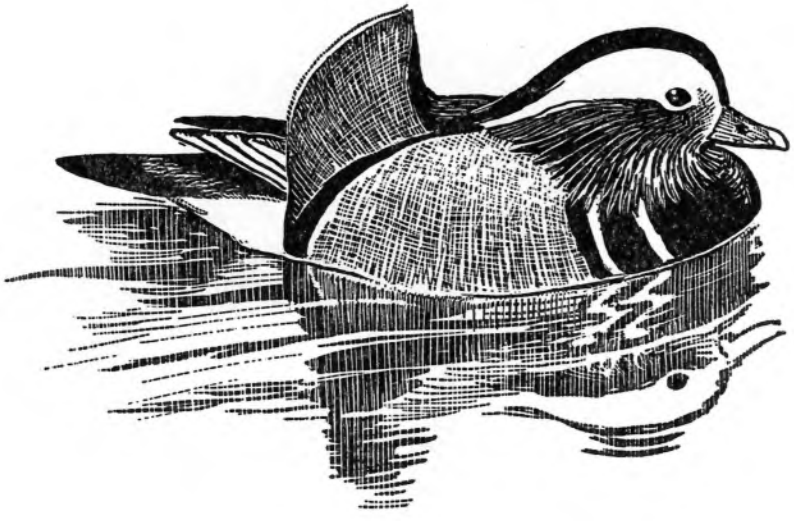

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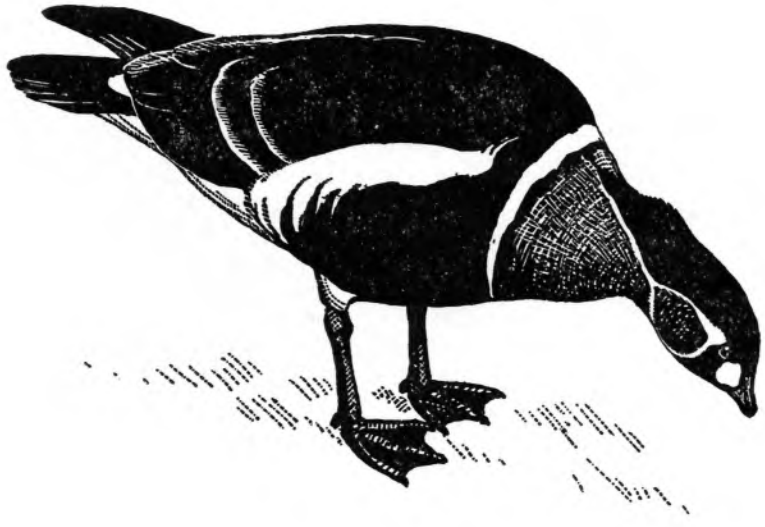
Published by the Wildfowl Trust, Slimbridge

1969



Editors: G. V. T. Matthews and M. A. Ogilvie

The Wildfowl Trust, Slimbridge, Gloucester, England

Cover painting by Peter Scott
Line drawings by Peter Scott, Thierry Robyns de Schneidauer, Robert Gillmor and others. The symbol on p. 94 is by Braque.

Price 17/6d. ($2.50). Postage extra
Issued free to Life and Full Members of the Wildfowl Trust

Printed for the WILDFOWL TRUST by
THE BERKSHIRE PRINTING CO. LTD., Reading, Berkshire, England, 1969

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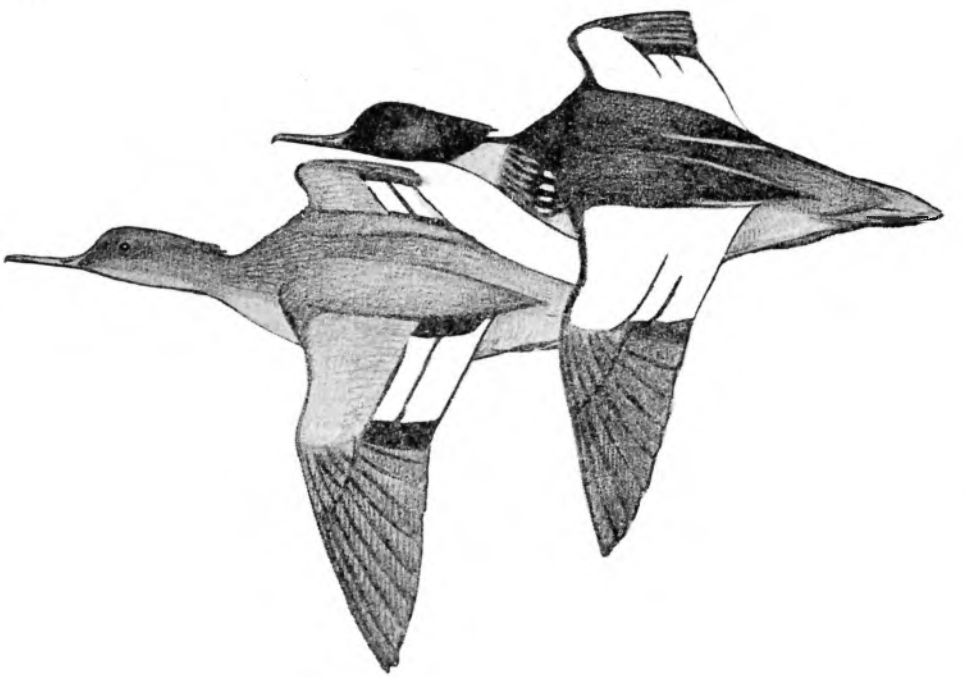


THE WILDFOWL TRUST

SLIMBRIDGE, GLOUCESTER

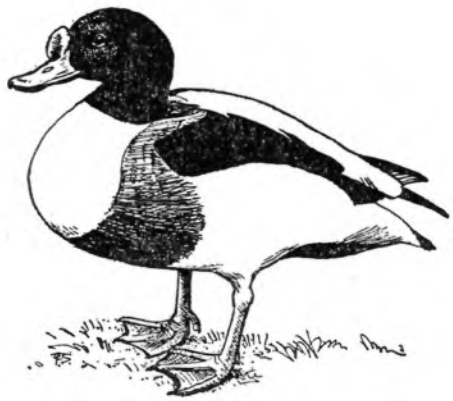
The aims of the Wildfowl Trust are:

1. To maintain and breed wildfowl in captivity, especially those species which are in danger of extinction.

2. To carry out scientific study of wildfowl in the wild state and in captivity.

3. To apply that scientific knowledge and experience to the conservation of wildfowl at home and overseas.

4. To educate the public by all available means to a greater appreciation of wildfowl in particular and nature in general.



Social and population studies in the Shelduck

JOHN HORI

Introduction

This paper describes breeding season studies of an estuarine population of Shelduck *Tadorna tadorna* on the Isle of Sheppey, north Kent, England. The population is part of the summer population of the Thames marshes, and although not strictly closed, there seems to be little movement, during the breeding season, between it and groups which centre on the adjacent Medway estuary and the Cliffe peninsula. The location and relevant topography of the island are shown in Figure 1; details of the habitat have been described previously (Hori 1964a).

Intensive field studies were carried out during the breeding seasons of 1964, 1965 and 1966, limited data from the years 1967 and 1968 are also included. These are combined with data from previous intensive field studies in 1960—63 to illustrate longer term trends. Methods were identical to those employed in the earlier study (1960-1963), except that colour marking of ducklings by injection of dye into eggs before hatching was used in 1966. This proved to be completely safe as far as ducklings were concerned and, in general, easy to execute. Difficulties of carrying out the work twenty feet up in a tree may however be imagined. The technique was that developed by Evans (1951) and others in the U.S.A. and information on it was supplied by the Delta Waterfowl Research Station and the University of Aberdeen. Eggs were injected with water - soluble food dyes, diluted with saline, shortly before hatching. A dosage of 0.3—0.4 ml. per egg, 3-4 days before hatching was used in most cases. Satisfactory results were also obtained with injections down to 24 hours before hatching with doses of 1.0 ml.

Injections were carried out with a 1 ml. hypodermic, a cork mounted on the needle limiting the depth of injection to just through the shell membrane. The dye was injected slowly and the hole closed with cigarette paper stuck down with nail varnish. Two trial clutches of captive birds, and eight clutches of wild birds were injected, and 100% hatching success was achieved. Purple, red, yellow, turquoise green and black were found to be particularly good colours in the field.

PART I: SOCIAL ORGANISATION IN THE BREEDING SEASON.

Territorial behaviour

This behaviour in Shelduck is of extreme interest because although vigorous inter- and intra-specific defence of a specific

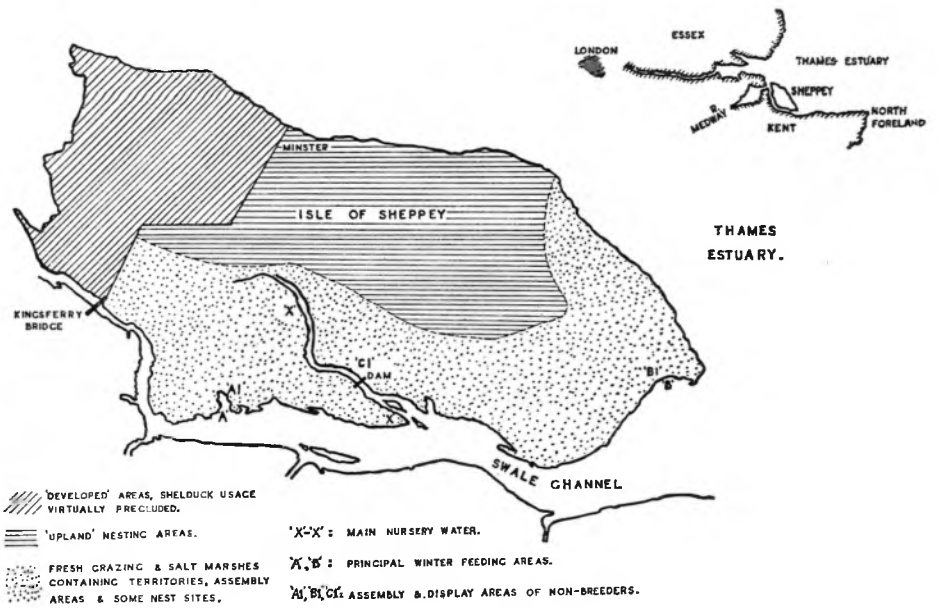


Figure 1. Shelduck habitat on the Isle of Sheppey. (Inset — location of the island.)

territorial location occurs, no nest was ever found within a territory. In a few cases nest sites were near territories, but in the great majority they were in distinctly different localities, up to 3 miles distant.

While investigating the use of territory a change in feeding habits was discovered. This occurred in most of the Sheppey breeding population as soon as it returned to the home range. Olney (1965) has shown that Shelduck wintering in the Thames estuary have an extremely narrow feeding ecology. Their diet in the Swale and Medway consists overwhelmingly of the small estuarine snail *Hydrobia ulvae*. This animal has been shown to be important to them in other localities, for example, in the Heligoland Bight (Goethe 1961) and in North Uist (Campbell 1947). However, direct observation on Sheppey showed that during the laying and incubation periods the majority of breeding adult Shelduck feed in the freshwater grazing marshes, mostly in territories. This was confirmed by examination of faecal material from females caught during incubation (Hori, in prep.). The situation was complicated because during the laying and incubation periods, the non-breeding population and a small proportion of those breeding continued to feed on the inter-tidal zone in locations where *H. ulvae* were prolific. Faecal material from one incubating female caught in 1966, on the 22nd day of incubation, contained 584 *H. ulvae* shells. Young (1965), working on the Ythan estuary in Scotland, maintained that most of the breeding birds there fed on *H. ulvae* throughout the breeding season. Observations from the Ythan and the observed feeding behaviour of part of the summer population on Sheppey support the belief that there is no significant seasonal variation in the biomass of *H. ulvae* (Dr. R. Newell, pers. com.). Thus the majority of breeding adults on Sheppey move away from prolific feeding grounds, which a few months earlier supported a winter population at least four times as large as the summer numbers. Defence of territory consequently appears conventional (Wynne-Edwards 1962) as far as food supply is concerned because there is an abundance elsewhere in the breeding habitat which is completely ignored. Since *H. ulvae* are not eaten by ducklings, the change of adult diet cannot be an advantage to the species in this context.

Shelduck territories are also puzzling if considered as a dispersion mechanism, not only because they do not contain nests, but because most of the birds holding territory congregate and act gregariously at nesting sites during the same period. The most likely explanations for Shelduck territorial organisation appear to be either that it provides isolation for pairs, or acts in a density dependent manner to achieve dispersion, or that it

provides meeting places for the pair during incubation. Hochbaum (1944) suggested that the primary function of territorial behaviour in ducks is to limit interference during copulation. This view has been criticised by McKinney (1965) who observed that Eiders *Somateria mollissima* successfully accomplished copulation in crowded colonies. However, isolation would appear to be advantageous because the sight of copulating or diving birds causes extreme excitement in other Shelduck with consequent interference. This is most evident in bathing parties seen in winter flocks, where a diving bird will release similar activity in many others so that twenty or thirty birds begin diving wildly. These displays are notable for their intensity and on two occasions males have been seen to mount another male, after the latter had dived, and remain in a typical copulatory position, hanging on to the nape feathers.

