An isolated population of small Canada Geese on Kaliktagik Island, Alaska

SCOTT A. HATCH and MARTHA A. HATCH

Introduction

Recently we discovered that a small form of the Canada Goose *Branta canadensis* breeds on Kaliktagik Island, one of the Semidi Islands, about 80 km south of the Alaska Peninsula near longitude 157°W (Figure 1). The unexpected occurrence of geese on this oceanic island and the possibility that they are closely allied with the endangered Aleutian race of Canada Geese *B. c. leucopareia* prompt this summary of observations made between 1977 and 1981, in the course of field studies on seabirds of the area.

Population on breeding and wintering areas

We first noted geese in the vicinity of Kaliktagik Island during a boat survey in May 1977, when two were observed in flight offshore. In June of the following year, our first ground survey disclosed that geese inhabited the island, but breeding was not confirmed until 1979, when several pairs with young were discovered in midsummer.

From the number of birds observed in the air or on the ground, we judged the population to be 20-25 birds in 1979, 30-35 birds in 1980, and about 50 birds in 1981. We consider only the last of these figures (actual count 49 birds) to be quite accurate, however, and the apparent trend in population size is very likely due to increasing proficiency on our part. It was difficult to get an absolute count because of vegetation and the movement of birds. We are confident, however, that any substantial departure from the 1981 count in the future may be attributed to real population change. It was our impression that only 10 to 15 pairs bred each year.

We conducted thorough ground surveys of all the Semidi Islands between 1978 and 1981 and found that nesting geese are at present restricted to Kaliktagik. Infrequently, one or two birds from Kaliktagik were seen loafing on Anowik Island, which is separated from Kaliktagik by only a narrow (0.5 km) channel).

In 1980 we banded, with United States Fish and Wildlife Service metal bands and numbered plastic tarsal bands (red with white numerals), 10 moulting adult geese and 6 goslings. Banded birds were subsequently sighted on the Oregon Coast by W. G. Henry and T. Livengood of the United StatesForest Service, to whom we are indebted for the following information: The wintering area is near Pacific City in Tillamook County, Oregon. Throughout the 1980-81 winter, geese roosted on an offshore islet and fed in pastures on the adjacent mainland. Most birds arrived during the first week of November, and 85 individuals, the high count for the season, were observed together on several days that month. All 10 banded adults were present in the flock, as were unmarked immature birds. None of the banded young was seen, however, a disconcerting fact for wich we have no likely explanation other than mortality. Generally, 60-70 birds were observed from December to February; the number dwindled in late February, and none was seen after mid-March.

It seems reasonable to conclude that the flock observed by Henry and Livengood comprised the adult population from Kaliktagik plus young produced in 1980. Thus the breeding and wintering areas of this small, apparently discrete population are precisely known. Henry noted the first arrival of geese (a group of 51) at Pacific City on 24 November 1981. By mid-December the flock contained 60 birds, including 6 of the adults banded in 1980 and 4 of 6 adults banded in 1981. The only gosling banded in 1981 was also present.

Nesting environment, phenology, and habitat use

Kaliktagik Island measures about 2000 by

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600 m with a maximum elevation of about 130 m in the north central third of the island. From this point, slopes of 15 to 25 degrees lead to a rocky, cliff-bound shoreline accessible in only two places by small craft. Most of the island is covered with a lush vegetation of grasses, forbs, and a few prostrate willows *Salix* spp. There is no standing or running fresh water.

Canada Geese share Kaliktagik Island with more than 100,000 seabirds of 14 species. The presence of about 1000 Glaucous-winged Gulls *Larus glaucescens* is especially noteworthy, since these are potentially important predators on eggs and young goslings. Bald Eagles *Haliaeetus leucocephalus* and Arctic Skuas *Stercorarius parasiticus* nest on the island, and Peregrine Falcons *Falco peregrinus* are regular visitors. Ground squirrels *Spermophilus parryii,* the only land mammals, are present in low numbers on Kaliktagik.

Geese arrived on Kaliktagik Island some time between 24 and 29 April 1981, 6 weeks after the last birds were seen in Oregon. Egg-laying probably does not begin until mid-May most years. In 1979 we found three broods on 26 June (one with two and two with three goslings). Young of all three broods appeared to be about 1 week old, and to have hatched within a few days of one another. If a 26-day incubation period is assumed, clutches were probably completed around 25 May. We found a nest containing 6 eggs on 27 May 1980 (mean egg dimensions 52.7 ± 1.36 mm by 78.8 ± 1.36 mm). One brood of three young was judged to be about 10 days old on 15 July that year, indicating that the goose had started her clutch around 1 June.

