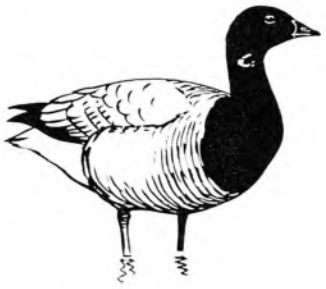
Duration of family bonds of Brent Geese *Branta bernicla* on the Pacific coast of North America



AUSTIN REED

During the course of field investigations along the coasts of British Columbia and Washington State over the fall, winter and spring 1987-88, I observed 147 groups of Brent Geese which behaved as family units. Another five such groups were observed and confirmed as genuine families based on records of their coded leg rings. Further observations of marked broods whose codes could not be read provided additional evidence of the maintenance of family bonds through the winter and into early spring. This is in contrast with an earlier report which indicated that Brent Goose family bonds disintegrated during fall staging on the Alaskan Peninsula; the contradiction probably arises from the difficulty of recognizing the relatively infrequent and subtle forms of family associations in the dense concentrations of Brent Geese which occur at staging and wintering areas. Brent Geese appear to have a social system in which overt display of family ties emerges only infrequently when broods compete for some secondary, patchily distributed food source or roost site. This system allows Brent Geese to benefit, on the one hand, from the advantages of flock feeding (vigilance, information on food availability, etc.,) without disruption from conspecifics while feeding over broad, dense Zostera meadows and, on the other, to deploy aggressive behaviour to confer increased feeding opportunities on brood members when a patchily distributed food source is exploited. Unattended juveniles occur in the flock, possibly as a consequence of the relative infrequency with which close family ties are expressed.

In most species of geese (*Anser* and *Branta*), the young of the year accompany their parents during fall migration, through the winter and over at least part of their first spring migration (Raveling 1969, Owen 1980, Prevett & MacInnes 1980). This form of extended parental care is believed to have been selected because it allows young geese to benefit from their parents' knowledge of traditional migration routes and the whereabouts of good feeding and roosting sites. Family members also benefit from enhanced feeding opportunities relative to other geese (Boyd 1953, Owen 1980, Black & Owen 1984, Warren *et al.* 1993). Most Brent Goose *Branta bernicla* populations also show extended parental care (Cramp & Simmons 1977:439, Owen 1980:88, Lambeck 1990 a & b) but an apparent exception was reported for Black Brant *B. b. nigricans* of the Pacific Coast of North America by Jones & Jones (1966) who noted the breakdown of family bonds during fall staging at the Izembek Lagoon on the Alaska Peninsula. If family units benefit from maintaining association, one would especially expect that Pacific coast Brent Goose families would remain intact because of the long oversea migration (>4000 km) between Izembek and wintering locations as far south as Mexico (Dau 1992) and because of the irregular distribution of suitable eelgrass (*Zostera marina*) feeding areas along the western coast of North America (Phillips 1984).

During the course of field studies on Brent Geese along the Pacific coasts of British Columbia and Washington State during the winter 1987-88 (Reed *et al.* 1989a), I observed a number of distinct family units. Those observations form the basis of this paper in which I establish that the disintegration of family bonds during autumn migration, as described by Jones & Jones (1966), is not complete.

My observations were made on two stocks of Brent Geese, both of which stage at Izembek (Reed *et al.* 1989b). Black Brant is by far the most common form along the Pacific coast but my observations also included Brent Geese of a grey-bellied form which more closely resemble *B. b. hrota* (Boyd & Maltby 1979, Boyd *et al.* 1988, Reed *et al.* 1989a). This second stock is referred to in

this paper, as in an earlier one (Reed *et al.* 1989a), as the Grey-bellied Brent Goose in recognition of its distintiveness with regard to plumage (Boyd *et al.* 1988) and genetic makeup (Shields 1990) from both *nigricans* and *hrota*.