Territory usage was well illustrated by a pair studied intensively in 1966. These were of special interest because they also adopted a sub-territory; the major part of their home range is shown in Figure 2. The pair occupied a primary territory on a main fleet in April and initially used this regularly. This was the territory which the female had used each year since 1963. Use of the sub-territory appeared to develop because of frequent disturbance on the primary territory, by fishermen or farm workers. Although the water of the sub-territory obviously contained sufficient food it was probably of insufficient depth for coition, being no more than 8″ deep. It was unusual in being small, approximately 2 yards × 30 yards total length, and in its position on the slope of a hill, and was more like the loafing places used by Shovelers *Anas clypeata.*

Both birds spent extensive periods feeding in the pool, which, being floodwater, gradually dried out. After incubation started, the female's range was restricted to the nest and sub-territory. The behaviour of the male in calling the female off the nest, her waning response, her greeting call when she flew down to the sub-territory and her return to the nest accorded with behaviour described by Hori (1964a). The female's feeding visits averaged two a day and when caught at the nest on several occasions her faecal discharge confirmed that she was not feeding at all on the inter-tidal zone. On the sub-territory she fed, preened and slept. The male left the sub-territory at irregular times, presumably to visit the inter-tidal zone; mainly in the evenings and possibly at night. During late May and the whole of June the male spent approximately 80% of the daylight hours on the sub-territory and he was seldom absent when the female arrived.

Territory in Shelduck may thus function to maintain the pair bond as it does weakly in other ducks. Mallard *Anas platyrhynchos* were often seen to rendezvous at feeding places in a similar manner during early incubation. The females leave nests as dusk gathers and fly low over the marsh to escape the attentions of other males. Their own males, who have been loafing in the vicinity, follow them to the feeding place or may already be waiting there. But this behaviour lapses quickly when the males desert incubating

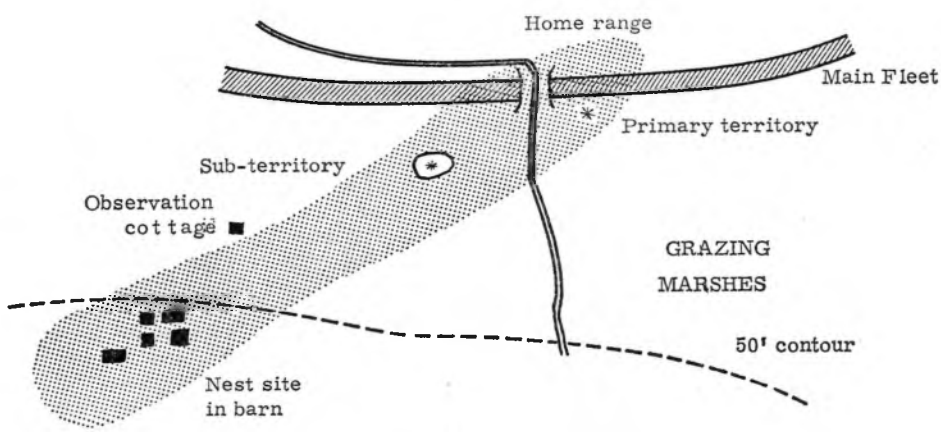


Figure 2. Home range of Shelduck pair in 1966 (stippled area). Included in it are the primary territory on the Main Fleet, the sub-territory on a small pond and the nest site in a barn (left-hand of group of buildings).

females and I have not been able to determine whether females continue to use the same feeding locations thereafter. Ducklings are never kept within the confines of a Shelduck territory, but in the vast majority of cases are taken to entirely separate nursery waters. Only in the few cases where, by coincidence, adults held territories along such nursery waters was there any possibility of confusion, but colour-ringed birds confirmed that even here territory had no relevance to the rearing of ducklings.

From 1964 to 1966 inclusive, prolonged observation in February and March from before first light showed that the tendency was for pairs to visit and adopt territories before making regular visits to upland nesting areas. By the second or third week in March pairs spent short periods on the territories, generally from around first light (c.05.00 hrs.) until farming and other activities often disturbed them about 07.00 hrs. Territorial attachment is not strong at this season and when disturbed, pairs range over the grazing marshes. Some make brief visits to nesting localities, others merely circle towards them before wheeling, to seek out social gatherings on the larger floodwater pools of the grazing marshes or in the estuary creeks.

Social organisation of breeding birds

The term communes was applied to persistent groups of breeding adults in the nesting areas (Hori 1964a). They are distinct from many of the larger gatherings of breeding adults which occur on the fresh grazing marshes early in the season, in the locality of territories and, of course, from the gatherings of non-breeding birds. The widespread occurrence and persistence of communes indicate that they are of considerable importance in Shelduck social organisation.

Attachment to territories and nesting areas develops steadily and by the beginning of April visits to territory are regular and purposive. During this period birds were seldom recorded on territories at dusk, but most were there at first light. At this stage the commune bond appears to become dominant; early each morning birds leave territories in pairs and fly direct to traditional assembly areas, for example four to six pairs from one fleet would move off adjacent territories each morning between 04.40 hrs. and 05.00 hrs. and fly towards known assembly areas. Colour-ringed birds were often watched off their territories and then followed by car to the assembly areas. On arrival at the latter, pairs join others which settle at varying distances from nesting sites. In one relatively remote locality, a grazing marsh commune often assembled outside or on the roof of a shed which contained two or three nests annually. In contrast, upland communes often assembled fifty or a hundred yards from subsequent nesting sites.

At this time the majority of adult pairs spend most of the daylight hours in communes. When disturbed, the latter usually move a short distance, perhaps only one field. Most of the late morning and afternoon is spent sleeping in groups in the nesting locality. Thus although most pairs have discrete territories and are within a month of laying, little time is spent in isolation. This behaviour persists until egg laying commences.

The complexity of the social organisation which produces inter-pair hostility on territories and, within a very few minutes, social gatherings of the same individuals underlines the suggestions made by Crook (1964) that analysis of such systems requires extensive experimentation and attention to the dynamic interaction of a large number of factors.

Unlike similar organisations described by Carrick (in Andrewartha 1961) for the Australian Magpie *Gymnorhina dorsalis*, communes were not exclusive. For example, when seriously disturbed, members often flew to the assembly area of another commune and joined them for the remainder of that morning. Colour-ringed individuals forced to find new nesting sites, for example when the previous year's sites were destroyed, were apparently able to join other communes readily.

During the remainder of April and early May, visits to nest sites become more purposive and pairs spend long periods searching hay and straw stacks. These birds attract other potential breeding pairs and cause grouping at such sites.

When clutches are complete nesting pairs act with considerable independence and seek the isolation of their home range. But the commune bond again becomes apparent if nests are destroyed. Such re-assembly made possible a preliminary judgement on the nesting success of communes. Thus a commune of 5 pairs in 1966 re-assembled daily on upland pasture during early June. An old hay stack, known to contain at least one nest, had been burnt the week before. A further stack left over from 1964, around which the commune often assembled, was found to contain four deserted nests.

Communes in which all nests failed were believed to break their tie with the home range and, after a short while, join the flocks of non-breeders which migrate first (Greenhalgh 1965, Hori 1966). The remainder of the breeding population then consists of three classes, pairs in which the female is incubating and which still have a bond to the commune, pairs in which the females, having laid their eggs in the nests of others or having lost nests, are tied to communes, and other pairs, believed to be in a small minority, which have isolated nests and no commune bond. The breeding chronology of the latter class is fairly obvious, but it was not discovered until late in the study that the commune bond remained intact in the two former classes. Thus commune members who lose nests or are nest parasitic, temporarily lose daily contact with incubating pairs, but instead of rejoining the non-breeding population they tend to stay in the breeding range and resort to the vicinity of the main duckling nursery. The presence of these birds was detected by colour-ringing during the brood season and previous work (Hori 1964b) suggested that they may stimulate brood adults to desert their ducklings. Groups of pairs following broods and crêches on the duckling waters are probably mainly parasitic pairs or failed breeders. In a number of instances known communes remained near duckling waters up to 12 days, until all members had broken their ties by brood attacks or by simple desertion. At the latter stage of the breeding cycle many instances were noted where sexes associated freely instead of in pairs, for example three or four adult females feeding or preening close together whilst the remainder of the commune might be 10 yards away. Marked females, including some who had freshly deserted broods, were also seen in such communes without their mates; whenever such groups were watched for prolonged periods the drakes were seen to return after feeding on the inter-tidal zone.

The commune bond thus exists at least from the end of March until adult pairs leave on moult migration. It has so far proved impossible to demonstrate the existence of such groups within the winter flocks, although pair bonds are obvious enough.

Multiple nesting (See Plate I, p. 32)

The phenomenon of a number of females laying in the same nest has been frequently reported in Shelduck, but its widespread occurrence and significance have received little attention.

Weller (1959), in a comprehensive study of parasitic behaviour in North American diving ducks, differentiated between nest and egg parasitism and suggested that the term parasitic could be logically applied where advantage or disadvantage to the participants occurred. Disadvantage was difficult to demonstrate in Shelduck, although females which did not incubate were clearly in better condition to undertake the moult migration and it is apparent that conditions similar to Weller's dump nests could arise. The largest number of eggs found in a single nest during this study was 32 but this was robbed. Surprisingly, hatching success in 21 clutches larger than 12 eggs did not differ from that in smaller clutches (Table I). The disadvantages of multiple nests postulated by Weller were thus not apparent.

Assuming that clutches or broods greater than 12 were the result of multiple nesting (see later), at least a quarter of the broods produced came from such nests (see Tables V and VI on p. 16).

Parasitic egg laying by Shelduck was entirely intra-specific and its origins are obscure. Commune organisation facilitated members following each other to nest sites, particularly where sites were rather restricted. As suggested by Weller, the sight of eggs appeared to be the stimulus to parasitic birds. Other species could be likewise stimulated, for example an egg of a Stock Dove *Columba oenas* was

Table I. Comparative hatching success in individual and multiple nests.

	1963	*1964*	*1965*	*1966*	*1967*
No. of clutches $\leq$ 12 eggs compared	8	12	9	8	6
Hatching success % (laid/hatched)	90	93	87	92	88
No. of clutches $>$ 12 eggs compared	8	2	2	6	3
Hatching success % (laid/hatched)	91	95	90	89	85

found on a pile of 22 Shelduck eggs, and Mallard eggs were frequently found in Shelduck nests in trees and haystacks. There appeared to be exact synchronisation of laying between host and parasitic female Shelduck and this would also appear to result from commune organisation.

Observations of commune females visiting multiple and other nests were commonplace. Females believed to be parasitic were also observed sitting, and even laying eggs, beside incubating females. A typical commune in which pairs are 'clumped' or over concentrated with regard to available nest sites was in successive years centred on a shepherd's shed in an undisturbed area of grazing marshes. This contained up to four nests annually, always begun in the latter part of the laying period, probably as a result of the poor nature of the site. Commune pairs assembled immediately outside the door and continued to do so throughout the incubation period, for example on 26th June 1966 five adult females and three adult males were gathered outside the shed and a female was sitting on one of two proven multiple nests with clutches of 15 and 14 eggs. When the ducklings were taken to the nursery water the whole commune moved with them.

Another aspect of behaviour considered to result mainly from multiple nesting is down-stripping away from the nest. Piles of down resulting from this habit were only found in areas used by communes and breeding pairs, often those under observation for periods of up to three weeks. In all cases location and direct observation confirmed that breeding adult birds were involved. Only subjective estimates of the quantity of down stripped could be made, but it was possible to date the occurrence of maximum quantities of fresh down (Table II). The maximum frequency of this habit occurs two to three weeks after the peak laying date. It therefore marks the virtual end of egg laying in the population. This suggests that the large drifts of down, spread over 30 to 40 yards, are the work of parasitic birds excluded from the multiple nests when one of their number begins to incubate. Many of these birds move to the nursery waters and it is near these that the large quantities of down are found. It might be possible to gain an impression of the annual extent of multiple nesting by recording the volume of down. Small puffs and piles of down, such as one might expect from single birds, are found in territorial areas, and the time spread suggests that these result from the destruction of individual nests during the incubation period.

Individual histories

Sixty adult females were caught at nests and marked with numbered metal rings and plastic colour rings on one or both legs. Experiments in 1963 with spirit soluble dyes were not entirely successful because such dyes were only recognisable for a few weeks. Some individuals were known either every breeding season or in various seasons for the last six years of the work. Table III shows examples of traditional attachments (Hochbaum 1955) to the home range.

Not only were these Shelduck traditional in returning to the home range, but they retained a tenacity towards various components of it. Approximately 7% to 25% of the breeding population of females were handled each year and, allowing for the difficulties of detecting colour rings on pasture and soft mud, these data suggest that most of the population acted in the same way. Work on other hole-nesting ducks has shown similar tendencies in Goldeneye *Bucephala clangula* (Siren 1957), Bufflehead *Bucephala albeola* (Eskine 1961) and North American Wood Duck *Aix sponsa* (Bellrose, Johnson and Meyers 1964).

Some remarkable examples of tenacity and tradition occurred in the Shelduck. One female, AJ 62813, used exactly the same hole for the three years 1962 to 1964. In 1965 a Wood Pigeon *Columba palumbus* laid there first. The Shelduck laid in the nearest available hole, in the same tree screen 40 yards from the original site. In 1966 this hole remained full of

Table II. Occurrence of down-stripping away from the nest.

