SITE SELECTION AND FORAGING BEHAVIOR OF ALEUTIAN CANADA GEESE IN A NEWLY COLONIZED SPRING STAGING AREA

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Abstract: The once endangered Aleutian Canada goose (*Branta canadensis leucopareia*) population made a dramatic recovery and was reclassified from endangered to threatened in 1990 and removed from the threatened species list in 2001. In 1997 the birds began using a new spring staging area adjacent to Humboldt Bay in northern California. The new staging area, primarily dairy pastureland, is located ~150 km south of the population's traditional spring staging area. Numbers increased in the new area from 1997, and peaked at 19,000 individuals (~50% of the total population) in early March 2002. In the northern Humboldt Bay staging area, foraging sites were located within 1 km of the bay's associated tributaries. Forty-five percent of goose-days were on pastures characterized as green (>95% green grass) with short to medium grass height (13–30 cm) and with some standing water, which represented 15% of the available habitat. Older pasture of medium grass height (30–60 cm) with standing water represented only 2% of available habitat but was the second most frequently used habitat (25%). At night the geese roosted initially on a pasture that was surrounded by narrow tributaries and later on a temporarily flooded pasture located behind large dunes that provided shelter from prevailing oceanic winds. A comparison between farms that did and did not attract the geese indicated that geese favored habitats with a larger percent cover of water (fresh or brackish) and those near to bodies of fresh water >750 m^2. The geese spent 87% of the observed periods foraging on pasture plants. The continual increase in abdominal fat score indices over 90 days indicated that the geese were apparently acquiring reserves beyond requirements for daily maintenance energy.

Key words: abdominal profile, activity budgets, Aleutian Canada geese, *Branta canadensis leucopareia*, habitat.

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The recovery of the Aleutian Canada goose population is 1 of the most spectacularly successful conservation programs of the Federal Endangered Species Act (1973). This small race of Canada geese, characterized by a white neck-ring at the base of the black neck and its long trans-Pacific migration from the Aleutian islands, Alaska to California, was initially listed as endangered in 1967 under the law that preceded the Federal Endangered Species Act (U.S. Fish and Wildlife Service 2001). The population's migration route and nonbreeding haunts in winter and spring were discovered in 1975 and a recovery program was initiated (Springer et al. 1978). Due to a series of conservation and management initiatives the population made a dramatic recovery from a reported low of 790 individuals in 1975 to an estimated peak of just under 37,000 (± 5,000) in the 2001–2002 late-winter and spring periods (Springer et al. 1978, Woolington et al. 1979, Byrd 1998, Springer and Lowe 1998, Drut and Trost 2002). The subspecies was reclassified from endangered to threatened in 1990 and removed from the threatened species list in 2001 (U.S. Fish and Wildlife Service 2001). The primary spring staging area was and still is in the coastal stretch of farmland just north of the traditional night roost on the major seabird island/colony at Castle Rock National Wildlife Refuge, near Crescent City, in Del Norte County, in northwest California.

As a contribution to the successful recovery of this notable subspecies, we document the expansion of the population's spring staging range at a previously little used region in the vicinity of Humboldt Bay, California, some 150 km south of the bird's traditional staging area. In particular, we describe (1) the build-up of numbers during the period of colonization, (2) pasture and other landscape features that may have attracted the geese to the area, (3) measures of foraging performance associated with the new habitat, and (4) general observations regarding the birds' roosts and frequency of disturbances including predators.