Study area and methods

Brent Geese were observed at staging and wintering sites from the Queen Charlotte Islands, British Columbia (lat. 52-54°N), to Puget Sound, Washington State (lat. 46°N), over the period 27 October 1987 through 11 May 1988 (see Reed *et al.* 1989 a & b for maps of the study area). More specifically, observations were made on fall staging and wintering geese in Padilla Bay (Puget Sound) from 27 October to 20 December 1987, on wintering geese on the Queen Charlotte Islands from 16 to 21 January 1988, on wintering and spring staging geese in various other locations in Puget Sound and the Strait of Georgia (Washington and British Columbia) from 24 January through 11 May 1988.

Telescopes were used in determining the age of individual Brent Geese, to identify family units, and to detect and read coded plastic leg rings. Most of these coded rings had been placed on Brent Geese during August 1987 on breeding grounds in the Yukon/Kuskokwim Delta, Alaska, (n = 2000, J.S. Sedinger pers. comm.) and on Melville and Prince Patrick islands in the western Canadian High Arctic (n = 709) (Reed *et al.* 1989a). Most had been captured in multi-family flocks; thus, for each ringed goose, its age (adult or juvenile) and sex were known, as well as its association with other members of that catch, though it was not generally possible to identify which of those other geese were members of its own family. Among some of the Alaskan ringed geese, however, family associations were determined by post-ringing observations.

Juvenile Brent Geese were identified by white edging along the distal edges of their wing coverts. I considered as families those small groups consisting of two (occasionally one) adults and 1-5 juveniles which showed strong cohesiveness in their movements, in which one or both parents engaged in agonistic interactions with other geese in apparent defense of young, or in which the adults displayed behaviours indicative of long term bonding such as the triumph ceremony.

Results

Observation of unmarked Brent Geese

Incidental to standard counts and scanning for ringed birds, I noted 147 unmarked groups whose behaviour suggested that they were genuine families (Table 1). Families of both Black Brant and Grey-bellied Brent were observed at most staging and wintering haunts of the study area. In two of these "apparent" families it was possible to verify that the adults were a pair: both groups (one with two juveniles, the other with one) were initially identified as they approached hunters in Boundary Bay on 5 and 7 March. All members of the groups were shot and in both cases the two adults of the group were of different sex. The strength of the bonding in one of these groups was evident when, on its first

Table 1. Distribution and size of Brent Goose broods at various sites in British Columbia and Washington State in the winter of 1987-88.

			Juveniles/family[1] n							
Location	Month	Stock[2]	1	2	3	4	5	Tot	Mean	SD
Puget Sound[3]	Nov-Dec	B&G	30	23	17	8	2	80	2.1	1.10
	Jan-Feb	G	9	13	10	1	0	33	2.1	0.84
	Mar-Apr	B&G	6	4	2	1	0	13	1.8	0.99
Queen Charlotte Islands	Jan	B	2	0	1	0	0	3	1.7	1.15
Strait of Georgia[4]	Jan-May	B	6	7	3	2	0	18	2.1	1.00
Total	Oct-May	B&G	53	47	33	12	2	147	2.1	1.02

[1]Only families with two parents are listed. In addition, nine single-parent broods with a total of 12 juveniles were observed in Puget Sound.
[2]B = Black Brant; G = Grey-bellied Brent.
[3]Padilla Bay, Washington.
[4]Includes the Qualicum area on the east coast of Vancouver Island, and Boundary Bay on mainland British Columbia.

pass over the hunters' decoys, two individuals were shot and the remaining two immediately circled and returned.

Unaccompanied juveniles were also noted in most flocks though, because it was usually very time consuming and difficult to ascertain their status, my records are fragmentary. In five counts conducted in Padilla Bay 12-23 December, ten of 114 (8.8%) juvenile Brent Geese (Black and Grey-bellied) were unattached, whereas six of 24 (25%) seen on 1 April in Boundary Bay (Black Brant) and 9 April in Padilla Bay (Black and Grey-bellied Brent) were unaccompanied. Also noteworthy were the observations of two lone juvenile Grey-bellied Brent Geese in poor condition on 8 December in Padilla Bay, and a group of 16 unattended juvenile Black Brant on the Queen Charlotte Islands on 16 January.

