

# Goose flocks and food finding: field experiments with Barnacle Geese in winter

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The adaptiveness of flocking as a means of enhancing foraging effectiveness of the individual has been convincingly argued by Krebs *et al.* (1972) in the Great Tit *Parus major*, where the advantage appears to reside in the opportunity to exploit chance discoveries by flock members, the birds keeping close watch of the movements and actions of their fellows. Further, it has been argued that communal roosts can act as 'information centres' in that birds doing poorly in locating adequate food might gain from the experience of more successful birds and follow these out from the roost (review in Ward & Zahavi 1973). Foraging in groups, or departing for the foraging areas in flocks, may thus be of direct positive value in food finding, quite apart from any anti-predator significance feeding assemblages may have.

If flocking is to enhance food finding in geese, some interchange of information must go on between individuals. Easiest to observe is the case that the activities of one foraging group might influence food finding in a more recently arrived group, and this possibility we here examine on the basis of some naive experiments using models. We ask the questions, (1) when approaching potential foraging sites on their morning flight, are geese prone to land near groups of geese already on the ground, (2) does the attractiveness of the group already landed depend on what these birds are doing, specifically the proportions of grazing as distinct from alert birds.

Our observations concern Barnacle Geese *Branta leucopsis* wintering in the northern Netherlands, and the rationale behind the experiments will become clear by considering how these birds exploit their food resources in our area.

## Food utilization by successive depletion

As noted by Ebbsing *et al.* (1975) the Barnacle Goose in our area relies heavily on pastureland grazed intensively by sheep or cattle in the summer months. In the period October through March during which goose visitation is heavy, several areas are used in succession, the main mass of the birds abandoning an area when a certain level of goose usage has accumulated (equivalent to about

2,000 goose-days per hectare over the whole area). We assume that at this point the food supply has been depleted to such an extent that intake rates would decline were the geese to continue visiting the site. At the 'cut-off point' the sward is shorn down to approximately 1.7 cm in height, and some observations collected by Schokker & Burgler (1975) indicate that Barnacle Geese experience difficulty in coping with grass much shorter than this because of a decline in intake per bite (see Figure 1). In these observations a tame Barnacle Goose was restricted to a 5 × 5 m enclosure for the period of one week, the pen being placed on grass (*Poa annua* with a few tussocks of *Holcus lanatus*) previously adjusted to the desired height (blade length measured with a ruler) by use of a hand mower. The goose was allowed access to the grass from about 09.00 to 16.00 hrs every day, and watched continuously during this time from a nearby building. Outside of this foraging period the bird was kept in a 2 × 2 m adjoining night pen which had a board floor. All of the droppings were collected at the end of each day, and allow an indirect estimate of the daily food intake since the digestibility of the grass can be estimated at 33% dry weight (see Ebbsing *et al.* 1975). This permits calculation of bite size, since the number of pecks per day was observed directly. From the figure it will be seen that the goose compensates for decreasing vegetation height by increasing the peck rate per minute of active foraging, and increasing the proportion of minutes devoted to foraging, but that in the region of 2 cm sward height bite size starts to decline markedly. Since wild geese are already devoting upwards of 50 minutes every hour of the time spent daily on the foraging grounds to active feeding, in the natural situation there is less of a margin in which to compensate for declining bite size. The highest peck rates observed in wild flocks are on the order of 200/minute, so here again the possibility of compensation is limited. The overall response to declining sward height, an increase in time devoted to feeding, coupled with an increase in peck rate at the cost of a falling off of bite size, is similar to that observed in sheep (Allden & Whittaker 1970).