STUDY AREA

The study areas consisted of 2 coastal floodplains north and south of Humboldt Bay, Humboldt County, California. The primary study area consisted of floodplains that were converted to agricultural lands north of the bay and west of the city of Arcata (40°53'N, 124°07'W). This area consists of farms totaling ~2,000 ha. During this study, 93% of these farms were pastureland used primarily to support dairy cows and beef cattle, with 3% and 4% consisting of crops or overgrown/unmanaged pasture, respectively. Our secondary study area consisted of the reclaimed floodplains south of the bay, including pastures, marshes and shallow ponds of the Humboldt Bay National Wildlife Refuge (40°41'N, 124°12'30"W) and the adjacent, private pasturelands north of the Eel River near Loleta (40°39'N, 124°15"W). Throughout the study areas are tributaries (sloughs) connected to Humboldt Bay, ponds, drainage channels, and smaller permanent and semi-permanent bodies of water. Pastures are dominated by a mixture of grasses and forbes, including ryegrass (*Lolium perenne*), velvet grass (*Holcus lanatus*), bluegrass (*Poa* spp.), meadow fescue (*Festuca arundinacea*), bent grass (*Agrostis* spp.), clover (*Trifolium* spp.), and buttercup (*Ranunculus* spp.) (Barnhart et al. 1992, Long 1993). We kept track of the build-up in numbers at both study areas, whereas habitat related studies were conducted only in the Arcata study area.

METHODS

Population Parameters, Landscape Characteristics, and Behavioral Measures

During 1997–2002, we conducted periodic ground counts along a road transect through our 2 study areas. During spring in 1999–2002, we drove the survey route through the Arcata study area every 3–4 days. Each farm (n = 92) was scanned from the road with a good quality spotting scope and the number of birds was recorded.

In 1999 and 2000 we classified the 477 fields on the Arcata study area with crude habitat descriptions prior to the birds' arrival. Fields were categorized as containing grass pasture, corn stubble, uncut corn, old unmanaged pasture, and marsh/rush. Pastures were characterized by appearance as primarily bright green (95% green cover with <5% covered by rank vegetation such as dead plants or clusters of rush [*Juncus* spp.]), or not green (<5% coverage by rank vegetation). Grass pastures were further categorized by a visual estimation of grass height, including short (13 cm), short to medium (13–30 cm), medium (30–60 cm), and tall (> 60 cm). The presence or absence of standing water was also recorded. Goose use of pastures was quantified in relative goose-days (sum of birds counted in a particular field on different days over the study period/ total number of recorded goose-days for all fields) and compared with relative availability of pasture types in the study area.

For each of the 92 farms in the study area, bodies of water, roost sites, and roads were digitized from a digital orthophoto image using ARCVIEW (Environmental Systems Research Institute, Redlands, California, USA). Only permanent bodies of water, determined from ground checks, were used in the analysis to provide consistency throughout the study period. Farm area and perimeter, water surface area and perimeter, and length of roads were measured. We used these variables to calculate the ratio of farm area to perimeter, proportion of a farm covered by water (fresh or brackish), the average size of bodies of water within a farm and distance from the central point of the farm area to

the nearest permanent bodies of freshwater >750 m^2 in size, including the birds' night roost used in 2002. Farms were assigned to a binomial category (used and not used), indicating that a particular farm had supported geese (≥ or < 50 goose-days, respectively) during the 2001 and 2002 spring staging periods. We used logistic regression with landscape characteristics as predictor variables to describe differences between used and unused farms. We conducted forward stepwise selection procedures using likelihood-ratio tests to derive variable combinations (Hosmer and Lemeshow 1989) that best differentiate used from unused farms.

Behavioral Measures and Abdominal Fat Score Indices

We recorded the proportion of geese that were vigilant and foraging in flocks via instantaneous flock scans (Martin and Bateson 1996). Multiple scans were separated by >10 min intervals and no more than 3 scans were taken per flock. A minimum of 12 scans (mean 55) was accumulated during the season for each hour of the daylight and distributed evenly across dates between 10 February and 14 April 2002. We recorded an index of fatness (abdominal profiles) by scanning flocks for birds that were oriented perpendicular to the observer (Owen 1981, Black et al. 1991, Boyd et al. 1998, Prop et al. 2003). The white-plumage abdomens were assessed by 1 observer (T.D.T.) according to the degree of sagging toward the ground, classified as (0) concave, (1) straight from top of legs to base of tail, (2) slightly convex, (3–6) increasing degrees of rounding and (7) well-rounded (Black et al. in press, adapted from Owen 1981). Weekly fatness scores were averaged and compared through the 10-week study period, using a Spearman Rank Correlation test. Studies in other goose species showed that abdominal profile classes (similar to ours) are linearly related to fat reserves (Madsen et al. 1997, Boyd et al. 1998, Zillich and Black 2002). We also describe casual observations regarding predators, disturbance and the birds' roost sites in the study areas.