The earliest dates on which adults began moulting are unknown. All birds were apparently flightless by about 20 July during all years 1979-81. On 22 July 1980 we captured a moulting adult male whose new flight feathers were already well advanced. The same bird proved to be fully capable of flight when it was flushed on 1 August. On 8 September 1981 it appeared that many birds had already left the island, and we may have witnessed the departure of the last of them on that date. This would indicate a period of about 11 weeks for the autumn migration in 1981.

The geese extensively use about 50 ha in the northwestern two-thirds of the island. Areas specifically avoided are characterized by dense stands of beach rye *Elymus arenarius* or other grasses which hamper locomotion on the ground. When the birds arrived in spring, they concentrated their activity on a south-facing slope where new growth of umbels *Angelica* and *Heracleum* and various other forbs, e.g. *Ranunculus, Claytonia, Epilobium, Geranium* and *Viola,* emerged first. They seemed to dig extensively while foraging at this time, possibly eating roots or entire seedlings. This behaviour may be responsible for certain quantitative and qualitative differences between the vegetation in goose habitat on Kaliktagik and that sampled on similar sites elsewhere in the Semidis. Nesting territories were scattered over most of the 50 ha primary use area, but families and moulting nonbreeders tended to move upslope to an area of shorter vegetation along the central ridge and east side of the island. Cover was available in adjacent waist-high stands of *Angelica* and *Heracleum,* forming an effective canopy with runways beneath. It was evident that preferred plant foods at this time included the seed heads or tender shoots of the following species: *Ranunculus occidentalis, Phleum commutatum, Carex macrochaeta, Agrostis exarata,* and *Hordeum brachyantherum* (botanical names follow Hulten 1968).

Except for the presumed role that geese have played in altering their own habitat, there are no conspicuous differences in physiography or vegetation between Kaliktagik Island and at least portions of several other islands in the group. However, the changes we ascribe to the presence of geese are extensive enough as to preclude the possibility that the birds colonized Kaliktagik Island only very recently.

Morphometric data and taxonomic status

Most recent authorities (e.g. Delacour 1954; Johnsgard 1975; Bellrose 1978) recognize 11 extant subspecies of the Canada Goose, 6 of which occur in Alaska. Two relatively large-bodied forms, *fulva* and *occidentalis,* are found in the region of the Copper River delta

and in southeastern Alaska. Both are quite dissimilar in body size to the birds breeding on Kaliktagik Island. The approximate breeding ranges of four smaller-bodied races are shown in Figure 1, in which the relative isolation of Kaliktagik from the known breeding areas of all three mainland subspecies is apparent. Buldir Island, the only known breeding site of subspecies *leucopareia,* is still further removed (1800 km to the west), but this race formerly occupied most of the Aleutian Chain. It was driven nearly to extinction with the introduction of arctic foxes *Alopex lagopus* to most of its breeding islands (Jones 1963) and is presently the object of an intensive recovery programme co-ordinated by the United States Fish and Wildlife Service (Springer *et al.* 1978). The possibility exists that Kaliktagik Islands harbours another remnant of what may once have been a continuous distribution of geese in marine habitats along the Alaska Peninsula and throughout the Aleutians. Alternatively, the Kaliktagik population may have originated recently with the settlement of