	1962	*1963*	*1965*	*1966*
Maximum down-stripping	17/6	9/6	12/6	4/6
Spread of occurrences	31/5—24/6	not recorded	5/6—13/6	27/5—5/6
Peak laying	29/5	12/5	24/5	23/5

Table III. Examples of home range tenacity.

	No. of breeding females involved in stated activity					
	1963	*1964*	*1965*	*1966*	*1967*	*1968*
On same territory as previous year	1	6	6	7	not investigated	
Same nesting locality as previous year	1	9	5	7	4	5
In same nest site as previous year	1	9	4	7	3	4
Broods taken to same nursery water as previous year	1	4	7	6	not investigated	
Cumulative no. of adult females ringed at end of previous nesting season	5	17	25	36	44	49

winter rain water and the female returned to the first site. In 1967 the female again used this site which, being a vertical hole in the centre of the trunk, was eroding relatively quickly. This made it difficult to catch her and moreover resulted in one duckling being abandoned in the nest. For this reason the hole was filled with hardcore and wood litter during the winter 1967-68 to a depth which would make capture easy again and in 1968 the bird nested in the same hole once more. Unfortunately the clutch was destroyed by Magpies *Pica pica* and it seems likely that the raising of the nest made it a little too readily seen from outside. This bird therefore nested for seven consecutive years in virtually the same spot. Throughout these years her territory remained on a freshwater fleet about 1,200 yards from the nest, and she and her mate were also to be seen feeding on the inter-tidal zone. The date of her first egg varied, being 23.5, 26.4, 1.5, 11.5, 20.5, 25.5 and 21.5, and so did clutch size and hatching success, 8/8, 6/10, 7/8, 9/9, 8/9, 8/8, 0/10. The incubation period was always 30 or 31 days, making the dates of brood exodus 3.7, 7.6, 14.6, 22.6, 2.7 and 23.6. The broods were always taken to the same place on the main nursery water and usually deserted within 10 days.

Individuals experienced varied breeding success from the complete success of AJ 62813 to almost the opposite. An unusually timid bird incubating a multiple nest under a water tank in 1963 deserted as a result of colour dyeing experiments. She returned with the commune in 1964 and began laying in a dutch barn some 50 yards away from the previous site where she was caught by mistake after laying only five eggs and deserted. In 1965 she used the barn again, where she was examined and carried on incubating, but unaccountably deserted six days later. In 1966, in spite of at least three successive years of total nest failure, she returned with the commune and completed a clutch in a prepared site in the same barn. All seemed well, she was examined several times during incubation and hatched 10 of her 12 eggs. But her timidity again caused failure. This clutch had been injected with colour dye and at 06.30 hrs. on 30th June the pair was seen leading two coloured ducklings in the direction of the main nursery water. The pair had been disturbed by farm-workers whilst calling the ducklings off. The remainder emerged by themselves the next day and were later found following hens in the farmyard. Ironically this female turned out to have loose brood ties and her two coloured ducklings were found five days later with another family group.

Behaviour of broods and attendant adults

Shelduck ducklings can be heard cheeping as the eggs chip, but I have not recorded a female communicating with the young at this stage. However, as the time to leave the nest approaches considerable vocalization occurs. The female uses a soft 'arrnk' or 'arrk' note which, with varied amplitude and frequency, is used for contact, indicating safe conditions to the brood, as a call note or as an alarm, in much the same way as dabbling ducks (Beard 1964, Collias and Collias 1956). The period of vocalization at the nest appears to last only a few hours, but during this time ducklings apparently learn to differentiate between the notes. In studies of Mallard and Wood Ducks,

Gottlieb (1965) has suggested that audible imprinting occurs at this time.

Since many Shelduck nests are hidden from the light, vocalization is clearly essential. Ducklings may have difficulty in finding their way out of dark labyrinths or, in tree holes, may find it physically difficult or impossible to climb out. In 1964 in a nest under hay bales in a small dark shed, eleven eggs began hatching on 22nd June and all ducklings were dry by the evening of the 23rd. Next morning at 04.55 hrs. the female was heard calling inside the shed. Besides the monosyllabic 'aarrk' note was another very soft running 'ugg, ugg, ugg'. The former was more frequent and was reminiscent of a domestic hen calling young, it seemed to be a combination of contentment and contact notes. Both calls were used almost continuously for the next 50 minutes; occasionally a duckling would appear briefly outside the shed. Calling was now interspersed with a further note, a quiet but hard bubbling 'ak ak ak' variant of the 'following' call, giving the impression of rising excitement as the female came closer to the door. At 06.59 hrs., after at least two hours calling, the female led the brood through a hole at the bottom of the door calling with a gentle 'arrnk, arrnk' note whilst the ducklings 'peeped' continuously as they ran hesitantly in single file behind her. Even so, two ducklings were left behind in the shed.

The calls described are of extremely low volume and can only be heard under quiet conditions when the observer is very close to the brood. In the open it is extremely difficult to detect contentment, contact and initial alarm notes of the female and ducklings; one usually hears only the later alarm and distraction notes of the female. Collias and Collias (1956) also noticed that low pitch, weak intensity, repetitive notes used for calling ducklings are similar to the clucking of domestic hens and found that Canvasback *Aythya valisineria*, Redhead *Aythya americana* and Mallard ducklings could easily be attracted by such clucking on their first day.

In difficult tree sites, vocalization is used to induce ducklings to climb and jump considerable heights. In one such nest where the ducklings had to get from a hole inside a hollow branch, they invariably fell into the bottom of the hollow trunk. In 1962 and again in 1964 persistent calling by the female induced three or four of the brood to climb out, but the remainder had to be rescued. In 1966 another female was unable to call any of her ducklings off this site and all ten were found dead in the trunk.

Shelduck ducklings are taken direct and rapidly to traditional nursery waters. Marked females and ducklings in their first day out of the nest moved up to three miles from the nest to the nursery; the maximum overland journey known was approximately two miles. The only divergence from behaviour previously described for this phase (Hori 1964a) was that several females led broods from upland nesting areas without accompanying males. Circumstances where a female calls a brood off during the mate's absence seem to occur with some regularity. In such cases the broods are often taken to the nursery water via the territory area where the male can join them.

On arrival at the nursery water, ducklings join a complex family and crêche organisation. Study of brood behaviour during the first five years of this work was greatly facilitated because approximately 80% of each season's ducklings were taken to one large fleet in the grazing marshes. This is unusual in estuarine Shelduck populations and possibly the relatively small area and non-tidal situation of this nursery produced inter-action not always present on tidal mudflats used by other populations. However, when a major shift of nursery occurred in 1966, brood and crêche behaviour appeared similar. The ducklings' initial brood tie may last only a day or two. It was confirmed that brood attacks (Hori 1964b) in which both parents drive their own ducklings away, are one of the basic methods by which ties are broken. Most brood attacks apparently occurred as a result of conflicting tendencies in the adults to break the brood tie and yet remain in nursery areas; possibly to rejoin communes which had assembled nearby. The rapidity with which brood ties are broken is in marked contrast to the dabbling ducks. For example, on 22nd June 1965 a colour-ringed female and her mate took 9 ducklings from the nest and on the next two days gave protracted and violent distraction displays on the main nursery water. The following day the pair had only four ducklings and on 28th June, although still at the same place, they had none, but were swimming close to a crêche. When disturbed the female flew straight out of sight towards the estuary, her mate followed for about 100 yards, but then came back as though still drawn to the ducklings. Observations on brood abandonment in Wood Ducks

by Mendall (1958) and in Hooded Merganser *Mergus cucullatus* (Beard 1964) show interesting similarities to the brood attack behaviour witnessed in Shelduck.

Most females deserted their broods each year. The few who raised their ducklings to fledging in discrete family broods generally appeared to be those which reached the nursery water earliest in the season. So that apart from parasitic females and failed commune members the adult pairs remaining on the nursery water were crêche adults. The identity of the latter has been conjectural. Hori (1964b) suggested that pairs which loafed on the nursery water and which often followed broods or crêches might be failed breeders or parasitic females anxious to adopt ducklings. In four fully documented cases since then, females in charge of crêches were adults which had successfully hatched their own broods the same year. Thus female AJ 87938 hatched all her 11 eggs in 1964. She led the ducklings out at 07.00 hrs. on 24th June and took them to the main nursery water some 80 yards from the nest. At 05.00 hrs. the next morning this female and her mate had a crêche of 55 uniformly sized Class I ducklings at exactly the same spot. Daily observations, between 05.40 hrs. and 08.00 hrs. but at 11.50 hrs. on 28th June, showed the numbers to be varying, 56, 52, 18, 65, 68, 28, 24, 6, 35, until 5th July when there were 22. The pair were not seen subsequently on 12th or 19th July. The following year this female appeared on 20th June 1965 on the main nursery water with 6 tiny Class I ducklings. Once again she and her mate became crêche parents, having 15 on 23rd June, 23 on 24th June, 10 on 10th July, 14 on 25th July and 20 on 1st August. The first wave of adults had left on moult migration before the last observation on AJ 87938 in 1964, and clearly in 1965 the pair, who were known to be members of a commune in both years, again stayed behind with the ducklings. This holds generally; for crêche adults the bond to ducklings is stronger than the commune bond and the migratory urge. It has not yet been established whether crêche adults make a moult migration later.

Daily life in broods and crêches on the main nursery water was the most sedentary observed. Feeding, preening and sleeping periods were all led by the adult female during the first two or three weeks. Typically, AJ 87938 would spend 15 to 40 minutes feeding and then gradually swim towards the bank, where, after a few minutes spent standing in shallow water preening breast and flanks, she would walk on to the bank, followed by the ducklings. During bad weather ducklings were brooded by the female. Activity of the brood appeared to be diurnal during the first week or two, and as darkness fell ducklings were kept on the bank with the female sheltering them under both wings.

Whenever broods were disturbed on their journey to the nursery water and during the first few days thereon, both adults gave violent and protracted distraction display. On dry land the adult display was equally as spectacular as a Mallard's and usually included injury feigning. This reduces to tolling (Hori 1964b) as broods develop, and it was generally noted that at this stage parents which subsequently deserted broods simply flew wide circles without any display or vocalization.

For the first few days broods and crêches are tight gatherings which follow the adults closely, but they soon become increasingly independent. Medium and larger sized Class II ducklings were often seen at first light on the banks with adults, but as the light increased and particularly during warm spells, they ranged widely. In consequence, they join the nearest brood or crêche when disturbed and this creates the impression that crêche sizes vary more than they actually do. By the time they are c.16-20 days old, ducklings were often largely independent, brooding each other at night and associating at other times in groups without adults. Occasionally males of brood or crêche pairs leave the group to feed on the intertidal zone and may be absent for an hour or more. Less often the female was absent. Movement of ducklings between broods and crêches was detected by regular counts of undisturbed groups, by movements of dyed ducklings in 1966 and by prolonged direct observation. This interchange is contrary to behaviour reported from the Ythan estuary in Scotland by Young (1965), and is almost certainly dependent upon the density of broods and crêches.

Adults in the nursery area were extremely passive towards ducklings, especially those without accompanying adults and only three exceptions were observed during six seasons. Whenever wandering Class I ducklings approached strange adults they were treated as though they belonged to the birds concerned. Three or four adult females might stand or swim around such an apparent orphan, examining it minutely and touching it gently

with their bills. Even when accompanied by adults, ducklings were treated passively.

When the water referred to as the main nursery water became less suitable, as it did towards the end of this study, it was found that the tradition of attachment to the creek was still intact, but the ducklings now resorted to its tidal reaches. Though the mass of ducklings could invariably be found in the creek on an early morning high tide, provided they had not been disturbed, they would regularly float out as the creek emptied on the ebb and might range two or three miles down the shore. Duckling behaviour on exposed mudflats and on saltings was similar to that recorded in the freshwater nursery except that on high tides birds used the saltings widely to hide when danger threatened. Adults would lead broods or crêches to side creeks or runnels and then into the grass/purslane saltings. However, when suddenly surprised such groups would invariably make for open water, running at high speed across the mudflats or swimming and diving down the creeks.

PART II: POPULATION DYNAMICS

The changing habitat

Usually habitat changes are too slow to be considered in ecological studies. Although the same is largely true of the present work, certain significant changes did occur in the period 1960 to 1966. By far the most important was in the physiography of the area called the main nursery water (Figure 3).

Prior to 1953 this had been the largest saltwater creek on the island and a traditional nursery. Its attractions as duckling habitat were its location in that part of the island least accessible to man, the shelter it afforded from prevailing winds, the shallow gradient of mud towards the edge of the saltings and the food supply.

This habitat was virtually halved when, following the 1953 sea floods, a dam was constructed across the creek to rationalise the previous sea wall system. Thus in 1955 the majority of the creek's length became non-tidal and a transition to fresh vegetation started: a sewage outfall kept the water level high and no doubt contributed to food supply, whilst the shallow water's edge gradually became almost perfect for ducks and waders. Construction operations prevented the area being useful to Shelduck until 1956. Thus the period of the present study, 1960-1966, commenced when that part of the duckling nursery above the dam had developed to an extremely favourable environment and the tradition of using the tidal portion of the creek as a nursery was being modified to take advantage of it.