Observation of marked Brent Geese

Brent Geese infrequently came ashore on mudflats or rocky points close enough to allow reading of coded leg bands. The ring codes of three marked Black Brant broods and two Grey-bellied Brent broods were read. The first Black Brant brood involved a single-parent family with three juveniles observed on 25 November in Padilla Bay; this group had been confirmed as a family unit prior to departure from its Alaskan breeding ground (J.S. Sedinger pers. comm.). The second and third, also confirmed as family units in Alaska, both involved two-parent families with one juvenile which were observed on the east coast of Vancouver Island between 12 April and 2 May. Both Grey-bellied Brent Goose broods were seen on 26 January in Padilla Bay and were single-parent families, one with one juvenile and the other with two; in both cases all members had been caught in the same banding drive, one on Melville Island and the other on Prince Patrick Island.

Between 13 November and 25 February in Padilla Bay, I recorded an additional 15 marked broods of Grey-bellied Brent Geese but was unable to read the codes; it is possible that this sample includes repeat sightings of some broods but on 26 January at least four different marked broods were observed. On 11 April, a marked brood of Black Brant was seen, but the codes not read, on the east coast of Vancouver Island.

Further probable evidence of brood unity was obtained on 12 December when a hunter shot two juvenile Grey-bellied Brent out of the same flock, both of which had been ringed in the same catch on Melville Island. J.S. Sedinger (pers. comm.) reported two similar cases from Black Brant marked by him on the Yukon/Kuskokwim Delta, Alaska. In one a hunter shot two young which had been banded in the same nest and in the second a hunter shot a female and one of her young.

The codes of seven unaccompanied marked juvenile Grey-bellied Brent and five Black Brant were read in Padilla Bay between 25 November and 20 April; one juvenile Grey-bellied individual was seen alone on four different days between 26 January and 20 April. Unattended juvenile Black Brant were also individually identified on the Queen Charlotte Islands (one on 20 January), Dungeness, Washington (two on 2 February), and on the east coast of Vancouver Island (one on 11 April).

Discussion

From the identification of marked broods and from other observations I conclude that many Pacific coast Brent Goose families remained intact through fall migration, over winter, and during the first stages of their spring migration. That the long duration of these brood bonds has gone unrecognized until now is explained in part by the infrequency with which Brent Geese, relative to other geese, overtly express their family bonds. Indeed, during many hours of observation I conducted on Brent Geese feeding over submerged eelgrass meadows or roosting on open water in Padilla Bay (and in Izembek during October 1987, A. Reed unpublished), the flocks appeared to be a random mixture of adults and juveniles, manifestations of family bonding being weak and infrequent. When such flocks encountered certain other feeding situations or moved on to dry roosting sites, family associations became evident and inter-brood conflicts became frequent. For example on 8 December in Padilla Bay a group of *c.*170 Brent Geese (approx. 50% Black Brant, 50% Grey-bellied Brent; overall 58% juveniles) were swimming toward shore on a rising tide. While roosting at sea or swimming ashore only two or three distinct families were identifiable, but as they reached shallower water and began feeding on large detached leaves of *Ulva lactata,* many more family associations became evi-

dent. Individual families appropriated large leaves of *Ulva* and defended them against other families and lone juveniles. After 20-30 min of this feeding activity, the passage of an aircraft prompted the flock to fly seaward where they roosted in a single flock showing little evidence of family associations. Near the Dutch Wadden Sea, Lambeck (1990a) also found it more difficult to distinguish individual families of *Branta b. bernicla* in the dense flocks grazing on homogenous inland pastures than in dispersed flocks on tidal mudflats.