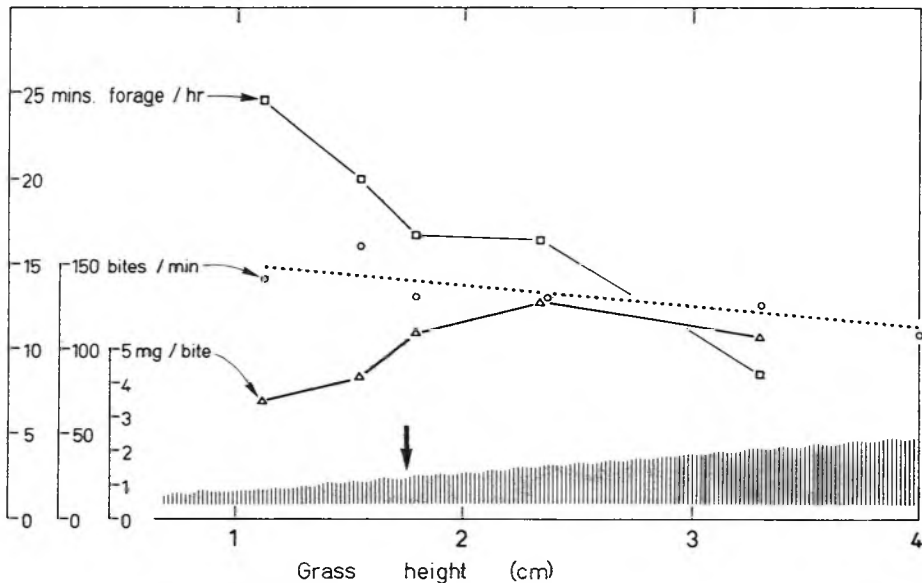


Figure 1. Grazing parameters of a tame Barnacle Goose in relation to grass height (mean of 500 measurements at start of a four-day exposure). Proportion of time devoted to grazing and peck rate were observed directly; bite size is calculated from daily intake (derived from weight of droppings produced daily) and the daily peck sum (observed). Each point is the mean from a four-day test period. The heavy arrow indicates the grass height at which wild Barnacle Geese generally abandon the area.

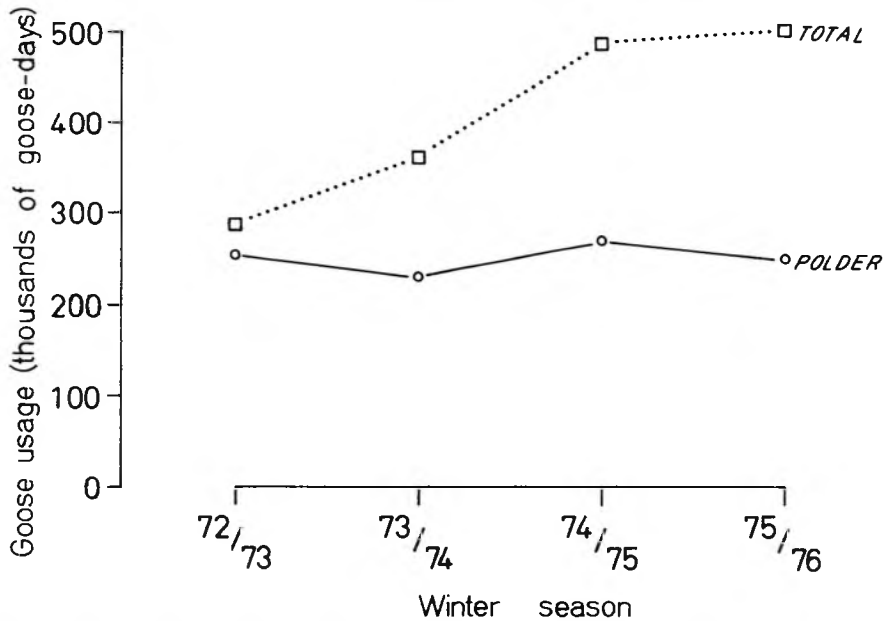
A second line of evidence indicating that shifts in feeding site are caused by local depletion of the food supply results from measuring the cumulative goose usage by means of droppings transects in one particular area in successive years. Our most complete data concern a 126 ha tract of enclosed pastureland on the island Schiermonnikoog. For reasons we cannot explain, this island has attracted steadily increasing numbers of Barnacle Geese in the past four seasons, yet the goose usage in the 126 ha tract covered by our droppings transects has been practically constant (Figure 2). Each year this point has been reached somewhat earlier in the season, and the birds then abandon the polder altogether in favour of the *Festuca* sward on the merse where fresh growth becomes available from February onwards. The shift does not seem to be brought about by the fresh growth of *Festuca* per se, but rather by an assessment of the polder in relation to the *Festuca* since the geese virtually ignored this vegetation during the first winter of observation. Long-term changes of the vegetation of the merse are, however, taking place, and these must be quantified before the movements of the geese can be fully interpreted.

