doubly-labelled water (Flint and Nagy 1984). Using these models of the energy requirements for flight and assuming that Cackling Geese flew at a speed of 38.9 km/h (thus completing the 2,800 km migration in 72 h as observed) an average of 483 g of lipid were required to power the autumn migratory flight. An additional 35 g of lipid were required to maintain the birds during the flight, based on the model of the relationship between weight and basal metabolic rate of Ashchoff and Pohl (1970). Thus a total weight loss of 518 g is predicted by the models. This estimate is within 5% of the overall average migratory weight loss indicated by the data in Table 1 (543 g). This may have been an underestimate because Alaska weights may not have represented peak premigratory condition and some weight may have been regained in California prior to collection (D.G. Raveling pers. comm.). Considering also that other factors might have affected the cost of migration (e.g. different flight speed, imperfect navigation, wind) there is remarkable agreement. Cackling Geese would require only 392 g of lipid to complete autumn migration if they flew at 58 km/h, the speed of minimum cost of transport.

Before leaving the Yukon-Kuskokwim Delta Cackling Geese feed heavily on *Empetrum nigrum* berries (C.P. Dau pers. comm.) which contain high concentrations of both lipids and soluble carbohydrates (Sedinger and Raveling 1984). Cackling Geese undoubtedly deposit large amounts of lipid before departing. However, given the energy cost of the flight from the Alaska Peninsula to the Klamath Basin it is unlikely that these geese could fly directly from the Yukon-Kuskokwim Delta to wintering areas, which would entail a 20% longer flight. Therefore, the Alaska Peninsula is an essential staging area for Cackling Geese in autumn. This may be especially true for hatching-year birds as indicated by their intensive feeding at Ugashik Bay. The diet there includes tubers of *Triglochin palustris* (D. Timm unpub. 1982) which have been shown to be a good source of energy for geese staging along the coast of James Bay, Ontario (Thomas and Prevett 1980). Nevertheless, one hatching-year bird shot by hunters weighed only 1,400 g, which is barely 100 g above average fledging weight (Sedinger 1986). Given the average weight loss during migration it seems unlikely that this individual contained sufficient reserves to complete the migration. However, at present we have no estimate of the number of individuals that fail successfully to complete the flight from the Alaska Peninsula to wintering areas.

Raveling (1970) showed that larger social units were dominant to smaller ones in wintering flocks of other Canada Geese *B. c. interior*. We observed associations of marked birds that were banded together and likely represented families. However, associations were seen at a lower rate than would have been expected, using unpublished data, if most families were still intact. If Cackling Goose families had been intact at Ugashik Bay, we should have observed a more even distribution of outcomes of aggressive interactions between males and females (Table 3) owing to the association of females with other family members. The disparity between males and females in the outcomes of aggressive interactions suggests that members of pairs were not associated with their mates. The observations of weak family associations during autumn staging were consistent with those of Johnson and Raveling (1987) who observed similar patterns in Cackling Geese during winter. Family break-up has been reported during autumn staging on the Alaska Peninsula for another small goose, the Black Brant *B. b. nigricans* (Jones and Jones 1965), suggesting that the benefits of social bonds may not outweigh the costs of reduced feeding due to time spent in maintenance of such bonds.

Despite the importance of the autumn staging and migration period to their annual energy budget, we still have a relatively poor understanding of the biology of Cackling Geese during this period. Some energy must be stored by geese on the Alaska Peninsula but we do not know how much weight is gained prior to departure from the Yukon-Kuskokwim Delta, nor do we know whether Cackling Geese can completely compensate for low lipid stores upon arrival on the Alaska Peninsula in years when they depart the Delta early. Furthermore, we do not understand the energetic implications of variable weather conditions during departure of geese from the Alaska Peninsula. Do geese depart the Alaska Peninsula in some years without the benefit of favourable winds, and if so, how does this affect the energetic cost of migration? Answers to these questions are important for the effective management of Cackling Geese.

The population of Cackling Geese is presently at about 15% of historic levels (O'Neill 1979; Raveling 1984). It is apparent that Ugashik Bay and Cinder River are especially important to Cackling Geese, particularly those in younger age classes. These two areas have only minimal protection and are unique along the Alaska Peninsula (R. Gill pers. comm.). Given the precarious condition of the population and the very restricted nature of its autumn staging area, steps should be taken to ensure that these areas receive sufficient protection while biologists are gaining a better understanding of their importance.

## Acknowledgements

Alaska Peninsula/Becherof National Wildlife Refuge provided fuel and U.S. Fish and Wildlife Service Special Agents R. Armstong, L. Hood and R. Parker provided logistical support in the field. R. Sellers kindly provided weights of Cackling Geese that were killed by hunters in 1980. The manuscript benefitted from the comments of D. Derksen, C. Ely and R. Gill.