In this respect the brood bonds of Pacific Coast Brent Geese differ from those of most other geese studied to date which generally display tight family cohesiveness almost continuously through fall migration and over winter: White-fronted Goose *Anser albifrons* (Boyd 1953, Warren *et al.* 1993, but see van Impe 1978 for contrary evidence), Lesser Snow Geese *A. c. caerulescens* (Prevett & MacInnes 1980), Greater Snow Geese *A. c. atlanticus* (Turcotte & Bédard 1989), large-bodied Canada Geese *Branta canadensis maxima, B. c. interior* (Hanson 1965, Raveling 1969) and Barnacle Geese *B. leucopsis* (Black & Owen 1984, 1989). In contrast, Johnson & Raveling (1987) found that the small Cackling Goose *B. canadensis minima* had extremely weak family bonds: fewer than 5% of the juveniles were associated with their parents over late fall and winter, nor were the parents regularly closely associated with each other. They suggested that the advantages gained by this small grazing subspecies by feeding in large, dense flocks (vigilance, information on food availability) and the requirement of maintaining high food intake on low-calorie grasses, outweighed the benefits of maintaining close brood bonds.

Most feeding by Brent Geese along the Pacific coast occurs over dense and extensive *Zostera marina* beds (Jones & Jones 1966, Phillips 1984, A. Reed unpublished observations). These largely subtidal meadows provide broad expanses with an abundant food supply which is readily available except at high tide when the submerged eelgrass leaves are beyond the reach of the geese; at high tide, dislodged leaves of *Zostera* floating near the surface remain available to the geese over large areas but at markedly lower densities. Most roosting occurs over open water or on broad expanses of uniform tidal mudflats. For most of the time, food and roosting sites are abundant and widespread, making defense of such sites both difficult and unnecessary. This is analagous to winter conditions for Cackling Geese which graze uniform swards of low-calorie grasses (Johnson & Raveling 1987) and like the Cackling Geese, Pacific coast Brent Geese show low levels of family cohesiveness and agonistic activity under such situations. Brent Geese, however, retain the ability to engage in vigourous interbrood defense when it is most likely to procure increased access for its members to a critical resource, especially patchily distributed food.

Maintaining brood bonds through the full winter may also be advantageous to Brent Geese by enhancing the transfer of information to juveniles regarding the suitability of spring staging areas, many of which are not visited during fall migration. Although most juvenile Brent Geese observed in this study occurred in family groups, many (9 to 25% in counts conducted in December and April) appeared to be unattached. The relative high proportion of unattended juveniles may be a consequence of the frequency with which brood cohesiveness is relaxed therefore increasing the likelihood of young geese becoming separated from their parents, especially when disturbances are frequent. But another factor may be the physical inability of some juveniles to complete the fall migration with their family. The two weakened lone juveniles seen in Padilla Bay shortly after arrival on fall migration (8 December) would have been unable to continue if the winter destination of their families had been much further south. The flock of 16 unaccompanied juveniles seen on the Queen Charlotte Islands in mid-January may have been individuals which had dropped out of migratory flocks at the first suitable site located along the lengthy migration route between the Alaskan Peninsula and the main wintering sites near Puget Sound and Baja California.

My observations did not cover the southern portion of the range (California and Mexico) where most Pacific coast Brent Geese overwinter. Hansen & Nelson (1957) suggested, on the basis of hunter ring recoveries, that a higher proportion of juvenile Black Brant overwintered in the most southerly portion of the range. Although that suggestion is consistent with the findings of Lambeck (1990b) for *B. b. bernicla* in western Europe, Hansen & Nelson (1957) did not account for regional differences in the timing of hunting seasons which could have resulted in

the availability of a greater number of juveniles for southern hunters during early winter compared to fewer but more experienced juveniles for northern hunters in late winter. It would therefore be useful to determine whether the age composition of flocks of Pacific coast Brent Geese influences their winter destination and whether family bonds are maintained in southern wintering flocks.

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Austin Reed, Canadian Wildlife Service, 1141 Route de l'Eglise, Ste-Foy, Québec, Canada G1V 4H5.