To sum up, geese in our area tend to graze local areas to depletion, abandoning the site when the sward has become too short. Since

geese extract only about one-quarter to one-third of the energy content of the grass they consume, relatively large amounts must be gathered daily, and in fact many hours are devoted each day to intensive grazing (amounting to 50 to 60 thousand bites per day). To what extent the high peck rate is due to selective tid-biting is not clear, but in any case there must be strong selective advantage to be gained by reducing the time spent in locating potential food sources, and again in the time devoted to assessing food supplies in the choice situations faced by the geese through the winter.

#### Experiments with goose models: methods

In the 1973–1974 season experiments were performed on Schiermonnikoog by presenting flocks of model geese and noting the reactions of the wild birds. The models were made of fibre glass and painted to resemble the Barnacle Goose, and could be mounted in a lifelike position by thrusting its legs into the ground. The models were made in two postures, grazing (with head down) and alert (head up with neck stretched). The procedure was to set out the models in the polder pastures whilst the geese were away at the roost on the tidal flats, and to observe the first landings of the geese as they returned to forage early the next morning. In



**Figure 2.** Barnacle Goose usage of Schiermonnikoog; grazing of a 126 hectare tract of enclosed pastureland ('polder') as determined by dropping transects (minimally 100 plots of 4 m<sup>2</sup> examined fortnightly) in comparison to total for the island (from direct counts of the geese, average counting frequency once every three days).

all, sixty models were made (forty grazers and twenty alert) and these were assembled in two flocks (differing either in size or in composition) to offer a choice situation to the incoming geese. During an experimental sequence the flocks were exchanged each night to counteract position preference. The sites used for the two model flocks were chosen on the basis of sample counts of goose droppings, similar densities (within ten percent of one another) being taken to indicate equal intrinsic attractiveness of the two sites to the geese.

Three questions were asked: (1) does the presence of models enhance the attractiveness of the site for feeding, as measured by an increase in the number of landings; (2) are large flocks more attractive than small ones; (3) are flocks where grazers predominate more attractive than flocks where birds in the alert posture predominate.

#### Effectiveness of models in eliciting goose landings

The model flocks clearly acted as a nucleus around which the wild geese collected as they entered the pastureland each morning. Of 22 first landings recorded in the polder in January and February when both groups of models were located in one field, 19 occurred

in the field with the models, and only 3 on the neighbouring fields. Because of the heavy grazing pressure induced by the models, sward height in the vicinity had declined to below 2 cm by the end of January, whereas in the neighbouring fields the average height was still 3.2 cm. When the models were removed for the period 2nd–12th February, no fresh droppings were deposited in the area formerly occupied by the models, but the adjoining fields were visited repeatedly. As soon as the models were returned the geese again landed in the now bare area, although they did not remain long in the immediate vicinity.

Contrary to our expectation, a flock of 36 models (32 grazers, 4 alert) was not noticeably more effective in attracting geese than a flock of 9 models (8 grazers, 1 alert) each attracting nine landings in the test period, involving almost all of the geese approaching the models (98% and 99% of the 311 and 1,380 geese flying over the models actually landing). In retrospect, a choice experiment on size should not have been complicated by the inclusion of both postures, since the proportion of birds showing the alert posture is influenced by group size.

In the third experimental series flocks of like size but differing composition were

offered. We noticed that there was a relation between group size and the incidence of the alert in undisturbed foraging geese (see Figure 3), as had previously been demonstrated for White-fronted Geese *Anser albifrons* by Dimond & Lazarus (1974). With increasing group size the proportion of birds showing the alert declines, but the absolute number alert at any time continues to rise. From our observations one would expect approximately 7–8 birds in a group of thirty to show the alert, hence our choice test involved a comparison of a group with more (15) and fewer (5) than the expected number in the alert, exaggerating the difference in presumed attractiveness as a nucleus around which to land. In fact flocks where grazers predominated attracted more landings, in-

volving larger groups and a longer duration of stay in the vicinity of the model flock (see Table 1). Whether the effect is due to a repulsion by the alert models, an attraction of the grazers, or a combination of both effects remains an open question, but there can be no doubt that geese take account of the behaviour of grounded birds when making a decision to land.