RESULTS

Staging Patterns

Initial counts in 1997 indicated that only small numbers of Aleutian Canada geese visited the area, with peak counts of 300 birds at each study site (Fig. 1). Larger flocks were counted in each subsequent year of the study, with the highest numbers occurring in 2001 and 2002. The increase in numbers was similar at both study areas until 2002 (Fig. 1).

The birds were present for about 16 days in 1998. In subsequent years they arrived earlier and stayed longer, arriving as early as 11 January and staying through 13 April (Fig. 2). The geese were present for a minimum of 90 days in 2002. After a gradual build-up

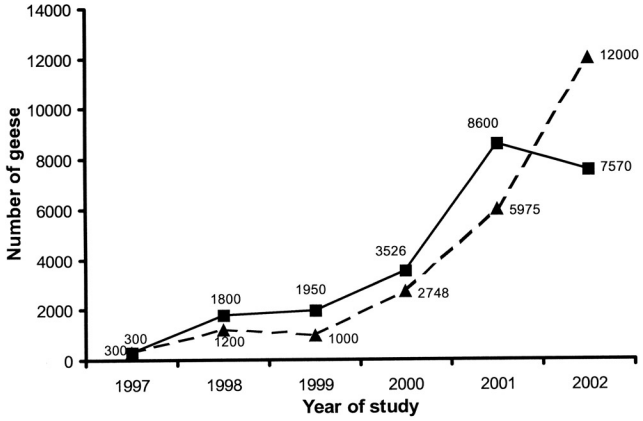

Fig. 1. Spring peak numbers of Aleutian Canada geese on the pastures of Arcata, California (northern study site; solid line with squares), and Humboldt Bay National Wildlife Refuge (HBNWR) and the adjacent foraging area in Loleta, California (southern study site; dashed line with triangles).

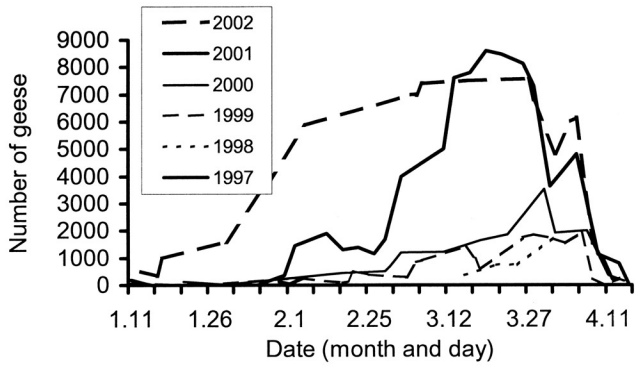

Fig. 2. Weekly population estimates of Aleutian Canada geese determined from ground counts along road transects through the Arcata study area in Jan–Apr 1997–2002. Values of the highest count per week are indicated.

of numbers, peak counts were usually achieved in the last 2 weeks of March. Mass departures from the study area occurred in late March and April (Fig. 2). Few birds remained after 15 May.

Pasture Use

In 1999, goose flocks were recorded on only 15 of the 477 fields on 5 farms in the Arcata study area. Mean flock size in 1999 was 273 birds (SE = 40, n = 41). In 2002 the birds used 131 fields on 27 farms and mean flock size was 353 birds (SE = 18, n = 570).

Goose attendance on pastures of particular types was disproportionate to the types' relative abundance. We recorded a total of 4,525 goose-days among 477 fields between 1 February and 1 April 2000. Geese were observed most frequently in green pastures with short to medium grass height, with some standing water. These fields represented 15% (300 ha) of the total field area and accommodated 45% of the recorded

