Geese, nutrition and farmland

AUSTIN REED

Introduction

In an era when dwindling wildlife populations are the rule, wild geese provide a remarkable exception. During recent decades, many holarctic geese have increased their numbers and some have expanded their range. Many species of wild geese while on wintering and staging areas have adopted farmland for feeding. The combined effect of these two factors, compounded by human demands for maximization of agricultural crop yield, has been a substantial increase in complaints of depredation. This has stimulated a great deal of study on how wild geese exploit farmland (e.g. Bell & Klimstra 1970; Kuyken 1969; Newton & Campbell 1973; Owen 1972a, b;) and their influence on yields (Kear 1970; Kuyken 1969). Kear (1963a) has reviewed the subject in considerable detail. Rather than examining how geese impinge on agriculture, this paper attempts to explore how the newly-adopted diet of agricultural products might affect wild geese.

Changes in diet and habits

Although rather strict vegetarians, geese undoubtedly consumed many types of foods prior to the inception of large-scale diking, draining and ploughing. It is in the changes from 'traditional' to present-day foods that man's influence, through agriculture, can best be seen. Future study of adaptive radiation in geese should take such historical information into account as many anatomical, behavioural and physiological adaptations undoubtedly evolved under conditions quite different from those of today.

The small species, with proportionally small bills, Ross's Goose *Anser rossii,* Lesser Whitefront *A. erythropus,* Red-breasted *Branta ruficollis* and Barnacle *B. leucopsis,* have probably always been almost full time grazers on short grasses but many of the larger species show adaptations for other types of feeding. The Greater Snow Goose *Anser caerulescens atlanticus* is clearly adapted to the physically demanding task of feeding on root stocks of the clubrush *Scirpus americanus* and other marsh plants. Until recently, their feeding on the staging area in the St Lawrence estuary and on the wintering grounds on the Atlantic coast of the United States has been restricted to tidal marshes where root stocks of *Scirpus* and cordgrass *Spartina* constituted the staple diet (Lemieux 1959; Andrews 1975). Only in the last decade have they begun to invade agricultural land to graze grasses and glean waste grains. The Greylag *Anser anser* and Lesser Snow (or Blue) Goose *A. c. caerulescens* are similarly adapted for rooting. At many wintering haunts of the Greylag grass has replaced *Scirpus* roots as the chief food item (Lebret 1965; Loosjes 1974; Zwarts 1972). Lesser Snows are gradually abandoning their traditional wintering grounds on the coastal marshes of Louisiana and Texas in favour of the new 'rice prairies' further north (Madson 1964); the roots of natural marsh plants (McIlhenny 1932) are being replaced in the diet by grasses and grains.

The Giant Canada Goose *Branta canadensis maxima* is believed, on the basis of bill features, to be adapted to stripping seeds from standing grasses (Hanson 1965). At present, in winter, it feeds on waste corn (maize) *Zea mays* and soybeans *Glycine soja* but seeks grass on exposed hillsides when the former foods are covered by snow. The intermediate-sized Canada Geese appear adapted to both grazing and seed stripping but they are remarkable in their ability to discover and exploit a wide variety of plant material: berries, bulbils and roots. Their long necks and readiness to feed on aquatic vegetation by up-ending appears to indicate the former importance of marshes to them.

Other changes from traditional to present day foods and feeding habitats can be found (Kear 1966; Lebret 1975). The shift to farmland has meant a greater dependence on grazing of grasses and gleaning of waste cereal grains during the non-breeding season. In many cases, this has caused a reduction in the diversity of the diet.

Nutrition, survival and breeding

For migratory waterfowl the energy required to produce eggs and to rear the progeny is very great. The quantity of material required for egg production is large in relation to body weight (for geese roughly 20–30% of body weight per clutch: calculated from Appendix 15 in Lack 1968) and the energetic costs per egg high (King 1972). The material and energy must be mobilized within a short time. In northern nesting geese the breeding season is apparently timed so that the young can

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benefit from new growth of protein-rich vegetation (MacInnes *et al.* 1974; Newton and Kerbes 1974). Egg laying must therefore commence before food becomes readily available (Hanson 1962; Harvey 1971; MacInnes *et al.* 1974; Ryder 1970;). Thus, a period of high energy output (egg production, territorial defence) partially coincides with one of drastically reduced intake of food, consequently stored reserves must have been obtained earlier at more southerly localities. Weight restrictions are imposed by vernal migration (Ryder 1970), which itself is a drain on energy reserves.

Generally body weights and fat reserves reach an annual maximum at the start of the breeding season (Ryder 1970). Hanson (1962) recorded annual maximum weights of adult Canada Geese upon arrival at the northern breeding grounds, but birds of the same population apparently did not put on substantial weight before departing from the wintering grounds in southern Illinois (Hanson 1962; Raveling 1968). Hanson supposed that most fat gain was made on a staging area from mid-March to late April. Data on weights of Icelandic Greylags wintering in Scotland suggested that adult females began to put on weight in February and March (Matthews & Campbell 1969) before migrating to Iceland in April. This scanty information suggests that reserves are laid down mainly in the few weeks preceding arrival on the breeding grounds but undoubtedly the ability of individuals to obtain and carry sufficient reserves will be better if they maintain good body condition through the winter.

Strong selective pressures towards increased efficiency in selecting, exploiting and utilizing food resources must operate during the critical stage of late winter and spring. The physiological processes of laying down stores for reproduction would have evolved in relation to the quality of the natural foods available then. Geese are generally thought of as inefficient feeders, relying on a rapid put-through of food to compensate for low absorption of nutrients; this has been particularly evident from studies of geese overwintering on grassland (Owen 1972a; Ebbinge *et al.* 1975). But feeding strategies and physiological processes employed to survive through the winter could be quite different from those evolved to store specific reserves for reproduction after vernal migration and with reduced food availability. Pressures must be strong to select only the most nutritious foods, rich in the specific nutrients required for the reproductive cycle. MacInnes *et al.* (1974) speculated that, as yet unidentified, nutritional factors might be influencing breeding performance in Canada Geese.