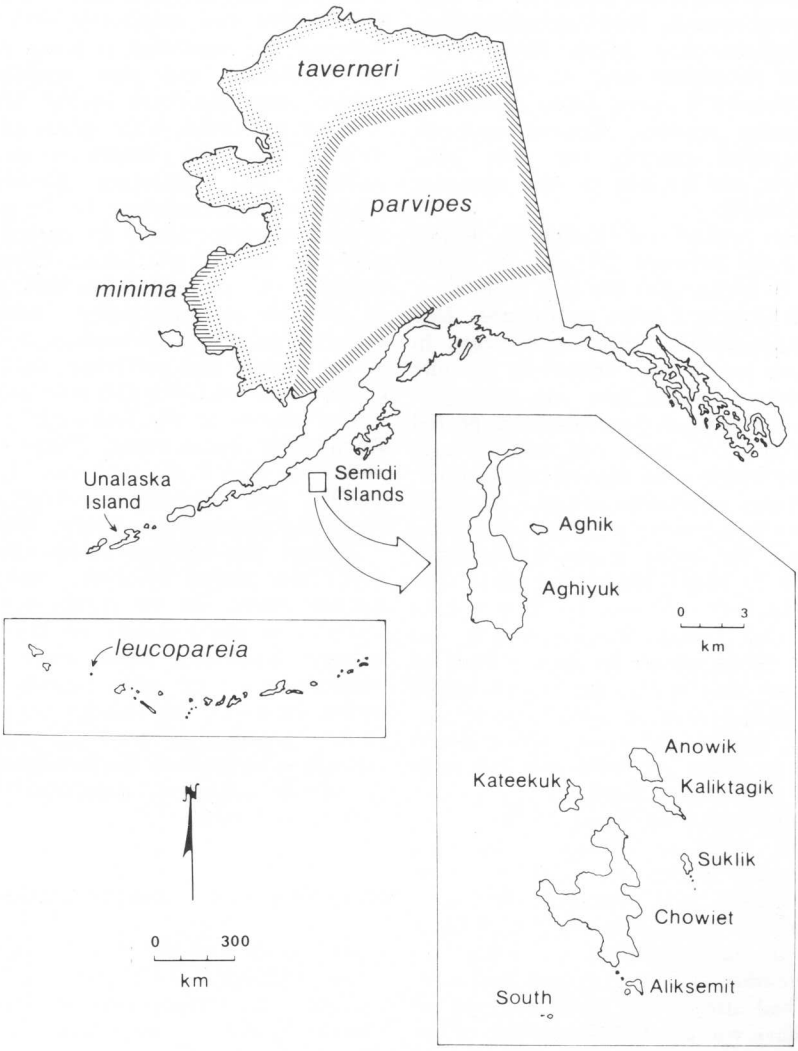

Figure 1. Location of Kaliktagik Island and approximate breeding ranges of four subspecies of Canada Geese in Alaska (after Johnson *et al.* 1979).

individuals from any one or a combination of subspecies. Morphometric data highlight but do not settle this question.

Table 1 summarizes body measurements of 13 geese captured during moult. Weights were measured with a 2.5 kg Pesola spring balance. All linear measurements were taken with a Vernier caliper (0.1 mm accuracy) according to methods described by Johnson *et al.* (1979). Neckring width is an important character for distinguishing subspecies, but we found that this measurement varies greatly with the extension and posture of the neck in relation to the rest of the body in live birds. The most consistent procedure was to take the measurement in two ways – first with the neck leaning forward so as to minimize mid-ventral neckring width, then with the neck extended back in order to maximize the width of the ring. The mean of these values approximates the condition in a bird standing in a normal upright posture. Means are used for comparison with published data for the various subspecies.

Kaliktagik Island geese averaged significantly larger than subspecies *minima* in all characters examined; a few of these differences are indicated in Table 2. They were generally smaller than *parvipes,* although our sample of birds had relatively large tarsi, approaching the size of *parvipes* in this one character. Together with *leucopareia* and *taverneri,* however, the birds from Kaliktagik form

Table 1. Means and variation in selected morphological characters of 13 Canada Geese on Kaliktagik Island (linear measurements in mm, weights in grams).

Morphological character	Males (n = 8) $\overline{X}$	SD	Range	Females (n = 5) $\overline{X}$	SD	Range
Exposed culmen	37.5	6.13	33.0-41.4	35.9	1.67	33.7-38.2
Bill width at nail	15.4	0.58	14.7-16.5	15.0	0.50	14.6-15.7
Bill width at nares	18.5	0.66	17.9-19.6	17.8	0.48	17.3-18.5
Bill width at base	20.9	0.80	19.8-21.8	19.8	0.49	19.1-20.3
Tarsus (diagonal)	77.9	2.80	73.8-82.4	73.9	3.47	71.0-78.0
Total tarsus	94.7	3.01	90.5-99.5	89.5	3.67	86.5-93.5
Mid-toe length	60.5	2.53	57.4-65.8	59.0	1.28	57.3-60.7
Neckring width *						
Minimum	4.9	2.86	1.0-9.3	7.0	1.55	4.3-8.2
Maximum	11.3	5.31	2.8-16.8	14.7	8.09	9.0-28.7
Mean	7.9	3.64	1.9-13.1	10.9	4.34	6.7-18.1
Weight	1798	223.40	1370-2080	1707	132.70	1550-1890

* See text for explanation of min-max.

Table 2. Morphological characters of four subspecies of Canada Geese (data from Johnson *et al.* 1979, D. H. Johnson, pers. com.). Asterisks indicate significant differences between means for these subspecies and means for the birds on Kaliktagik Island (Table 1).