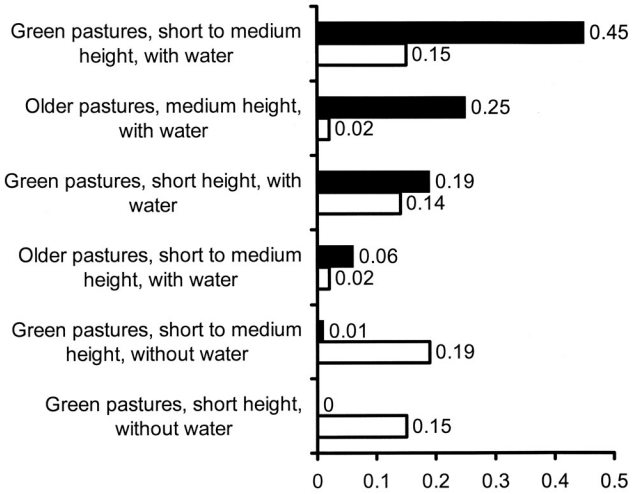

Fig. 3. Relative goose use of 6 pasture types on the Arcata study area in the year 2000, based on 27 flock locations on a potential 477 fields. Black bars indicate total goose-days in each habitat type. White bars indicate total area for each habitat type available in study area. Values on right side of bars refer to the proportions.

goose-days. Mature pastures with medium grass height and some standing water were the second most used pasture-type, with 25% of the recorded goose-days. These pastures accounted for only 40 ha, 2% of the total area. Comparisons of the same pasture-types in Fig. 3, with and without standing water, indicate that the geese may prefer foraging in fields with water.

Landscape Characteristics of Farms

Nine landscape characteristics of farms in the Arcata study area, as determined by analysis of an orthophoto image with GIS software, are outlined in Table 1. Farms that were used by the geese in 2001 and 2002 had a greater percentage cover of water and were closer to a permanent water body than unused farms (Table 2). Other landscape variables such as size of farms and length of roads within and around farm areas were not significantly different between used and unused farms.

Foraging Behavior

Aleutian Canada geese in the northern, Arcata study area in 2002 spent 87.0% of the daylight hours actively foraging (SE = 0.01, n = 700 scans) and 12.7% being vigilant (SE = 0.01, n = 700 scans), leaving little time for other activities (Fig. 4). Seven observations were conducted at first light at the night roost. Very little feeding took place at this time, as most birds were in head-up posture and preparing for departure (Fig. 4). Geese left the roost approximately 10 minutes prior to official sunrise and dispersed up to 6 km to fields in the central and southern portion of the study area. No

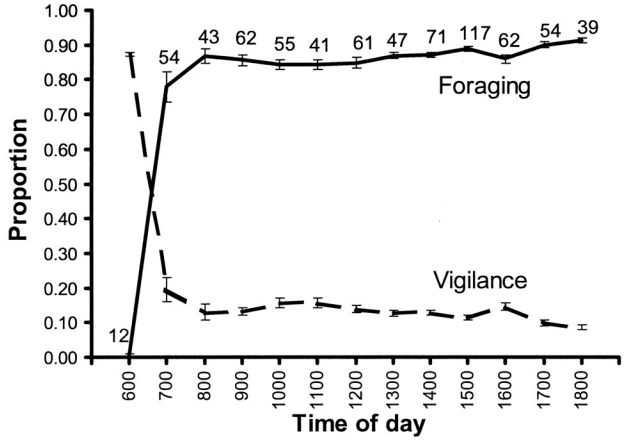

Fig. 4. Proportion of Aleutian Canada geese that were feeding or vigilant in Jan–Apr 2002 in the Arcata study area. Shown with standard error bars and sample sizes (number of flock scans).

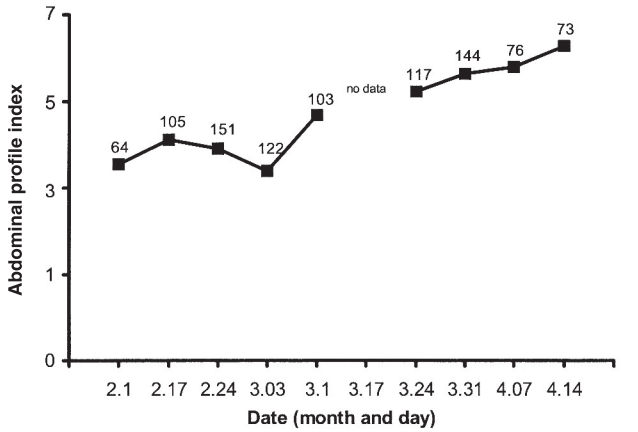

Fig. 5. Abdominal profile scores of Aleutian Canada geese determined by an ocular assessment of geese in the field in Jan–Apr 2002 in the Arcata study area. Abdomens were assessed according to the degree of sagging toward the ground, classified as (0) concave, (1) straight, (3) slightly convex, (5) rounded and (7) well-rounded. Sample sizes (individual birds) are indicated.

geese were observed on the roost between 0700 and 1700 hrs.