Geese have not been studied intensively in very late winter or on spring migration when, presumably, reproductive reserves are being taken on, but observations on Greenland Barnacle Geese by Fraser Darling (1940) and Hugh Boyd (pers. com.) are of great interest. Throughout the Hebrides, just prior to northward migration, the Barnacle Geese congregate on small offshore islands where they eat little. They then move to and stop off for three weeks in May, in Iceland, chiefly near the north coast where grass growth has scarcely started (mean date 6th May). This behaviour suggests a voluntary reduction of a food intake prior to this being forced on them by conditions in the far north. Clearly, during this period, selection for high quality foods would be extremely advantageous. Owen (pers. com.) suggested that storage organs of dormant plants might be eaten in Iceland at that time. Perhaps untapped reserves of seeds from wild plants are also available. Owen & Kerbes (1971) have pointed out the potential high energy value of stolons and seeds as foods in autumn. Brief but drastic changes in diet in response to reproductive needs, such as those described by Krapu (1974) for Pintail *Anas acuta* females, would be difficult to detect in geese inhabiting remote areas.

Canada Geese in North America overwinter on agricultural land where waste grain (particularly corn) and cultivated grasses presumably form the bulk of the diet. But our recent studies of migrating Canadas on their major spring staging site on the St Lawrence indicate a very diversified diet. Even on farmland wild plants such as seeds of docks *Polygonum,* bulbils of *Cyperus* and sprouting horsetails *Equisetum* are important in the diet. Hanson (1962) reported immature Canadas feeding on *Equisetum,* berries and basal portions of grasses and sedges on the northern breeding grounds immediately following spring migration.

During the critical period of late winter and spring the strategy employed may therefore be aimed at diet selection rather than increased food intake; a reversal of the winter emphasis on rapid throughput with little selection. Although more time may be spent on feeding, there is little evidence to indicate that increased quantities of food are consumed.

Some possible effects of agriculture

Cereal and pasture crops are clearly attrac-

tive to most geese and seem adequate for winter needs from a nutritional point of view. But perhaps of greater importance for winter sustenance is their abundance and availability and the efficiency with which flocked geese can exploit large expanses of monoculture. Cultivated crops are generally considered to be more nutritious than their indigenous equivalents (Kear 1963) but a 'farmland' diet, particularly in early spring, may not be ideally balanced for the specific requirements for breeding (Hanson 1962). One would expect geese to know what to select at the proper time but it is possible that the 'new' agricultural habitat simply does not contain all the elements necessary to satisfy a system which evolved to cope with a quite different range of foods. This should depress the reproductive rate. Yet many goose populations which have made the shift to agriculture are on the increase. Greater survival over the winter months could, however, readily mask the effects of a decreased output.

We do not have population data on geese in pre-agricultural times, but a long-term study of wintering Pinkfeet *Anser brachyrhynchus* in Britain (Boyd & Ogilvie 1969) may be revealing. From 1950 to 1968, they recorded a decreasing trend in brood size (as recorded by family group counts), a reduction in annual mortality of full grown birds and an increase in the percentage of non-breeders in the population.

A detailed study of reproduction of Canada Geese on their nesting grounds in the Canadian arctic (MacInnes *et al.* 1974) showed high success amongst breeders but at least 6–22% of potential breeders failed to nest or lay eggs.

Despite increasing populations and 'normal' brood sizes, all might not be going well in terms of goose reproduction. If reproductive rates are dropping and being compensated for by increased survival, then populations would only recover from catastrophes with alarming slowness.

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Dr Austin Reed, Canadian Wildlife Service, 1141, Rte de l'Eglise, Federal Building, 9th Floor, Ste Foy, Quebec. G1V 3W5 Canada.

A study of the winter movements of the Dark-bellied Brent Goose

A. K. M. ST JOSEPH

Since January 1973, Dark-bellied Brent Geese *Branta bernicla bernicla* have been caught and marked with plastic lettered rings, permitting individual identification at 300 m. Catches were made in six different estuaries, and by March 1975, 817 geese, or more than 1% of the sub-species (population about 75,000 in 1974–1975) had been marked. 3,350 re-sightings of 578 individuals have been made in estuaries in south-east England, and on the North Sea coasts of the Netherlands and West Germany. These sightings have provided information on the winter movements of individual geese and the pattern of estuary use of the population.

There are large numbers of Brent Geese in Europe, south of the Baltic, for seven months each year. In October the first large flocks arrive in England at Foulness Island, Essex, and the population there reaches a peak in November/December. As more birds move south-west, those at Foulness disperse to estuaries between the Wash and Western France. These 'late winter areas' then hold the majority of the world population and the numbers of geese there remain relatively stable for much of January, February and March. There follows a spring movement north-east to the Netherlands and West Germany, where marked individuals have been observed to stay for one and a half months before migrating to their breeding grounds in Siberia.

Information collected in 1974–1975 suggests that during mild winters the second-year birds return in proportionately greater numbers than adults to their areas of ringing. Research on the marked birds is continuing, to study the changes in flock composition, the traditional use of wintering areas, and the behaviour of families. The population is now at its highest level since the major decline caused by the loss of *Zostera* in the 1930s. This is reflected in the increasing level of inland feeding, first observed on a large scale in 1973–1974.

A. K. M. St Joseph, Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT.