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Some factors affecting egg production in waterfowl populations

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Climatic factors

Low spring temperatures and late snow-melts in the arctic produce 'late seasons' in which typical responses by breeding birds are indicated by the following examples.

1. A delay in egg laying by up to 10 days—for example Ross's Goose *Anser rossii* (Ryder 1972), Lesser Snow Goose *Anser caerulescens*, Black Brant *Branta bernicla orientalis* (Barry 1962), Canada Goose *Branta canadensis*, Whistling Swan *Cygnus c. columbianus* (Lensink 1973), and Common Eider *Somateria mollissima* (Milne 1974).
2. A reduction in the proportion of laying females—Whistling Swans from about 35% to 17%, and Eiders from about 80% to about 50%.
3. A reduction in both mean egg size and mean clutch size—Whistling Swans and Eiders.
4. In extreme cases, when the season is very late, some species may not even attempt to nest—Lesser Snow Goose.

For any one breeding location, there appears to be a graded series in which swans are more affected than geese, and dabbling ducks more affected than diving ducks.

Food and body condition

The requirement of higher protein food for egg production has been demonstrated in the Pintail *Anas acuta* in which invertebrates increased their proportion of diet from 56% prior to laying, to 77% during egg laying and then dropped to 29% postlaying (Krapu 1974). Changes in habitat preference during the pre-laying and laying stages therefore may well reflect a change in food requirement rather than the state of the food supply previously being utilized. There is a real need for further work associated with food selectivity and the changing nutritional requirements during the annual cycle.

Prior to egg-laying, Eider females feed at 2–3 times their 'normal' over-wintering rate, whilst Harlequin *Histrionicus histrionicus* females spend 30% more time feeding (Bengtson 1972) and Shelduck *Tadorna tadorna* may spend up to 50% more time feeding (Buxton 1975). Bengtson's study (1971) of

eight species of ducks breeding at Lake Mývatn, Iceland, showed that a decline in food supply (Chironomid larvae) to about 20% of its normal level in 1970 resulted in a drop by 20%–30% in mean body weight of adult females in four species, and clutch size in that same year was significantly lower in five of the eight species studied.

Such a link between food supplies, body weight of females, and mean clutch size has been incorporated in a hypothesis by Ryder (1970) in which it is claimed that clutch size in Ross's Goose is largely determined by the fat reserves accumulated before getting to the breeding grounds. A similar system seems to operate in the Eider duck in which it has further been demonstrated that there is a direct relationship between mean weight of females in winter and mean clutch size the following spring (Milne 1976).

Many of the species breeding at higher latitudes are long distance migrants and must incorporate a moult between breeding and migrating south. The subsequent recovery of body condition occurs on their wintering grounds where the birds must also lay down extra reserves before a flight north in spring to breed. The quantity, quality and dispersion of the winter food supplies may well determine reproductive potential through physiological condition of the breeding birds.

Pesticides

Since waterfowl are so highly gregarious in winter in lakes and coastal waters, often close to human habitation and industrial development, the possible effects of chemical pollutants on reproduction is now a real threat. A study of the Long-tailed Duck *Clangula hyemalis* in North America only serves to underline the problem (A. Petersen, pers. com.). These birds, breeding in Arctic Canada and overwintering in Lake Michigan, follow the same general pattern in body weights and fat levels described for Eiders and several arctic breeding geese. Whilst accumulating fat, prior to going north in spring, they also accumulate high levels of DDE residues and PCB's from the polluted muddy substrates via their invertebrate food. Adult females held only 2.8 ppm in DDE residues on arrival at their wintering grounds in the autumn but had 32.05 ppm in their fat store by spring. The utilization of these fat reserves in the formation of eggs has repercussions. DDE residues found in eggs ranged from 0.1–16.0 ppm and were closely related to the amounts found in the adult females. Such levels of chemical pesticides are known to affect both hatching success of eggs, through shell-thinning, and survival of the adult birds.

Bird density

At high bird densities on winter feeding grounds social interactions can act to reduce food intake and may affect the eventual body weights achieved before migration.

In Eiders an inverse relationship between bird density and mean body weight in winter again implies that the overwintering situation may well hold the key to the spring breeding performance of many of our northern species of waterfowl. To date too little significance has been given to the relationships between bird density, social behaviour in winter flocks, food quality and quantity in winter and the reproductive potential of breeding populations. Further studies linking winter feeding ecology with breeding output should be given high priority.

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