In 2001–2002 in the southern study area, the geese foraged in nearby fields on the Humboldt Bay National Wildlife Refuge or flew up to 5 km southwest to feed in pastures west of Loleta.

Fatness scores in the Arcata study area increased significantly through the study period (r_s = 0.883, df = 7, P = 0.002) from an index value indicating a slightly convex abdominal shape in early February to a fairly well-rounded shape prior to departure in mid-April (Fig. 5).

Table 1. Summary of Arcata, California farm landscape characteristics included in a logistic regression testing for differences in used and unused farms. The last 2 variables are featured in Table 2 with regard to farms that were used by Aleutian Canada geese in 2001–2002.

	Mean	Range	SE	*n*
Farm area (ha)	23.3	2.9–89.8	1.87	92
Farm perimeter (m)	2116.3	697.7–5714.8	104.08	92
Farm area: perimeter ratio	97.3	36.3–195.1	3.70	92
Water area (m^2)	97.3	0–172544.2	2294.15	92
Average area of bodies of water (m^2)	960.0	0–24532.2	279.24	92
Farm perimeter adjacent to roads (m)	563.4	0–2459.0	54.30	92
Average distance to roost (m)	4673.5	1673.7–7996.3	188.38	92
Proportion of farm covered by water	0.027	0–0.20	0.004	92
Distance to water (m)	195.2	0 –1464.2	33.00	92

General Observations

The birds were rarely disturbed from the pastures around Humboldt Bay. They did not take flight (i.e., no disturbance events) during 1 6-hr continuous observation period. The geese often used fields bordered by public roads, and on most occasions they did not take flight when cars, bike riders and joggers, passing within 50m, kept moving. We saw no terrestrial predators during the study and only 1 instance of an aerial attack when a bald eagle (*Haliaeetus leucocephalus*) was observed chasing the geese.

Western Canada geese (*Branta canadensis moffitti*) also visited fields used by Aleutian Canada geese. When Aleutian Canada geese were present, western Canada geese had already dispersed into smaller flocks, and pairs were establishing territories along levees and sloughs (Griggs & Black 2004). There was little physical interaction or spatial overlap between the races. Normally, during the nonbreeding season, the western Canada geese made daily flights to roost on the mudflats of Humboldt Bay, but we never observed Aleutian Canada geese on the flats or the bay.

In 1999, the Aleutian Canada geese roosted at night in the southwest part of the Arcata study area. The roost was in a dairy pasture (26 ha) that was surrounded by brackish sloughs and adjacent to the larger Mad River slough. In 2000–2002 the birds' night roost was in a temporarily flooded ~3 ha pond in the northwest corner of the Arcata study area. Both roost sites were on privately owned farms. The birds' night roosts in the southern study area in 2001 and 2002 were also on shallow temporary ponds on the Humboldt Bay National Wildlife Refuge that had been constructed in 1999.

DISCUSSION

During their spring migration in the 1970s and 1980s, most Aleutian Canada geese passed through the Humboldt Bay area without stopping (Woolington et al. 1979, Springer and Lowe 1998). Our records in spring 1997 indicate that up to 600 birds were seen for about 1 week in the Humboldt Bay area. In spring 1998, flocks totaling 3,000 individuals arrived and were present in the area for a few weeks. In the following years, even more birds stopped and stayed for longer in the study area. In 2002, Aleutian Canada geese were in attendance in the Humboldt Bay area for 3 months, and numbers peaked at 19,000 individuals on 1 March. Most birds had departed by the second week of April. The geese were concentrated in roughly equal numbers in the northern and southern parts of the study area, although we have not yet determined the amount of turnover and mixing between the sites. The new Humboldt Bay staging areas combined, based on simultaneous peak counts, attracted approximately 50% of the entire Aleutian Canada goose population in 2002.