Interpretation of these experiments on the influence of posture hinge on how one interprets alert behaviour. There is evidence that predator detection is one of the functions of the alert. In large groups more birds are alert at any one time than in small groups, not only in geese as has been mentioned, but also in Starlings *Sturnus vulgaris* as documented in the captive situation by Powell (1974) and

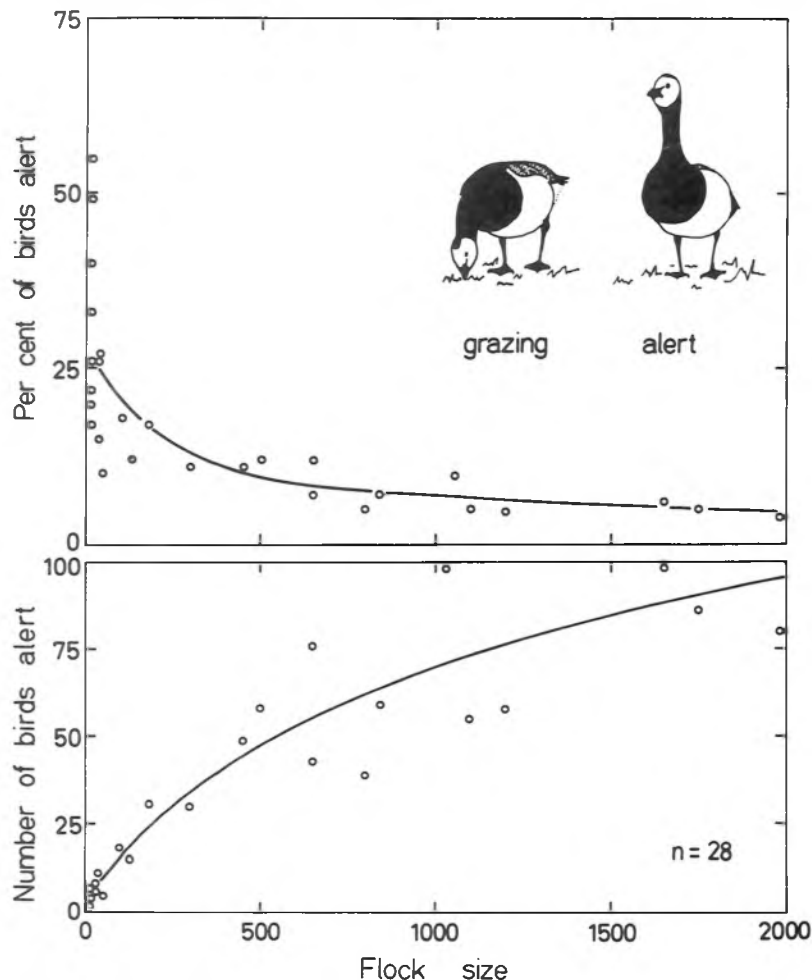


Figure 3. Relation between flock size and the incidence of alert behaviour, as determined by scanning the flock by telescope and classifying each bird seen. Such virtually instantaneous records reflect equally the time allotted to the 'alert'. Data restricted to undisturbed conditions.

Table 1. Results of choice experiment in which two groups of 30 models each were placed in a field (g = grazing posture, a = alert posture).

	25 g 5 a	15 g 15 a
Number of goose flocks landing	16	7
Proportion of birds flying over the models that actually land	1115/1510 = 74%	140/1001 = 14%
No. of flocks remaining more than ten minutes	12	2
Initial flock size (range)	1-299	1-69
Goose-minutes spent grazing in vicinity of models during test	38219	2048

in doves *Streptopelia senegalensis* according to field observations by Siegfried & Underhill (1975). Both starlings and *Streptopelia* reacted more quickly when suddenly confronted with a model hawk as the size of the foraging group, and hence also the number of birds with the head up, increased. We do not have direct measures of 'detection lag' in our birds, but we have observations suggestive of an additional function. We noted that when geese had been attracted to a heavily grazed area by the use of a model flock, typically a brief spell of intensive grazing was followed by a wave of alert behaviour, after which the newly arrived birds walked rapidly to areas of higher grass where they resumed grazing. We suggest therefore that the alert is a scanning posture with a broader significance than merely watching for potential predators. In any case, a high proportion of alert birds in the flock is a clear indication that the site is at that moment unlikely to offer favourable feeding opportunities, either because of the presence of disturbance or because the vegetation is inadequate.