## Summary

Cackling Canada Geese *Branta canadensis minima* undergo a long (2,800 km) migration between their autumn staging areas on the Alaska Peninsula and wintering areas in Oregon and California. Adults and young lost an average of 543 g during this migratory flight. Weight gains between fledging and autumn migration are essential for the successful completion of the flight. Autumn staging is important for the acquisition or maintenance of energy stores, particularly for young of the year, as evidenced by the intense feeding of this age class at Ugashik Bay. Factors associated with the arrival and departure of Cackling Geese at Ugashik Bay are presently unknown.

## References

Aschoff, J. and Pohl, H. 1970. Der Ruheumsatz von Vogeln als Function der Tageszeit und der Korpergrosse. *J. Ornithol.* 111:38–47.

Dixon, W.J. 1983. *BMDP Statistical software*. Berkeley, California: University of California Press.

Ebbinge, B., St. Joseph, A., Prokosch, P. and Spaans, B. 1982. The importance of spring staging areas for arctic breeding geese, wintering in western Europe. *Aquila* 89:249–258.

Flint, E.N. and Nagy, K.A. 1984. Flight energetics of free-living sooty terns. *Auk* 101:288–294.

Greenewalt, C.H. 1975. The flight of birds, the significant dimensions, their departure from the requirements of dimensional similarity, and the effect on flight aerodynamics of that departure. *Trans. Amer. Phil. Soc.* 65:1–67.

Johnson, J.C. and Raveling, D.G. 1987. Weak family associations in Cackling Geese during winter: effects of body size and food resources on goose social organisation. *Waterfowl in Winter symposium* Univ. Minnesota Press. Minneapolis.

Jones, R.D. and Jones, D.M. 1965. The process of family group disintegration in Black Brant. *Wildfowl* 17:75–78.

McLandress, M.R. and Raveling, D.G. 1981. Changes in diet and body composition of Canada Geese before spring migration. *Auk* 98:65–79.

Nelson, U.C. and Hansen, H.A. 1959. The Cackling Goose – its migration and management. *Trans. N. Amer. Wildl. Nat. Res. Conf.* 24:174–186.

O'Neill, E.J. 1979. Fourteen years of goose population trends at Klamath Basin refuges. Pp. 316–321 in Jarvis, R.L. and Bartonek, J.C. (Eds.). *Management and biology of Pacific Flyway geese*. Corvalis, Oregon: O.S.U. Book Stores, Inc.

Prevett, J.P., Marshall, I.F. and Thomas, V.G. 1979. Fall foods of Lesser Snow Geese in the James Bay region. *J. Wildl. Manage.* 43:736–742.

Raveling, D.G. 1970. Dominance relationships and agonistic behaviour of Canada Geese in winter. *Behaviour* 37:291–319.

Raveling, D.G. 1978. Morphology of the Cackling Canada Goose. *J. Wildl. Manage.* 42:897–900.

Raveling, D.G. 1979. The annual cycle of body composition of Canada Geese with special reference to control of reproduction. *Auk* 96:234–252.

Raveling. D.G. 1984. Geese and hunters of Alaska's Yukon Delta: management problems and political dilemmas. *Trans. N. Amer. Wildl. Nat. Res. Conf.* 49:555–575.

Ricklefs, R.E. 1974. Energetics of reproduction in birds. Pp. 152–292 in Paynter, R.A. (Ed.). *Avian energetics*. Nuttall ornithol. Club. Cambridge, Mass.

Sedinger. J.S. 1986. Growth and development of Canada Goose Goslings. *Condor* 88:169–180.

Sedinger. J.S. and Raveling, D.G. 1984. Dietary selectivity in relation to availability and quality of food for goslings of Cackling Geese. *Auk* 101:295–306.

Thomas, V.G. and Prevett, J.P. 1980. The nutritional value of arrow-grasses to geese at James Bay. *J. Wildl. Manage.* 44:830–836.

Wypkema, R.C.P. and Ankney, C.D. 1979. Nutrient reserve dynamics of Lesser Snow Geese staging at James Bay, Ontario, *Can. J. Zool.* 57:213–219.

Ydenberg, R.C. and Prins, H.H.Th. 1981. Spring grazing and the manipulation of food quality by Barnacle Geese. *J. Appl. Ecology* 18:443–453.

**James S. Sedinger [1] and Karen S. Bollinger**, Alaska Fish and Wildlife Research Center, U.S. Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK 99503.
[1]Present address: Institute of Arctic Biology and Department of Biology, Fisheries and Wildlife, 211 Irving Bldg., University of Alaska, Fairbanks, AK 99775–1780.