Table 2. Variables used in a multiple logistic regression analysis exploring landscape variables that best differentiate used farms from unused farms during Aleutian Canada goose spring staging, in the northern study area near Arcata, CA, 2001–2002.

Period	Predictor variables[ab]						Model		
	Used farms			Unused farms					
	mean	SE	n	mean	SE	n	Chi-square	P	% correctly classified
2001									
Distance to water (m) *	19.5	13.3	20	243.9	40.2	72	19.52	< 0.001	80
% cover of water *	6%	1%		2%	0%				
2002									
Distance to water (m) *	29.6	14.1	34	292.3	47.3	58	33.12	< 0.001	72
% cover of water *	5%	0%		1%	0%				

[a] Distance (m) from central point of farm area to nearest body of water > 750 m^2, % cover of water = proportion of farm covered by water.

[b] Significance within the multiple logistic regression model, * $P < 0.05$.

We suspect that the reason the geese are moving away from their traditional area near Crescent City has to do with their inability to meet daily energetic needs. The increasing number of geese that use private farm pastures in this area resulted in a reduction in the apparent amount and quality of forage that was available for cattle grazing during the spring months. In response, the ranchers there began to haze the geese in the mid-1980s with shotgun cracker shells, and this intensified in 1996 with the use of ATVs, and in 2002 with use of a microlight aircraft. These factors may have forced the expanding goose population to seek additional feeding areas (including another new staging site 110 km to the north near Langlois, Oregon) and to leave the Crescent City area sooner than normal. It seems likely that the availability of favorable grazing habitat and roost sites at Humboldt Bay eventually attracted the geese to this new spring staging area. Until 1997 the geese habitually passed over Humboldt Bay during fall and spring migration without stopping except in small numbers. It is possible that the presence of western Canada geese that have become established from earlier translocations, may also have decoyed Aleutians to the new area (Griggs and Black 2004).

In a study on barnacle geese (*Branta leucopsis*) describing the colonization of a new staging area, the birds' pioneering tendency was linked to a decline in foraging performance that was associated with an increasing population density and a decline in habitat quality at the traditional staging area (Black et al. 1991, Prop et al. 1998). In that study, numbers declined in the year after 1 staging habitat had become degraded by water voles (*Arvicola terrestris*), indicating that fidelity to traditional sites can be influenced by foraging conditions (Black et al. in press).

Increased hazing of pink-footed geese (*Anser brachyrhynchus*) at their northernmost spring staging area in Norway resulted in less time for foraging, a reduced accumulation of fat reserves and lower reproductive success that may have been enough to influence the birds' probability of returning to sites (Madsen 1995, 2000; Madsen et al. 1997, but see Rusch et al. 1985). Black et al. (1991) found that younger geese were more likely to abandon traditional sites that had become degraded and colonize new sites than older birds (also see Cooch et al. 1993, Black et al. in press).

The Aleutian Canada geese at the Arcata study site appeared to be visiting pastures based on habitat criteria rather than relative availability. They apparently preferred green fields with short to medium-height grass (13–30 cm), presumably reflecting new/fresh regrowth after the frequent rains in the study area. The geese also favored fields with standing water, even less-green fields with heavy rush cover. On a larger landscape scale, we found that the geese frequented farms with greater percent cover of water (fresh or brackish) and with shorter distance to bodies of fresh water >750 m^2 in area. Fresh waterbodies are important as roost ponds, provide bathing and drinking sites, loafing areas, and may be associated with more nutritious and digestible vegetation. Greater percent cover of water may also be associated with foraging advantages, especially at the end of the spring staging period when plant growth on drier areas may be more limited.

We did not test the nutritional value of the food that was available during this study, but the geese likely favored 'wet' pastures because they produced vegetation that is high in protein. Most birds in our area have come from the San Joaquin Valley wintering area where the diet is protein-limited due to the corn-dominated (maize) diet in that area (Woolington et al. 1979). There is increasing evidence that geese must balance their need to obtain both fat and protein reserves for long-distance flights and subsequent breeding attempts (McLandress and Raveling 1981, Prop and Black 1998).