Character		*minima* Males	*minima* Females	*leucopareia* Males	*leucopareia* Females	*taverneri* Males	*taverneri* Females	*parvipes* Males	*parvipes* Females
Culmen	$\overline{X}$	29.7***	28.1***	35.6*	34.1*	37.8	36.1	43.0***	40.2***
	SD	2.12	1.71	2.03	1.79	2.26	2.16	2.56	2.08
	n	121	175	119	122	62	58	30	17
Tarsus	$\overline{X}$	70.2***	65.6***	76.7	72.0	75.8	71.4	80.8*	75.3
	SD	2.90	3.00	3.12	3.38	3.39	3.16	3.33	3.29
	n	106	157	118	121	61	58	28	17
Neckring	$\overline{X}$	...	...	15.9***	15.5	0.8***	1.2***	0.5***	1.1***
	SD	...	...	6.06	5.74	1.81	2.68	1.39	3.74
	n	...	...	93	98	40	42	15	12
Weight	$\overline{X}$	1546***	1312***	2059**	1801	2607***	2421***	...	...
	SD	199.4	199.6	214.4	195.0	267.4	238.2	...	...
	n	98	157	113	117	17	23	...	...

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

a cluster of morphs in which mean differences are generally small and single characters are usually inadequate for distinguishing subspecies. Kaliktagik birds differed from these two taxa chiefly in the width of the neckring and in their curiously small body weights. Weight varies seasonally, of course, but the data for *leucopareia* pertain to moulting birds on Buldir, and should be roughly comparable with our own. Moreover, the difference between summer and winter weights in *leucopareia* amounts to less than 10 per cent (Johnson *et al.* 1979), compared with a difference or more than 40 per cent between Kaliktagik birds and the figures available for *taverneri.*

We studied 25 adults geese through a spotting scope and found that 23 (92 per cent) had a well-defined neckring at least 5 mm wide. The widest rings probably measured 20 to 25 mm midventrally. Field observations on *leucopareia* and *taverneri* (Johnson *et al.* 1979, including information not summarized in Table 2) indicate that nearly all adult Aleutian geese have a neckring, averaging 20 mm wide, and about 40 per cent of adult *taverneri* have neckrings averaging 5 mm wide. Thus the birds on Kaliktagik Island appear to be intermediate in this trait, one of the key characters used to distinguish *leucopareia* and *taverneri.*

Johnson *et al.* (1979) developed discriminant functions for distinguishing subspecies of Canada Geese using various combinations of characters. Employing their initial discriminant function to determine the probable affinity of each bird captured on Kaliktagik, we would assign about equal numbers to subspecies *leucopareia* and *taverneri* (Table 3). Two birds most closely matched *parvipes* with respect to culmen and tarsal measurements. Secondary functions incorporating additional characters are available to assign individuals to one or the other of two morphologically close subspecies when the results of the initial discriminant function are equivocal. Making pairwise comparisons (functions 2c, 2f, 3a, and 4b in Johnson *et al.* 1979), we find that most birds are designated *leucopareia,* largely on the strength of their neckring measurements.

The results of discriminant analysis reinforce our conclusion from the comparison of means, i.e. the geese on Kaliktagik are morphologically intermediate between *leucopareia* and *taverneri.* With respect to body size (exclusive of weight) they are more similar to *taverneri,* whereas the presence of a prominent neckring strongly favours classification with *leucopareia.* Certainly this population is not clearly differentiated at the subspecies level on the basis of morphological characteristics we have evaluated. The birds' unique combi-

Table 3. Results of a two-stage discriminant function analysis (Johnson *et al.* 1979) to assign Kaliktagik Island geese to one of six Alaskan subspecies of *Branta canadensis.*

Analysis	Characters used	Subspecies	No. of individuals assigned to subspp. Males	Females	Total
Initial DF	Culmen, tarsus, Total tarsus	*minima*	0	0	0
		leucopareia	4	1	5
		taverneri	3	3	6
		parvipes	1	1	2
		Total	8	5	13
Secondary DFs	Bill widths at nail and nares, Bill at nail/ Bill at base, Tarsus/bill at Nares, neckring	*leucopareia* vs. *taverneri*	7	5	12
			1	0	1
	Culmen, tarsus, Neckring	*leucopareia* vs. *parvipes*	6	4	10
			2	1	3
	Culmen, tarsus, Bill at nail	*taverneri* vs. *parvipes*	8	5	13
			0	0	0

nation of characters could have resulted from genetic drift or hybridization among recent colonists. The subspecific taxonomy of Canada Geese continues to be a disputed matter in any case. Palmer (1976), for example, chose not to recognize *taverneri,* suggesting that this form is merely the hybrid product of crosses between *parvipes* and *minima.* Perhaps the geese on Kaliktagik should be viewed as partly bridging the gap between *leucopareia* and the mainland subspecies.