During the period 1960-62 inclusive, at least half the broods taken to the nursery area stayed for long periods above the dam, in 1963 about two-thirds did so and in 1964 and 1965 something like three-quarters of those using the nursery were above the dam. Even many of the broods which later used the creek spent their first few days above the dam. However, by 1965 changing plant communities began to affect the situation and this was made strikingly obvious in 1966. The population then virtually returned to using the tidal creek as a nursery. The maximum count of ducklings above the dam dropped to 20% of the total in the nursery area.

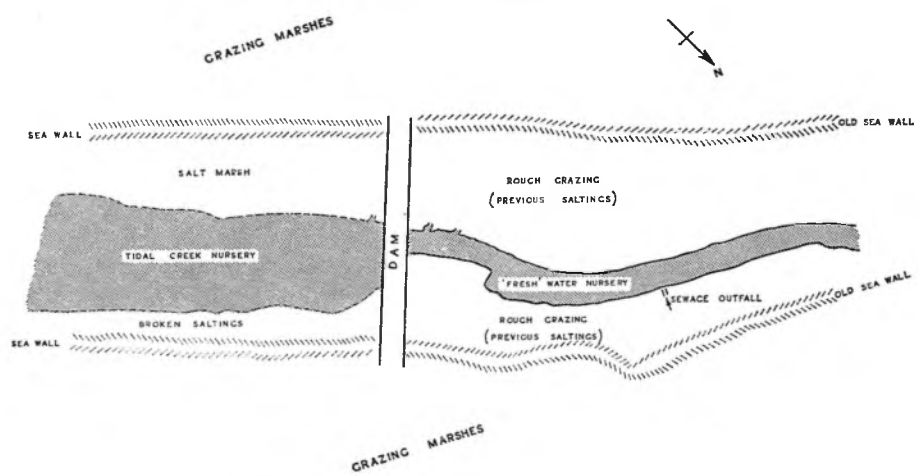


Figure 3. Principal features of the main nursery water. (Scale: 1 in.=approx. 600 yds.).

The change was brought about by the spread of sea club-rush *Scirpus maritimus*, as plant succession above the dam turned that water into a typical Thames marshland fleet. This reed, although providing food for surface feeding ducks, was disadvantageous to Shelduck and to Pochard *Aythya ferina*. Spreading from the upper reaches of the fleet and colonising shallow water first, it gradually obstructed the edge so that ducklings were unable to negotiate it easily and adults were no longer able to maintain a view of broods and crêches from the bank. The number of ducklings found dead, apparently killed by foxes *Vulpes vulpes*, stoats *Mustela erminea* and weasels *Mustela nivalis* increased, and the new reed beds probably aided these predators by concealing their approach. In 1966 none of the marked females which had been observed closely in previous years remained on the old main nursery. The population, which in 1964 successfully exploited the new habitat, had thus largely completed a cycle of adaptation and re-adaptation in the space of twelve years.

Other human pressures affected the habitat noticeably. Destruction of nest sites was apparent in the annual felling of trees, the clearance of derelict buildings and the intrusion of holiday camps and caravan parks into previously undisturbed areas. This must in the long term affect a species with such strikingly coloured females, but in the span of this study the population prospered. It is interesting to note that something like a third of the nesting sites in this study were provided by man and that Shelduck are to this extent parasitic on him. Some pastoral communities have recognised this as a ready means of farming the birds for eggs, and I found no difficulty in inducing birds to lay in nests which I prepared for them. This could be a method of conserving Shelduck populations in the future and provides interesting conjecture as to whether breeding populations such as that on Sheppey will ultimately become semi-feral. Whilst there was as yet no evidence of any change in the relative importance of nest locations, it was apparent that the use of trees will gradually decline. All the tree sites were in elms *Ulmus procera* and many in holes caused by the Dutch Elm disease. Although elm screens on the island were thick when Hasted (1797-1801) noted that Shelduck were frequently seen on Sheppey, re-planting to replace those which deteriorate badly stopped some years ago and all subsequent re-planting has been with other species; suitable tree holes are thus becoming less common.

Clutch size

Clutch data are shown in Table IV. These include data for obvious multiple nests and those which had been tampered with, 'milked', which were excluded in previous work (Hori 1964a), and give an overall mean, for 130 nests, of 11.1. Such means are useful in estimating laying dates and incubation periods from brood studies, but since they include multiple nests they do not give an accurate result if used for population deductions. Estimating the proportion of breeding females which use multiple nests remained a major difficulty and could only be approached by intensive study of individual clutches. In a sample of 60 nests in which eggs were counted daily and the behaviour of adults studied in detail, all clutches greater than 12 eggs were proved to be the work of more than one female. This was supported by the finding that in 69 additional nests in relatively solitary sites, with no evidence of visits by other

Table IV. Number of eggs in nests examined.

Year	*Nests counted*	*No. of nests containing eggs shown*													
		<8	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*>18*	*Mean*
1962	13	1×4 1×5	6	1	1	—	—	1	—	—	—	—	1	1×20	9.7
1963	25	1×3	2	4	3	1	2	2	3	3	—	1	1	1×22 1×25	12.6
1964	22	2×7	5	3	6	3	—	—	—	—	—	1	—	2×19	10.4
1965	19	1×6	5	6	3	2	—	—	1	1	—	—	—	—	9.5
1966	25	1×6 1×7	3	4	6	1	2	—	1	2	1	—	—	1×20 1×21 1×23	11.7
1967	13	1×6	3	2	1	—	1	—	2	—	1	1	—	1×32	12.5
1968	13	1×4	2	2	3	2	—	1	—	—	1	—	—	1×23	11.0

Table V. Individual and multiple nests and clutch sizes.

	1962	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*
Individual mean clutch size	7.6	9.2	8.0	8.9	9.3	8.8	9.0
Multiple mean clutch size	17	16.3	18.3	14.5	17.4	18.6	17.3
% of multiple nests	23	48	14	11	28	38	15

females, clutches never exceeded 12 eggs. Re-analysis of nests in Table IV according to this criterion is shown in Table V.

Brood size

Ducklings were classified in three age groups: Class I — tiny downies up to approximately three days old; Class III— those having most of their feathers, but not necessarily flying; Class II — all ages between Class I and Class III. Every duckling count included records of family and crêche grouping, of location and of the parent female's identity when known. Ducklings were counted on two days each week throughout the brood season and every day during the peak of this season. During the latter peak, counts were augmented by motor boat surveys along the whole length of the Swale channel. It was then possible, for limited periods, to differentiate between broods; so that tabulations maintained on this basis enabled the season's aggregate of ducklings to be deduced, i.e. the total number taken to saltwater nursery areas in any one season. Precautions necessary to obviate duplication probably gave aggregates slightly lower than actual numbers which reached nursery waters, but these errors were considered to be consistent. To assess further the incidence of multiple nesting, broods were separated according to whether they contained more or less than 12 ducklings. Data shown in Table VI refer to sample sizes of 290 and 294 brood days for Class I and Class II ducklings respectively. Wherever there was reason to believe that a group of ducklings might be a crêche, either from its large size or from marked disparity in the size of ducklings, the data have been excluded.

Apart from 1961 when the sample was comparatively small, Class II brood size in Table VI correlate well with Class I data. The percentage of broods greater than 12 ducklings, i.e. those assumed to result from multiple nests also show reasonable correlation with the sample in Table V. Both sets of data show the same

Table VI. Brood data for Class I and Class II ducklings.

	1961	*1962*	*1963*	*1964*	*1965*	*1966*
Mean brood size for all Class I broods	6.8	8.5	9.6	9.3	9.1	8.5
Mean brood size for Class I broods not exceeding 12 ducklings	6.1	6.5	6.7	7.2	7.8	6.9
% of Class I broods larger than 12 ducklings	6	20	27	25	14	17
Mean brood size Class II broods not exceeding 12 ducklings	8.2	6.5	5.2	6.8	7	6.2

Table VII. Dates for main aspects of breeding cycle.

	1961	*1962*	*1963*	*1964*	*1965*	*1966*
Start of laying	2/5	30/4	25/4	22/4	15/4	19/4
Peak of laying	22/5	29/5	12/5	26/5	24/5	23/5
Span of laying season (days)	60	59	65	80	90	78
Span of incubation season (days)	78	84	81	85	91	80
First brood	5/6	10/6	7/6	29/5	26/5	28/5
Peak number of ducklings on nursery waters	9/7	14/7	7/7	1/7	5/7	9/7

pronounced increase in the incidence of multiple nesting in 1963.

Timing of breeding phases

Incidence and duration of the main phases of the breeding cycle are shown in Table VII, in which the following terminology is used: *Start of laying:* date on which the first egg was laid, in the whole population. This was obtained either from nest records or by deduction from the appearance of the first duckling using previously derived data (Hori 1964a). *Peak of laying:* the date at which the majority of birds in the breeding population were laying, determined by deduction from the incidence of Class I ducklings. *Span of laying season:* the period between laying of first and last eggs by the population, extreme dates being determined by direct observation or deduction from Class I broods. *Span of incubation season:* the period during which females in the population were incubating.

Meteorological data collected at H.M. Meteorological Station at Grain, 8 miles NW. of the breeding area, were examined, but no satisfactory correlation was found between these and breeding success or any aspects of the breeding season included in Table VII.

Non-breeding adults

Recent suggestions have included the hypothesis that in some Shelduck populations a varying number of the mature adults do not attempt to breed every year (Young 1965). The basis for such suggestions is not clear, particularly the identification of breeding and non-breeding populations. A fundamental consideration is the ability accurately to differentiate between adult and immature birds. The ready assumption that this was possible by body plumage, bill shape and intangibles such as 'gravid appearance' has probably led to substantial errors in the past. Experience indicates that the only consistent method of identification is the wing pattern (Hori 1965).

The following counts were made in the Sheppey study area using techniques already described (Hori 1964a), to determine the breeding and non-breeding portions of the population:

i) Regular estimates of the total population during February, March and April to obtain a first estimate of the summer population and to determine the date when breeding and non-breeding populations separated.

ii) Estimates of the non-breeding population from mid-April to the end of May by prolonged observation at gathering grounds.

iii) Estimates of the potential breeding population by counts of 'communes' and territorial pairs, consisting entirely of adults, during the same period as (ii); with (ii) these estimates provide a first check on (i).

iv) As the non-breeding population, together with some failed breeders, made their moult migration before the majority of the adult population, counts of the bulk of the breeding population could afterwards be made with high accuracy at their pre-moult concentrations. Making allowance for part of the failed breeders, these estimates gave further verification of counts in (iii).

v) Estimates of nesting pairs were made to determine whether there was a substantial variation between these and the total of paired adults. They were based on: a) nest finding, which annually accounted for 20-30% of those estimated to be present; b) nest site identification by conclusive evidence of nesting, e.g. incubating birds hissing, adult females without down regularly entering holes, etc.; c) flight line observations and prolonged observation of territorial and commune birds as a check on (b) and to discover pairs using nesting areas which had not been searched; d) detailed duckling counts.

Table VIII gives data accumulated on nests. The number found includes all failed nests even though these might have been deserted during laying. The number identified includes all those estab-

Table VIII. Number of nests in relation to breeding population.

	1962	*1963*	*1964*	*1965*	*1966*
Estimated breeding pairs	70	73	65	115	147
Number of nests found	18	25	35	38	40
Number of nests identified	61	64	60	100	125
Proportion of pairs identified with nests	87%	88%	92%	87%	85%

lished beyond reasonable doubt plus those inferred from regular observation. Thus estimates of the total population of adult pairs showed close agreement with the total of nests identified in all years. On Sheppey, at least, there does not appear to be a substantial and varying proportion of the adult population which does not breed.

Population regulation

In the evolutionary time span, density dependent factors could account for the overall distribution of Shelduck. For example, Olney (1965) has shown this species to be overwhelmingly dependent on *H. ulvae* as a winter diet. Correlation between Shelduck distribution and habitat containing plentiful supplies of this mollusc is obvious for Western Europe and for the British Isles. For the Kent shore of the Thames estuary, Newell (1965) has shown the mollusc to be densely distributed in the black muds west of Whitstable, but to decrease sharply on approaching the clean sands of Herne Bay. This distribution corresponds precisely with the eastern limit of Shelduck distribution in Kent. Upstream distribution is limited by the virtual end of appreciable inter-tidal mudflats and the start of industrial development at Gravesend.

However, when local populations are examined in the shorter term, density dependent regulation does not appear to fit the observed facts. It seems, as one might expect intuitively, that a mechanism capable of determining dispersion does so rather coarsely, and that other factors control finer adjustments. On Sheppey the breeding population was far below that which the food supply could have supported. Even if it is argued that delayed density dependent regulation occurred so as to provide for the needs of winter flocks, direct observation suggests that the latter do not come near to taxing available food supplies. Whereas *Hydrobia* appear to be widely and fairly uniformly distributed through the mud of the inter-tidal zone, Shelduck group together during feeding. Two large flocks mass on each rising tide, ride the high water in packed rafts and then, as the tide falls, they exploit the tidal cycle of the mollusc.

From 1959 to 1962 the summer population experienced a stable phase with estimates of 220, 250, 270, 260 birds. The severe winter of 1962-63 brought heavy mortality and at least 5% of the winter population perished at this time. Heavy mortality was reported from other areas, for example a total of 400 corpses were counted on the Kent shore of the Thames estuary (*Kent Bird Report* No. 12, 1963) and Shelduck suffered heavily throughout the British Isles (Dobinson and Richards 1964). The heavy losses were undoubtedly accentuated by the species' narrow winter feeding ecology. The effect was discernible on Sheppey in the total summer population of 1963 which totalled 245, but it did not materially affect adult numbers; winter casualties must therefore have been predominantly sub-adults.