Observations in the Arcata study area in 2002 indicated that foraging was the predominant activity (87%) followed by vigilance (12%) during the daylight hours, leaving little time for other activities. A similar pattern of intensive foraging throughout the day was described for barnacle geese foraging in marginal maritime habitat, while those foraging in improved agricultural pastures had periods of sleeping and maintenance in the middle of the day (Black et al. 1991). A time budget allowing more time for maintenance activities was reported for the geese at the Crescent City staging area in years prior to the intensive hazing program, with 79% foraging, 11% vigilance, 7% maintenance and resting, and 3% walking (Stabins et al. 2002). Although Stabins et al. (2002) did not indicate how frequently the activity of the geese was influenced by predators, he did note, as did we, that the birds would react by flushing when approached by eagles. He also observed peregrine (*Falco peregrinus*) and prairie falcons (*F. mexicanus*) chasing the geese and 1 instance of a peregrine falcon killing a goose (Stabins 1995).

We are currently conducting an investigation of energy expenditure and foraging opportunities of the Aleutian Canada geese that make use of the different staging areas. The geese may have to maintain a constant rate of foraging in order to obtain and store fat and nutrient reserves within the limited number of daylight hours that are available. Daylight lasts about 11 hrs when the birds arrive in January/February and increases to nearly 14 hrs in April. Other arctic geese make use of more northerly spring staging areas where day length is longer. For example, the barnacle geese staging in northern Norway in May had 18–22 hrs of daylight (Black et al. 1991, Prop and Black 1998).

Apparently, because Aleutian Canada geese at Humboldt Bay foraged at a near-constant rate through-

out the day, they were able to build fat reserves during their stay. The average abdominal fat index increased steadily through the study period. However, fat score data were not recorded on the same individuals through time. Increasing average fat scores could also indicate variation in the arrival and departure of individuals with varying degrees of fatness. For example, black brant (*Branta bernicla*) arriving late at Humboldt Bay from southern wintering areas were older and fatter than those arriving earlier in the spring (Lee 2001). Arctic geese can exhibit a variety of arrival and departure strategies on migration that are linked with the build-up of fat and nutrient reserves (Madsen et al. 1997, Madsen 2000, Prop et al. 2003).

MANAGEMENT IMPLICATIONS AND FUTURE STUDIES

The rapidly expanding size of the Aleutian Canada goose population and its use of agricultural habitats has become an important issue for both public and private land managers in late winter and spring staging areas. In addition to the recent colonization around Humboldt Bay, the geese have also begun to use agricultural land in southern Oregon, so that the range for spring staging Aleutian Canada geese now extends some 260 km from the Eel River south of Humboldt Bay to the New River in southern Oregon. Currently, the Pacific Flyway Study Committee has an interim objective of 40,000 birds for this population of geese (Pacific Flyway Council 1999). The most recent monitoring efforts in spring 2002 (based on mark-resight) put the population within 3,000 of this number (Drut and Trost 2002). Some conservation/management issues related to the expanding population of Aleutian Canada geese are being addressed by a partnership including biologists and managers of local, state, and federal agencies, researchers and students from Humboldt State University and private landowners. Some of the group's research goals that will provide information to help alleviate conflicts and meet population management objectives include:

(i) Assessment and identification of pasture management techniques that will allow public-land managers to better attract and maintain the geese on public lands.

(ii) Use of PROGRAM MARK to describe estimates of survival, site fidelity, length of stay, turnover and movement among staging areas.

(iii) Assessment of factors affecting different staging areas (e.g., nutritive quality, degree of disturbance, distance from roost site) in relation to daily energy budgets (expenditure and intake).

(iv) Assessments of carrying capacity and the effect of intensive grazing and goose droppings/feces on regrowth of pasture grasses on different soil types.

(v) Assessment of impacts from large flocks of Aleutian Canada geese that roost each night in spring on sensitive seabird nesting islands, especially Castle Rock National Wildlife Refuge.

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