Possible history of Canada Geese at the Semidi Islands

In a recent translation of the field notes of Carl Heinrich Merck (Pierce 1980), there is a reference to Canada Geese breeding at the Semidi Islands nearly 200 years ago. As the naturalist on a Russian voyage, Merck briefly visited one of the smaller islands on 25 June 1790 and found adults with young. This apparently is the only literary reference to Canada Geese breeding historically anywhere along the Alaska Peninsula. Surely it is a remarkable coincidence that Merk happened to report his find at the Semidi Islands, specifically. (His physical description of the island is, in fact, explicit enough that we know he probably visited Kaliktagik Island itself, or possibly Anowik.) Merck also described nesting Canada Geese on Unalaska Island, 700 km west of the Semidis and 300 km east of the previously known historical range of Aleutian geese (Jochelson 1933 *in* Springer *et al.* 1978). If Canada Geese formerly were common on islands off the Alaska Peninsula, they would have been largely eliminated with the introduction of foxes that occurred extensively throughout the region.

Far from being exempt during the fox-farming era, the Semidi Islands were among the earliest and most successful producers of fox skins in the Gulf of Alaska (Bower & Aller 1917). Arctic foxes were first released on Aghiyuk Island in 1885 and on Chowiet Island the following year. They thrived for perhaps 20 years until, by 1907, the number of animals had dwindled substantially and a full-time caretaker was no longer employed by the 'Semidi Propagating Company'. The operation was apparently abandoned altogether by 1914, and it seems likely that foxes died out within a few years after this date. The managers had also stocked 'a small island (probably Kateekuk) adjacent to South Semidi (Chowiet) Island' with red foxes *Vulpes fulva* about 1895. They recorded that foxes soon managed to cross the channel between this island and Chowiet. There is little reason to think that foxes ever reached Kaliktagik, however, nor would they have persisted long on any of the small islands unaided by the caretakers, who provided winter food. Although it is unlikely that foxes have been present on any of the Semidi Islands for at least 50 years, the episode may have eliminated geese from formerly occupied habitats on Chowiet, Aghiyuk, and Kateekuk Islands.

Regarding the more recent status of this population, the apparent effect that geese have had on the vegetation on Kaliktagik Island is evidence of continuous use over a considerable number of years. There is also evidence from the wintering area for the continuity of this flock. W. G. Henry learned from local property owners in Oregon that a group of small Canada Geese numbering 'a few more than the present flock' has been visiting the same pastures near Pacific City every winter since about 1943. The appearance of the birds at their present wintering site may have resulted from local changes in land use, which have been extensive in the area.

Conclusions

We believe the balance of historical, ecological and morphological evidence favours the view that Kaliktagik Island supports a remnant marine population of Canada Geese. As such the discovery offers encouraging potential for the conservation of genetic and behavioural diversity in this species. The geese now have total protection from human activities on the Semidi Islands, a National Wildlife Refuge, and no adverse developments on the breeding grounds are anticipated. With fewer than 100 members, however, the population may require additional measures to ensure its con-

tinued existence. Additional protection may be needed on wintering areas or the still unknown areas used during the period of migration. If geese formerly bred on other islands near the Alaska Peninsula, as now seems likely, the birds on Kaliktagik are perhaps the only stock from which restoration of this population could be achieved.

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Summary

Some 50-60 Canada Geese *Branta canadensis* inhabit Kaliktagik Island, Alaska, in summer (late April to mid-September); in 1980 the corresponding population size was 80-90 adults and young on the wintering area in Oregon. The birds are morphologically intermediate between subspecies *leucopareia* and *taverneri*. They are ecologically distinctive for their use of a nesting environment which is unlike that used by any other Canada Geese except those on Buldir Island, 1800 km west. These facts, together with historical records, suggest this population is a remnant one, possibly representing the eastern margin of a former continuum of island populations extending from the western Gulf of Alaska to the Commander and Kurile Islands of the Soviet Union.

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Scott A. Hatch, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska, U.S.A. 99503

and: Museum of Vertebrate Zoology, University of California, Berkeley, California, U.S.A. 94720.

Martha A. Hatch, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska, U.S.A. 99503.