In 1963 an adult summer population numerically equal to the level which had come to be regarded as normal produced the largest number of ducklings ever recorded on Sheppey (Table IX). Again, a similar result occurred nationally (Hugh Boyd, pers. com.). The ability of bird populations quickly to restore their numbers after major depletion has often been noted (Lack 1954). The effect on Sheppey was a 'step' in the summer population of 1964 to 390 as the previous season's ducklings became sub-adult non-breeders. Further increase in summer totals, to 465 in 1965 and to 495 in 1966, occurred as the breeding population was augmented.

In 1963 the breeding population produced more than twice as many ducklings per pair than it did in 1962 or 1964. From Table VII it will be seen that the peak of laying was at least ten days earlier than usual yet the peak number of ducklings was reached at the usual time. This suggests that the early ducklings survived unusually well. The losses in the 1962-63 winter were thus more than compensated. In 1965 and 1966 the effect of the large number of ducklings born in 1963 became apparent in the adult population, and

Table IX. Duckling production per pair of the breeding population.

	1962	*1963*	*1964*	*1965*	*1966*
Estimated breeding population (pairs)	70	73	65	115	147
Total number of ducklings reaching nursery stage/season	245	515	243	285	244
Ratio, ducklings/breeding pair	3.5	7.1	3.5	2.5	2.0

duckling production per pair by the latter dropped progressively (Table IX). So, although external factors such as territory and nesting density, food supply and meteorological conditions were apparently constant, regulation occurred which was consistent with the size of the winter population. This widely different performance by a relatively constant breeding population suggests that density dependent regulating factors, for example food supply during the breeding season, territory and nest site availability, were ineffective.

Table V shows that individual clutches were large in 1963, but not uniquely so. This result was also corroborated in the histories of six birds known for at least three years (Table X). However, the Class I broods (Table VI) which, being only a few days old, should correlate closely with clutch sizes and are drawn from much larger samples, do not show any rise in 1963. Thus, while some individuals may have responded to the population check with larger clutches, this was not general throughout the population and this could not explain the overall increase in duckling output of 100% which occurred that year.

has also been suggested that hatching success would vary and be lower in the larger multiple nests because of the physical size of the clutch as well as accidental ejection and damage to eggs resulting from numerous females visiting nests. The latter could also disturb incubating birds to the extent that desertion might occur. In the Redhead, Williams and Nelson (in Weller 1959) regarded 'community' nesting as the most important single cause limiting production in Utah. Other investigators have reported evidence of widespread nest failure resulting from parasitism.

However, Shelduck breeding season social organisation is entirely different from that of most other ducks with, as already described, special provision for facilitating and encouraging gregariousness. So, although the behaviour is referred to as parasitic, it is considered that at the level witnessed on Sheppey it is actually advantageous to the population. Thus, disturbance during incubation was considered to be low in the Shelduck because of the parasites' precise synchronisaton of laying and the intra-specific tolerance observed. Synchronisation of laying dates within communes was ex-

Table X. Clutch sizes in individual females.

Female	*Clutch size*						
	1962	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*
AJ 62813	9	10	8	9	9	8	10
AJ 87943		12	8	8			
AJ 87909		12	10		10	11	11
AJ 87941		9	19*	10			
AJ 87908		14 (M)	8	10	12		
AJ 87904		14 (M)	17 (M)	12	10	9	13 (M)

Note: (M) indicates multiple nest
* indicates nest 'milked'

The present study does not support suggestions that there is a variable proportion of the adult population which does not breed in some years (p. 17) and which might therefore provide an 'emergency reserve'. However, commune organisation could be a possible regulating mechanism. The latter may produce over concentration with regard to available nest sites and it encourages multiple nesting. Effects on individual birds are difficult to measure, but studies of American diving ducks have suggested numerous possibilities. Weller (1959) and others found that parasitic egg laying limited the clutch size in parasitised nests; presumably by depressing ovulation. It

tremely precise by comparison with the wide span of such dates through the population (Table VII). The span of laying in the whole population varied from 59 to 90 days, whereas the span in nests known to belong to the same commune did not exceed 29 days. This is illustrated by the dates for the first eggs, for example: Commune A — 1.5, 4.5, 15.5, 17.5, 18.5; Commune B — 2.5, 7.5, 12.5, 14.5, 14.5, 18.5; Commune C — 17.5, 23.5, 25.5, 5.6; Commune D — 12.5, 16.5, 18.5, 22.5, 27.5, 30.5; Commune E — 17.5, 23.5, 26.5, 26.5; Commune F — 10.5, 20.5, 20.5, 29.5. Also, additional eggs were never found in multiple nests after incubation had been in progress for more than four

days. The requirement for precise synchronisation, to prevent incubation interference, may help to explain the remarkably long period between the return of breeding pairs to the home range and the laying of first eggs in this species; approximately nine weeks. This period contains considerable group and inter- and intra-pair display which could achieve social stimulation. Similarly, egg wastage by dump nesting which is common in American diving ducks and which has been recorded in Shelduck, was only observed once in the present work. There appeared to be no difference in hatching success between individual and multiple nests for the clutch sizes which were given in Table I (i.e. up to 22 eggs). Although larger multiple clutches than this occurred, nest failures, etc., precluded measurement of hatching success in these. It is extremely doubtful, however, that the clutch of 32 recorded in 1967 could have been hatched with comparable success. This was the only nest recorded which resembled a dump nest, and it was robbed of 20 eggs just after incubation started.

When we consider complete nest failures, the multiple nests have an advantage. Thus in the four years 1963-1966, only 28% of 25 multiple nests were lost as compared with 47% of 88 individual nests. Further, multiple nesting might be more advantageous in some years than others. Situations were apparent where over concentration caused by the communes resulted in relatively few satisfactory nest sites being available for certain communes. In these situations multiple nests using the best sites would be advantageous, whereas appreciable nest loss could occur in marginally satisfactory individual sites. Such considerations are not merely concerned with the clutch. The chances of a predator noticing one very brightly coloured female's visits to a multiple nest over a six-week period are less than if the equivalent number of females were visiting single nests. Thus the use of multiple nests could be an important factor in limiting risks. Many instances were recorded where communes returned to a nesting locality to find hay and straw sites considerably changed from the previous year, for example in 1963 most haystacks had been removed before egg laying began. In some years birds went on searching for new sites well into May. Ultimately some laid in extremely precarious situations, for example under a single paper meal bag, or in rabbit and rat infested haystacks. Multiple nesting might also be advantageous because incubating females in such cases were experienced birds. Conflicting tendencies of commune association and incubation could cause higher desertion rates amongst birds breeding for the first time in individual nests. The latter effect may have been responsible for an apparent carelessness in laying and incubation which was detected in some years, but not in others.

The outcome of multiple nesting in Shelduck is subject to dynamic interaction of many factors. When the population was being regulated upwards in 1963, an unusually high proportion of the breeding population used multiple nests (Table V). It would appear therefore that in this population the advantages of more secure nest sites, stronger incubation attachment and the possible advantage of larger duckling groups more than outweighed the disadvantages of multiple nests. The hypothesis suggested by this study is that multiple nesting is the instrument by which commune organisation achieves regulation. This could have resulted from the fortuitous shortage of nesting sites, but could also occur by influencing the conflicting tendencies in adult females to incubate their own clutches or to assume parasitism and remain in full time association with other commune members. This could function by stimulation of the pituitary whose action has been shown by various studies to control the breeding drive (Nalbandov, Hochhauser and Dugas 1945). Principal contributors to pronounced regulation would be those commune pairs which vary their annual behaviour between parasitism and separate nesting as distinct from those adult females which incubate every year. The nature of the former group has not yet been discovered, but it seems possible that it may consist largely of the younger inexperienced birds.

Thus in a year when the population needs to be regulated upwards the commune bond would be strong and would induce many females to multiple nesting resulting in increased overall hatching success. Conversely, in seasons when the commune bond was weak, more females follow the tendency to incubate their own clutches and therefore use marginally satisfactory nest sites or lose clutches or ducklings in the nest through inexperience.

Regulation of the type suggested would require that adult females initially measured, or received stimuli from the size of the winter population or from the

total of non-breeding and breeding birds in the summer population. Wynne-Edward's (1962) suggestion that the moult assemblies could affect such an epideictic function seems rather unlikely since for most of this time the birds are in their eclipse plumage and flightless. More probably the origin of the migration relates to a combination of ample supply of their specialised diet and the protection which an area like the Knechtsand affords conspicuously coloured flightless birds. Moreover the relevant reduction in population witnessed in this study had occurred in the winter immediately preceding the 1963 breeding season.

It is impossible at the present time to demonstrate when epideictic conditioning occurs. It must be remembered that there are indications that other factors may be involved, particularly nest site shortage and early nesting in 1963. But it is worth recording the widespread and intense group display in winter flocks on tidal water before the separation of breeding and non-breeding flocks which characterises the beginning of the breeding season. These displays can be seen during bright weather from late December to early February and often attract attention by the volume of female vocalisation which is greater than at any other time of the year. Vocalisation consists of the female's repulsion note, uttered whilst she performs inciting displays. The most important aspect of these displays is that they are of an inter-pair nature. They are thus completely unlike winter display in other species of anatidae. Pairs threaten each other and advance and retreat with females violently inciting as though defending territory, but in fact they may be floating fifty yards from the shore. The whole display is of the same nature as that seen early in the breeding season in groups on the fresh grazing marshes and in communes, but is then less intense.

Acknowledgements

I am indebted to Dr. G. M. Dunnet and P. Ward for information on colour marking of ducklings, to Dr. R. C. Newell for information on distribution and habits of *Hydrobia ulvae* and to K. H. Hyatt for help with analysis of faecal material.

My grateful thanks are due to landowners, farmers and farm workers on the Isle of Sheppey for access permission and assistance of all kinds. I am particularly grateful to L. Eels for help in locating nests and to K. C. Cooper for frequently ferrying me along the Swale channel.

Professor V. C. Wynne-Edwards and Hugh Boyd kindly read and made many helpful comments on the first draft of this paper and I am especially grateful to the latter for encouragement and help throughout the work. Finally, I wish to thank Dr. G. V. T. Matthews for numerous improvements and suggestions, and much active help in producing the final text.

Summary

During the breeding seasons of 1964-66 inclusive, studies of social organisation, breeding biology and population dynamics were made on the summer population of Shelduck on the Isle of Sheppey, north Kent. Most breeding pairs change their feeding habits to food available in the territory in the spring instead of continuing the narrow highly specialised winter feeding ecology. Territorial occupation appears to be conventional as far as food supply is concerned. Territory may be a dispersion mechanism, but the simultaneous existence of a social organisation which causes nest grouping throws doubt on the effectiveness of territory in this respect. It is thought to be important on Sheppey in maintenance of the pair bond.

Commune organisation, i.e. the persistent grouping of breeding adults is described in relation to territorial occupation, incubation period, brood season and moult migration. The commune bond lasts at least from the end of March to moult migration. Multiple nesting was considered to result principally from this form of organisation. Such nesting was not disadvantageous to the species, making no difference in hatching success and reducing the number of complete clutches lost.

Histories of individual breeding birds are given in detail to illustrate home range usage, tenacity of attachment and individual behaviour and success in the brood season. The identity of those adults which attend crêches is demonstrated. Brood attacks were considered to be one of the basic mechanisms by which adults break the brood tie in order that they can make the moult migration.

Habitat and population changes during eight years' field work are discussed. A relatively constant adult breeding population produced a very varied annual duckling output and that when the population was severely depleted, immediate improvement of breeding success followed. It is not considered that a variable proportion of the adult population fail to breed annually. Commune organisation operating through the multiple nesting habit is suggested as being the principal regulating mechanism.

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Nesting of the Black Swan at Lake Ellesmere, New Zealand

K. H. MIERS and MURRAY WILLIAMS

Introduction

Black Swans *Cygnus atratus* were introduced to New Zealand last century. Thompson (1922) reported the first birds were introduced by the Nelson Acclimatisation Society 'in, or just before, 1864'. The Canterbury Acclimatisation Society (now the North Canterbury Acclimatisation Society — N.C.A.S.) released four birds on to the Avon River in Christchurch in 1864 and in the following year, the Christchurch City Council liberated a further 13 pairs in an effort to control watercress in the river (Lamb 1964). Seventy birds were liberated in the Southland and Otago Acclimatisation Society districts prior to 1870, the largest liberation being 42 on to Kaitangata Lake, Otago, in 1867 (Drummond 1906b). The only North Island records prior to 1870 were Sir George Grey's liberation of 'some' on Kawau Island in 1864 and the Auckland Acclimatisation Society's liberation of four in 1867 (Thompson 1922).