#### Discussion

We have shown that geese approaching the foraging grounds on their morning flight from the roost may be induced to land in the vicinity of a small flock of models, particularly when the majority of the models are in the grazing as distinct from alert posture. Since the 'alert' can be elicited when the flock has been lured to an already depleted field by the presence of models, and in these circumstances is followed shortly by a movement away to longer vegetation in the vicinity, it would be a misleading oversimplification to consider the alert only in the context of anti-predator behaviour. Rather, a general scanning of the environment is implied, and this opens the possibility that the alert behaviour which one sees at a low frequency in undisturbed foraging flocks of geese may function in a food context as well as in predator

detection. It is conceivable that individuals in the alert are gathering information on foraging conditions elsewhere, either by direct examination or at second hand as revealed by the actions of geese in the neighbourhood. The human observer can predict sward height on the basis of pecking rate, and vegetation density on the basis of step rate, so it is perhaps not too far-fetched to suggest that a goose might assess local foraging conditions by watching his fellows. Flock feeding in this view would enable an individual to take advantage of the experience of all flock members each sampling continuously to effect subtle changes in flock dimensions and direction of movement in accord with what actively foraging geese reveal about local yield.

Other investigations of social feeding assemblies tend also to emphasize the food functions of looking around (Murton *et al.* 1971; Krebs 1974). Further, in the only previous model experiment we know of, Krebs (1974) showed that in the Great Blue Heron *Ardea herodias* a model in the 'hunched neck' roosting posture attracted less landing than an 'upright' model (the hunting posture), so the use of such cues in making a decision on where to land to feed must be rather general.

We cannot resist speculating briefly on the reasons for the shape of the curve relating alert behaviour to flock size (Figure 3). It is our impression that birds on the periphery of the flock are more often alert than those more to the centre. In other words, we feel that the relationship is mainly brought about by what birds along the edge of the flock are doing. If goose flocks tend to be more or less circular in shape (and some preliminary measurements indicate that this may well be true) then the ratio of 'edge birds' to the total number in the flock will describe a function such as the percentage data in Figure 3 because large flocks have a shorter perimeter in relation to the number of birds present. The simplest hypothesis consistent with the data is that a peripheral goose tends to spend

a certain proportion of time in the alert, regardless of the total size of the flock.

The question why flock feeding has evolved in geese is unlikely to be answered in an either/or fashion, but we should like to offer the following speculations. We assume that flocking enhances feeding opportunity in two ways: food finding and food sampling may be more efficient when pooling experience, not only during actual foraging, but a number of flocks dispersing over the foraging area but roosting communally allow a daily interchange of information. Secondly, flock grazing will have the effect of removing vegetation over sizeable areas, and this might well stimulate renewed growth thus providing opportunity for future foraging on high quality material (low cellulose content, high protein content). Since concentrations of geese may attract predators, the flocking habit can only operate successfully if adequate anti-predator behaviour can evolve: we thus see the predator detection function of vigilance behaviour as a consequence and not the sole function of group feeding.

As far as we know there is no direct evidence in wildfowl for the information-centre function of roosts although the idea has been applied to the 'remises' of Teal *Anas crecca* by Tamisier (1974). Obtaining such evidence will require considerable in-

genuity, but is the necessary next step in exploring the implication of communal feeding in wildfowl.

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#### Summary

Choice experiments involving two groups of model geese set out during the night on fields frequented by Barnacle Geese *Branta leucopsis* in the winter showed that, (1) the model flocks acted as a nucleus around which the geese landed as they arrived from the roost each morning, (2) a model flock composed of a majority of individuals in the grazing posture induced more landings, involving larger numbers and a longer duration of stay, than a model flock composed predominantly of individuals in the head-up 'alert' posture. On the basis of observations of geese lured to already depleted pastures by the use of models, we speculate that the 'alert' functions in food-finding in addition to predator detection, in agreement with the discussion of Dimond & Lazarus (1974).

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