Within a few years, considerable numbers were seen hundreds of miles from liberation sites. Drummond (1906a) reported Christchurch birds making 'long and rather notable migrations to the wild country on the West Coast, and to Otago, and even Marlborough' in 1867, and Lamb (1964) recorded 'In September 1867, thirty-three swan eggs were collected from nests found floating on Lake Ellesmere. There the swans were particularly numerous, and large flocks were continually being seen by sportsmen'. Lamb also quoted a letter dated March 1871, which makes mention of 300 or more swans in a mob at the mouth of the Halswell River. The success of establishment may be judged from the comments of Kirk (1895) who remarked that the Black Swan 'sometimes occurs in thousands as in the great lagoon at the entrance to the Opawa River (Marlborough) . . . Its simultaneous appearance in so many localities between 1865 and 1868 proves that it must have been a spontaneous immigrant and that its naturalisation is not due in any large degree to its having been introduced by man'. Although no similar comment can be found in early literature, Kirk's hypothesis of spontaneous immigration is not unreasonable despite the remarkable coincidence involved. The sudden appearance of large numbers of the Australian White-eye *Aythya australis* in 1867 (Oliver 1955) adds further support to this idea. However, growth of the swan population was very rapid. By 1900 the species was common throughout New Zealand and Thompson (1926) remarked that 'it is now so common that it is often difficult to make people believe that it is not a native'.

Today the species is to be seen on all major waterways, occupying a wide variety of habitats, ranging from extensive inland harbours (for example Kaipara, Tauranga) to lakes (with particularly heavy concentrations on Lakes Whangape and Ellesmere) and small coastal lagoons.

On Lake Ellesmere, swans quickly increased in numbers and were shot as game from 1875. The very large numbers in the early 1900s resulted in considerable damage and fouling of surrounding pasture. As a means of control, the N.C.A.S. were, in 1915, granted statutory authority to collect eggs, a practice that has continued to the present day. It is the policy of the Society to limit the number of cygnets hatching around the lake to an average of 20,000 per year. The figure fluctuates according to the success of the previous year's breeding and shooting season. The aim of this study was to assess the management programme and to gather details on the productivity of the Ellesmere swan population and factors likely to affect that productivity.

Study area

Lake Ellesmere (43° 47′ S, 172° 30′ E) lies on the coast to the south of Banks Peninsula (Figure 1). It is 14 miles long, 7½ miles wide at its widest point with an indented margin of approximately 58 miles, and, at a height of 3.5 feet above mean sea level, its area is about 60 square miles. The North Canterbury Catchment Board controls the level and is required to open the lake to the sea when it reaches 3.45 feet above mean sea level in summer and 3.7 feet above mean sea level in winter. Occasionally, as in 1959 when stormy weather prevented drainage to the sea, the lake may rise as high as 7.0 feet above mean sea level.

Ellesmere is shallow, with approximately 80 per cent. of the bed lying just below mean sea level and with only a

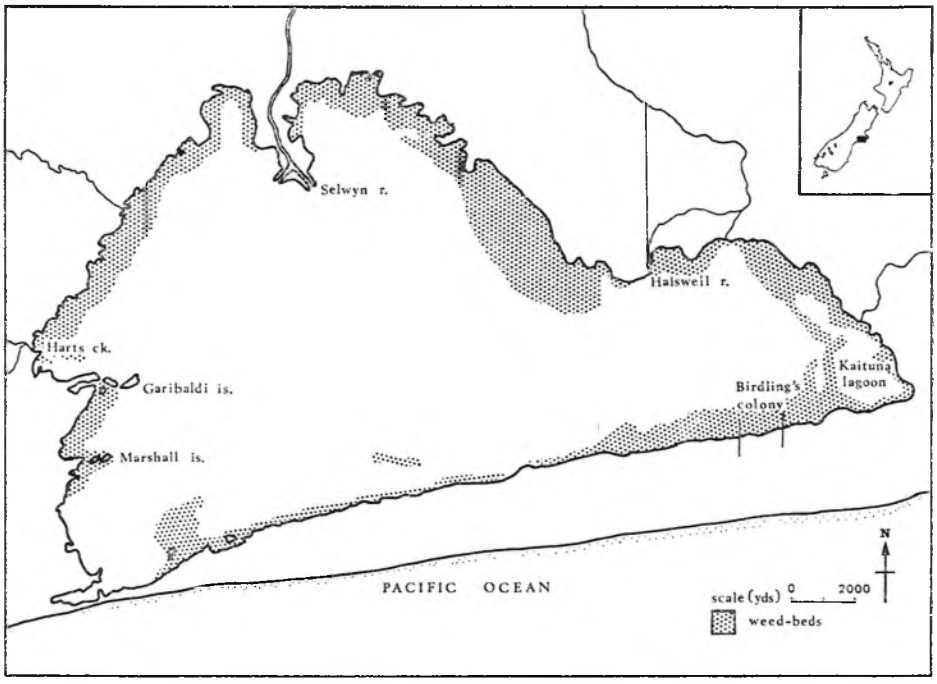

Figure 1. Lake Ellesmere showing main weed-beds and place names mentioned in text.

few channels deeper than 7 feet below mean sea level. When the lake is low the sea may enter through the drainage channel during high tides. This, with water interchange through the gravel banks during tide cycles and waves breaking over the spit at the western end during storms, maintains the lake's salinity. Fresh water enters through several rivers and canals, of which the Selwyn River is the largest and most important.

The main feeding areas for swans are inshore of a line from the Selwyn River mouth to the Marshall Islands. Smaller but important weed beds lie west of the Halswell River outlet and in and adjacent Kaituna Lagoon. Weed beds consist mainly of *Ruppia spiralis* but near freshwater influence, particularly Harts Creek and Selwyn River, *Myriophyllum elatinoides* occurs. The *Ruppia* beds are however the more extensive and the more important food source.

Breeding is concentrated on Birdling's Flat (Figure 2) at the eastern end of the lake although pairs are to be found scattered around most of the lake margin and on Garibaldi and Marshall Islands. Current management practice is aimed at preventing breeding in all areas other than on Birdling's Flat.

Materials and methods

At the commencement of this study on 13th September 1960, there were 5,322 active nests in the Birdling's colony; and of these 1,050 were marked with wooden pegs. Lake Ellesmere was at that time 3.6 feet above mean sea level and the greater part of the colony was at risk of being flooded. Because of this, and the immediate necessity of recording nesting details, the sample was pegged in groups of 100 to 200 nests. Each group was judged representative of a particular area and contained approximately one-fifth of the nests in it. The areas were however selected in order to give a cross-section of ground-type, i.e. high and low ground, marginal or central within the colony. The pegged nests were visited daily till the breeding season end in December.

The 1961 sample of 650 nests was pegged on 11th September when the colony contained 5,160 occupied nests. The method of sampling differed from that used in the previous year in that nests were pegged in groups of ten. Each group was chosen in a random manner by throwing a tennis ball over one's shoulder. The nest closest to where the ball landed was taken as the first of the group. Individual nests within each group were pegged following a systematic procedure. After the first nest was marked,

the nearest adjacent nest was pegged; the 'nearest adjacent unpegged nest' rule being followed until the sample was complete. At the date of pegging, many clutches were complete and the sample was restricted to nests containing one or more eggs.

Details of each clutch were recorded daily between 09.30 hrs. and 13.30 hrs., following a set route through the colony, commencing at its western part. In the second year data were usually completed by noon. Afterwards, details of each nest were transferred from record books to coded, edge-punched cards, from which most analyses were made.

Many of the pegged nests were used more than once during the course of the season, with the result that details were gathered from 1,477 nests in 1960 and 821 nests in 1961.

Lake Ellesmere reaches a height of between 3.5 and 4.0 feet above mean sea level about three times a year (Figure 3)

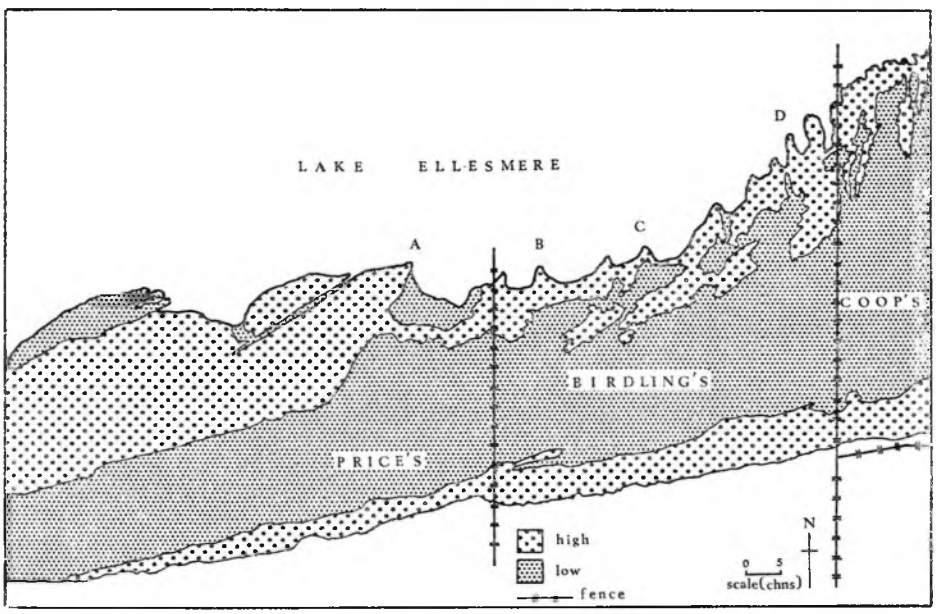

Figure 2. Nesting area showing land contour and sample areas.

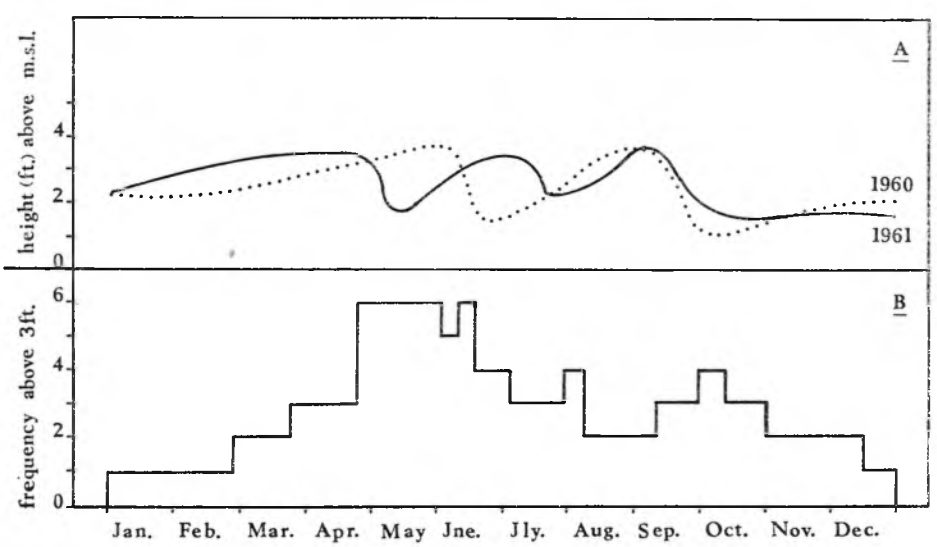

Figure 3. Fluctuations in the level of Lake Ellesmere throughout the year (based on figures supplied by the North Canterbury Catchment Board).

and swans usually breed just after the final winter peak. During July, adult swans begin to gather off the Birdling's breeding ground and by the end of the month, many go ashore to spend most of the day near their future nest.

Breeding season and dispersion

Nests (*See Plate II, p. 33*)

First nests were established on points of relatively high ground jutting into the lake (Figure 2, points B, C, D) and later around the margin on suitable high ground up to 150 yards from the water. Within a fortnight, most of the area was occupied and there was gradual occupation of high ground to the west on Price's property (Figure 2, point A).

Nests are a miscellany of shape and size depending on availability of material. Those along the lake edge, where there is ample nest material, mostly wind-driven *Ruppia* and other debris, are very large. The bird simply stands in one spot and heaps material up about it, gathering all within reach. Conversely, those further inland where nest material is sparse and consists mainly of *Salicornia australis* are little more than ringed depressions with a characteristic rosette of denuded, bare ground around them, caused by birds plucking every available stem of *Salicornia* within reach. Stealing of nest material occurs, particularly where nests are close together, and abandoned nests are quickly incorporated into adjacent ones. Stealing also occurs just prior to hatching; the cob of a pair with eggs about to hatch will gather considerable extra material and add it to the nest. Abandoned nests (without eggs) or those vacated upon successful hatching may become occupied by new pairs.

Practically every rush *Juncus* sp., tussock *Poa caespitosa* or shrub *Olearia virgata* becomes the focal point of more than one nest. A rush or tussock a foot high can be an effective barrier between nests as close as two feet apart. As the distribution of these plants is discontinuous and patchy, except for rushes at the western end of Price's property, so the distribution of nests tends to involve dense aggregations surrounded by less densely packed nests. This is especially so on Birdling's property.

Nest spacing

Measurements of spacing were made to the nearest foot and from centre to centre of nest bowls. Data refers to the nearest adjacent nest and was collected three days after pegging in both years.

In 1960, when large blocks of nests were pegged, those on the edge of the block may have been closer to an unpegged nest than to a pegged nest. The method of sampling in 1961 ensures that the nearest adjacent nest is pegged.

Nest spacing varies throughout the season. Once hatching commences, considerable destruction of vacated nests, rebuilding by re-nesters and re-occupation of vacated and successful nests occurs. Measuring immediately after peak laying and before hatching ensures that these complicating factors are minimized and correspond to peak occupation of nests.

Mean distances between nests differ markedly in the two years; being 10.0 feet in 1960 and 7.9 feet in 1961. While 93% and 94% of nests in 1960 and 1961 respectively were spaced within 20 feet of another nest, 7% in 1960 and 38.3% in 1961 were spaced at five feet or less. This difference is significant and is probably a reflection of lake level affecting availability of nesting ground. The implications of this are discussed elsewhere.

Figure 4 gives details of lake level fluctuation and the spacing of nests. In 1960 when laying commenced the lake level was at 2.5 ft. and reached 3.0 ft. on about 19th August. On this date and later, much of Birdling's area was under water and unsuitable for nesting. Many swans therefore nested in the adjacent Price's area where there was ample room and less competition. Consequently, spacing was greater (mean distance 10.0 ft.) than in the following year when conditions were in marked contrast. In 1961 the lake was at about 2.5 ft. when laying began. It was, however, receding and reached a low point of about 1.9 ft. on or about 15th August. Throughout the weeks of peak egg laying until approximately 9th September the lake stayed below the 3.0 ft. level. For the greatest part of this time the traditional Birdling's area was available for nesting and the birds made use of the opportunity. Since the lake was rising quite sharply from about 25th August through to 18th September more and more birds tended to pack on to the limited high grounds of the Birdling's lake margin. Consequently, nests were closer than in 1960 (mean distance 7.9 ft.) with greatest number of nests being spaced at or less than 5 ft.

Laying

Laying usually begins in the first week of August but may start as early as mid-

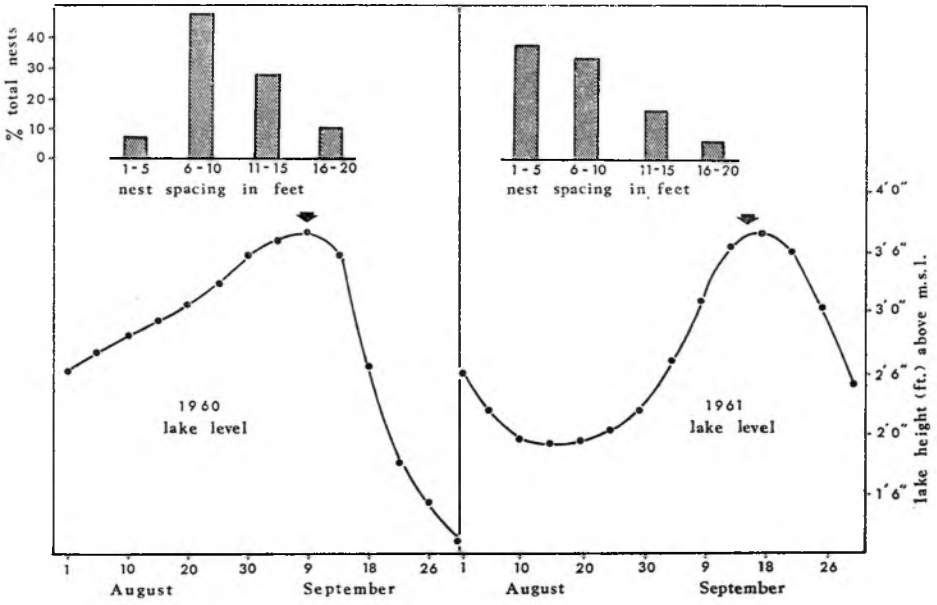

Figure 4. Lake level fluctuation during period of peak nesting. Arrow indicates date on which nest spacing was measured.

Table I. Laying period of clutch in days.

Clutch size	*Days*																*Number of clutches*	*Mean days per egg*	*Mean days per clutch*	*S.D. days per clutch* ±
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*				
2	2	5	8	2	.	1											18	1.4	2.8	1.1
3			7	11	11	5	2										36	1.5	4.5	1.1
4			1	5	10	47	27	11	5	2	2						110	1.6	6.5	1.1
5				1	2	10	28	83	20	13	4	1					162	1.6	8.0	1.2
6					1	2	13	30	50	19	6	3	1				125	1.5	8.8	1.2
7							3	8	8	9	4	1	.	1	1		35	1.4	9.5	1.8
8							1	1	3	1	2	2	.	.	1		11	1.3	10.3	2.1
9								1	.	.	.	1	.	.	.	1	3	1.3	12.0	—
10										1	.	1					2	1.1	11.0	—
																	502	1.5	7.7	2.1

July (as in 1957) or as late as the last week of August (as in 1959 following heavy winter mortality). In the two years of study, first eggs appeared on or about 4th August and first clutches hatched on 17th September in 1960 and on 18th September in 1961. Laying usually ceases in early December.

Breeding at Lake Ellesmere is markedly seasonal, whereas in more northern parts of New Zealand, such as Lake Whangape, downy cygnets may be seen in most months of the year.

The number of new nests increases rapidly during August, reaches a peak during the first week of September then tapers gradually to the beginning of October when a smaller secondary peak occurs. Thereafter numbers drop rapidly. This secondary peak is made up of late nesting birds supplemented by re-nesters.

Eggs are laid at intervals of about 1.5 days although 33 (6.5%) of 502 clutches for which the laying period is known, were completed at a rate of one egg per day or less. Table I gives details of the laying period for 502 clutches. The mean clutch size for the sample is 5.1, the clutch being completed in 7.7 days. As the mean clutch size for the overall study was 5.4 (see below), a correction gives 8.1 days as the mean laying period of the average clutch. There is a tendency for small and large clutches to be laid at a faster rate than intermediate clutches. However, the difference is not statistically significant.

Breeding rate

Clutch-size

For the purpose of this study, a clutch was considered complete when, after an

interval of six days, no additional eggs were laid. The maximum number of eggs appearing in the nest up to that time, making allowance for any losses during laying, was taken as the true clutch-size. The mean clutch-size was 5.4 eggs (S.D. ± 1.7) based on a sample of 1790 clutches known to have been completed. Their distribution is given in Table II.

The mean differs slightly from the figure of 5.9 obtained by Cutten (1966) from a sample of 225 nests of the Ellesmere population in 1963, but agrees closely with Frith's (1967) 5.5 for 407 nests at Canberra. There is however a large difference from the figures of Lavery (1964) who obtained a mean of 4.5 eggs from 187 nests in Queensland and Guiler (1966) who recorded 4.4 from Tasmania.

Table II. Distribution of clutch-size.

Number of eggs	1	2	3	4	5	6	7	8	9	10	11	12
Number of nests	5	39	136	277	501	449	233	97	27	21	4	1

Total: 1790 *Mean:* 5.4 S.D. ± 1.7

Clutch-size is however dependent on the condition of adult birds following the winter months. In 1959, following a heavy winter die-off due to starvation, swans did not begin breeding until late September, and clutch-size was significantly lower with a mean of 4.3 eggs. Similar results were obtained in 1968.

The range of clutch-size is similar to that of Cutten (1966) but higher than that reported from Australia. Two nests, one of 13 eggs and one of 14 eggs, were located during this study, but both failed to hatch any young. Because of the zeal with which pairs guard their clutches, it is considered unlikely that an interloping female would have the opportunity of dumping eggs in or stealing eggs from other occupied nests. The larger clutches recorded here are thus considered as laid by one bird.

The size of clutches completed during the initial egg-laying peak in late August/early September was 5.60 (S.D. ± 1.54) while those completed during the secondary peak in early October were smaller with a mean of 5.17 (S.D. ± 1.23). The difference between means is significant (standard error = 0.083) and is caused by smaller clutches being laid by re-nesting and late nesting (usually young) birds (Brakhage 1965, Sowls 1949, 1955).

Egg dimensions

Cutten (1966) recorded the mean egg size for Ellesmere swans as 104.1 × 67.2 mm. with a range of 87.2 — 114.0 × 58.0 — 71.2 mm. These figures are very close to those given by Frith (1967) at a mean of 104.0 × 67.0 mm. and a range of 96 — 115 × 60 — 73 mm. for Canberra birds. However, both these authorities have figures considerably lower than those of Guiler (1966) whose Tasmanian birds had eggs with a mean of 106.9 × 69.8 mm. and a range of 98.0 — 118.2 × 65.2 — 79.2 mm. Unfortunately, standard deviations are omitted from all of these works.

Incubation

Incubation period is here defined as the time (in days) elapsing between the completion of the clutch and the hatching of the last egg. The last egg laid is usually the last to hatch but this is not always so.

Records of 495 clutches (Figure 5) give a mean incubation period of 36.4 days (S.D. ± 1.7 days). There was no significant difference between the two breeding seasons and records from both years are combined. The range of 32-43 days was greater than expected and cannot be statistically correlated to differences in clutch-size although small and large clutches tend to be incubated longer than clutches near mean size (5.3 eggs for this sample).

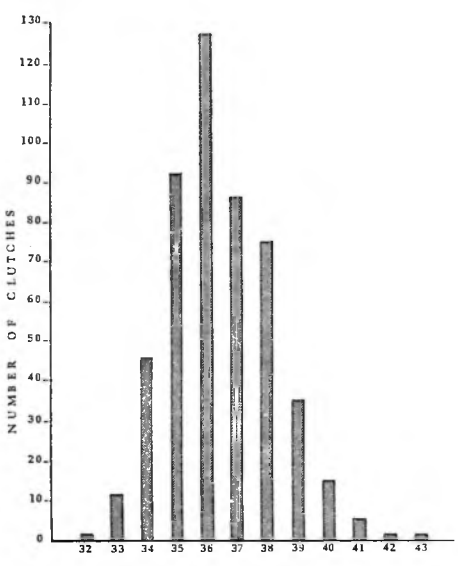

Figure 5. Distribution of incubation periods of 495 clutches.

Soper (1960) reported an unusually long incubation period of 44, perhaps 45, days for a pair of Black Swans at Lake Hayes, Otago. Soper's account indicates unusual behaviour as the cob never sat and both birds often left the eggs unattended for 1-2 hours. This behaviour at Lake Ellesmere would almost certainly have resulted in eggs being predated by Black-backed Gulls *Larus dominicanus*.

Black Swan incubation periods are recorded by several authorities. Delacour (1954) gave 34-37 days, Frith (1967), 39.7 (35-45) days from 44 clutches, while those from captive birds in the northern hemisphere are similar, for example Japan, 33-39 days (Kikkawa and Yamashina 1967), Wildfowl Trust, U.K., 36 days from 12 clutches (J. Kear, pers. com.). Guiler (1966) recorded 42 ± 1 days but remarked that some eggs of the clutch were incubated up to four days longer than the last egg laid. In his summary and abstract, Guiler gave an (undefined) incubation period of 39 ± 2 days.

Frith (1967), like Guiler, considers effective incubation to commence before the laying of the last egg of the clutch. Examination of a small sample of clutches of four or more eggs shows clearly that the incubation period is fairly constant for the first, second and penultimate eggs (Table III). The difference in incubation periods between the last two eggs (0.6 days) is not significant statistically but it does indicate that incubation may commence with the laying of the penultimate egg. Incubation is shared by the sexes, a feature apparently unique amongst swans (Delacour 1954).

Hatching

All eggs hatch within a 24-48 hour period and although the last egg laid is usually the last to hatch, this is not always so. First eggs hatched 17th September 1960 and 18th September 1961. The number of eggs hatching rises very quickly, reaching a peak in early October. Although hatching commenced on roughly the same day in both years, the peak in 1961 was about a week behind that of 1960. The number of eggs hatching drops off very rapidly but rises to the secondary peak in mid-November. This peak was considerably lower in 1961 than 1960 (Figure 6). Hatching was almost completely finished by the end of November and only exceptionally (for example in 1959) does hatching continue into December and January.

Breeding success

Details of overall nesting success are presented in Table IV. Successful nests are defined as those hatching one or more cygnets. Unsuccessful nests are those from which no birds hatched and include those abandoned during incubation or destroyed while laying was still proceeding and before incubation had commenced. Nests occupied but abandoned before eggs were laid are not included.

Including all nests in both years, there was a 67.3% hatch of eggs, giving a mean hatch per nest of 3.62 cygnets. There is, however, a considerable difference in mean hatch per nest figures for the two years. When breeding pairs number approximately 5,500 such a variation accounts for a difference of almost 4,000

Table III. Incubation period for different eggs of a clutch.

	First egg	*Second egg*	*Penultimate egg*	*Last egg*
No. of clutches	46	44	47	47
Total days incubated	1622	1562	1672	1701
Mean incubation period (days)	35.3	35.5	35.6	36.2

Table IV. Overall nesting success.

		1960	*1961*	*Both years*
Total nests		1477	821	2298
Successful	— number	1247	543	1790
	— per cent.	84.4	66.1	78.0
Unsuccessful	— number	230	278	508
	— per cent.	15.6	33.9	22.0
Total eggs		7725	4618	12343
Total hatch	— number	5714	2594	8308
	— per cent.	74.0	56.2	67.3
Mean hatch per nest		3.87	3.16	3.62

cygnets hatching. If 3.62 cygnets per nest is taken as the representative figure, close to 20,000 cygnets are hatched annually from the Birdling's breeding ground.

Reasons for failure of nests were categorised as follows: nests in which eggs were laid but not incubated (clutches may or may not have been complete), nests lost because of flooding, nests predated and finally those abandoned during incubation (mostly infertile or dead embryos). Non-incubated and abandoned nests comprised a remarkably constant percentage of total nests over the two years — being an average of 2.9% and 4.7% respectively. The lower nesting success in 1961, however, was due almost entirely to the effects both direct and indirect of flooding. No nests were flooded in 1960 but 11.3% of total nests were lost for this reason in 1961. Losses due to predation increased from 8.2% to 14.4% of total nests. The Black-backed Gull is the only significant predator and a small breeding colony of

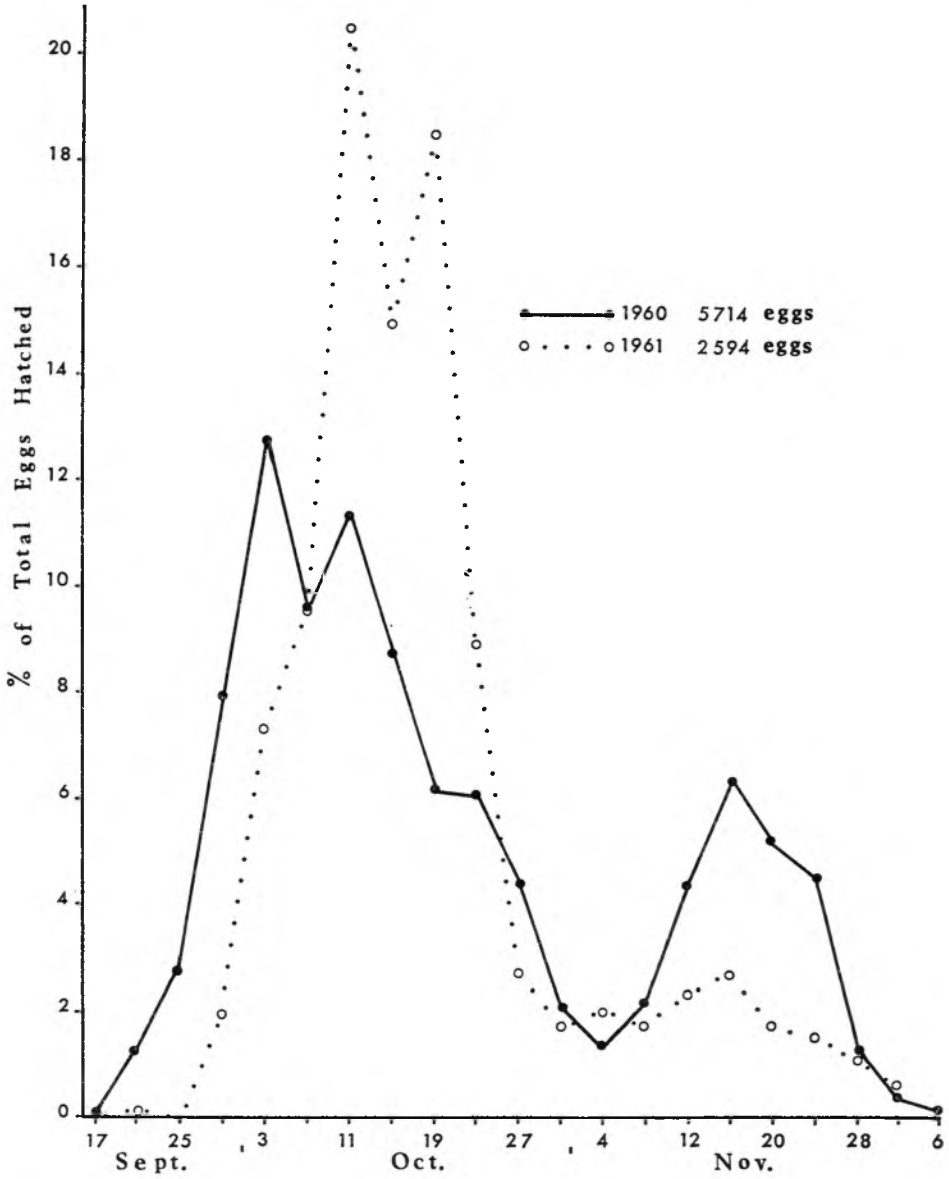

Figure 6. Distribution of hatching with time. Note the difference in the secondary peaks in the two years, illustrating the effect of flood waters on re-nesting.

80 — 100 pairs is located less than two miles north-east of Birdling's Flat. The rising floodwaters and the subsequent large number of nests abandoned allowed many gulls the opportunity to specialise on eggs as a food source.

Figure 2 shows the four areas in which nests were pegged. Predation was greater on the margins of the colony (points A and D) than in the centre (points B and C). In 1960 predation caused the loss of 11.8% of total nests marked in areas A and D as opposed to 4.6% in B and C. The 1961 figures were 18.0% and 10.8%.

Success may also be related to nest density. The proportion of unsuccessful nests was significantly greater amongst those spaced up to five feet apart (26%) than amongst those in the modal group spaced six to ten feet apart (18%). Amongst the more distantly spaced nests, the percentage of unsuccessful nests shows little variation from the mean of 19%. The figure of 22% for nests spaced 31-35 feet apart is not significant as only nine nests are involved.

Clutch-size and nesting success cannot be related because of the obvious complication that many nests are lost before the clutch is complete, and unless incubation has begun, there is no positive way of knowing if all eggs have been laid.

Discussion

Lake level appears to be one of the most important factors in the ecology of the Black Swan at Lake Ellesmere. Not only does the level determine the food availability but it has a significant effect on breeding success both at the nesting and brood stages. This study suggests lake level, not always acting of its own accord but in combination with other agencies such as predators, Man's management practices, etc., determine such factors as the start and duration of the breeding season, nest density, nest and egg destruction, the number of birds likely to re-nest, and therefore the overall success.

Frith (1967) concluded the breeding season of Black Swans in Australia was controlled by fixed annual factors although the species had the capacity to breed at any time should conditions prove suitable. The onset of breeding varies from place to place but in all cases is related to the wet season and the availability of suitable water areas. There is evidence to suggest that water-levels are a factor in the timing of the breeding season in New Zealand. In the Waikato district of the North Island, breeding extends over six to eight months of the year but with a well defined start to the season in June. Water-levels in the lower Waikato River valley are stabilised to an extent by the activities of hydro-dams on the Waikato River. Swamps and lakes reach peak levels in June and high levels are maintained by the dams well into the summer. (R. T. Adams, pers. com.). At Lake Ellesmere, breeding follows closely the lake level's winter peak. The rivers flowing into the lake quickly dry up in summer and the lake level drops rapidly. Here the nesting season is considerably shorter than in the Waikato and water levels may be a factor influencing the length of the season. Water-levels could also be an important factor in fixing the onset of laying in Tasmania three to four weeks earlier than at Lake Ellesmere.

High water-levels can have quite a different effect on the length of a breeding season. Depending on the time at which floodwaters invade the nesting ground, the breeding season may be shortened by the prevention of large-scale re-nesting. Figure 6 shows considerably less re-nesting to have taken place in 1961 and this is considered to be the result of floodwaters invading the colony at a time when most nests were at least two weeks incubated and early nests almost ready to hatch. The ability of a female to lay more eggs the same season is probably lost very soon after the completion of the clutch. Destruction of nests once incubation had commenced meant that these birds would not re-nest. The small re-nesting peak in 1961 therefore comprised those already late nesting birds whose nests were destroyed before egg-laying had ceased. A period of three to four weeks appears to elapse before re-nesting occurs.

The influence of lake level on nest spacing has already been illustrated. The N.C.A.S. management programme of deterring swans from nesting beyond the confines of Birdling's Flat must play a part in determining nest density, the effect being more pronounced in years of high lake level when suitable nesting space is limited. High nesting density can affect nesting success in various ways as illustrated by the results of breeding in 1961; aggressive encounters between birds nesting very close together may cause abandonment of the nest and clutch; nest spacings influence predation levels. The lower nesting success of 1961 is therefore causally related to a high lake level in the middle of the nesting season.

Acknowledgements

It is a pleasure to thank Messrs. H. McAllum, T. A. Caithness, C. D. Roderick, J. O'Brien, P. Morrison, and D. Arthur of the Wildlife Service and Messrs. L. Hoff, V. Henderson and D. Wright of the North Canterbury Acclimatisation Society for their assistance to the senior author in the field; and Mrs. Helen Morrison and Mrs. Lorraine Tietjens for their help in analysing of data. We wish to record our gratitude to Dr. G. M. Dunnett and our Wildlife Research Section colleagues for helpful criticism of the manuscript and constructive comment.

A considerable debt of thanks is due to the North Canterbury Acclimatisation Society whose willing assistance at all times made this study possible.

Summary

A total of 2,298 nests of Black Swans *Cygnus atratus* at Lake Ellesmere, New Zealand, were studied during the 1960 and 1961 breeding seasons. Systematic egg collection begun in 1915 has concentrated nesting at the eastern end of the lake. Occupation of the breeding ground starts in late July following the lake level's winter peak. Higher ground along the lake margin is occupied first. Birds nesting later are forced to utilise lower, more flood-prone land on the margins of the colony. Nests were significantly closer together in 1961, a reflection of lake level affecting the availability of nesting ground at the time of occupation. Egg laying is markedly seasonal, in contrast to more northern parts of New Zealand, in the first week of August, reaching a peak in late-August early-September, followed by a secondary peak (mainly re-nesters) in early October. Mean clutch size of 1,790 nests is 5.4. Mean incubation period of 495 clutches is 36.4 days. Effective incubation may commence with the laying of the penultimate egg. All eggs hatch within a 24 — 48 hour period, the last egg laid usually being the last to hatch. Successful nests, those hatching one or more cygnets, comprised 78.0% of nests studied in the two years and hatched 67.3% of all eggs laid. Mean number of cygnets hatched per nest was 3.62. Predation, by Black-backed Gulls, and flooding were the main causes of nest loss. Predation was greatest on the margins of the colony. Success is related to nest density. Lake level appears to be one of the most important factors in the ecology of Black Swans at Lake Ellesmere, affecting not only food availability but also length and duration of nesting season, availability of nesting ground, nest spacings, nest destruction, the number of birds likely to re-nest and therefore, the overall nesting success.

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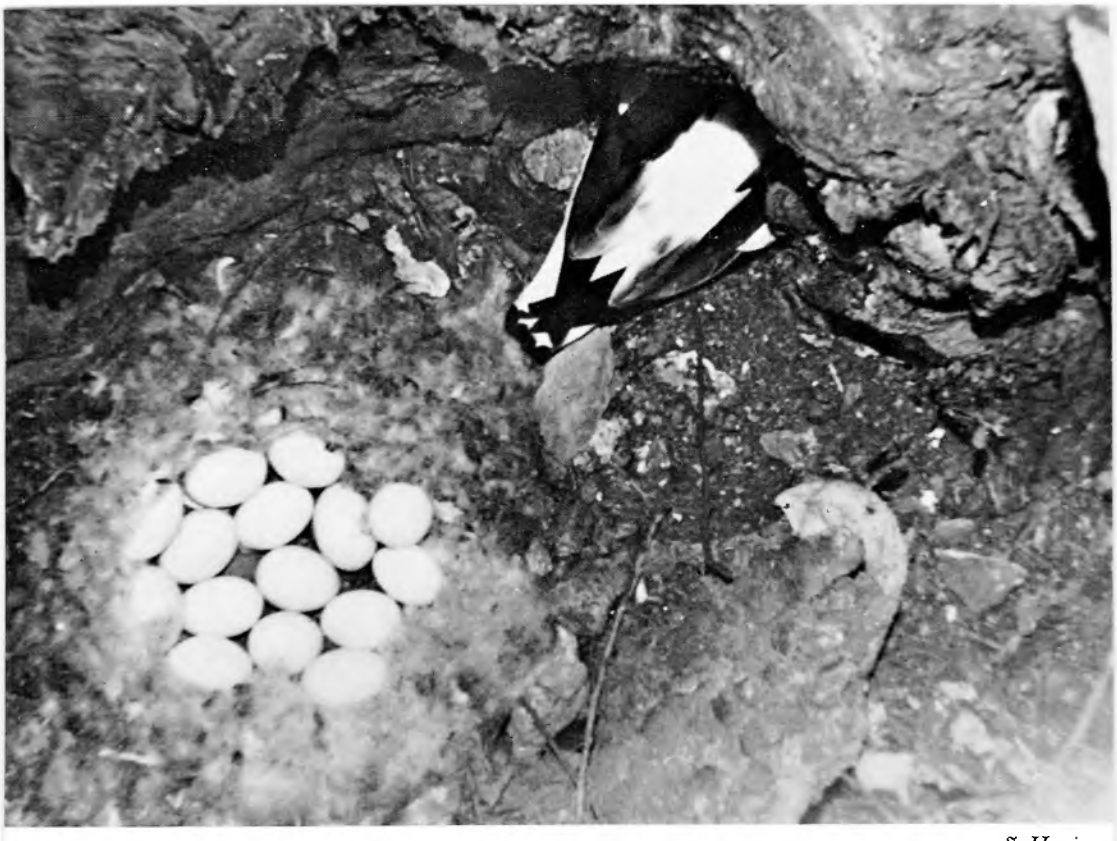

J. Hori

Plate I. (a) A multiple nest of Common Shelduck *Tadorna tadorna* in a hollow tree. The female is hiding from the photographer (see p. 5).

(b) Two Shelduck nests close together in the same straw stack.

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Plate II. Black Swans *Cygnus atratus* at their nesting colony at Lake Ellesmere, New Zealand (see p. 23).

Changes in the British-wintering population of the Pink-footed Goose from 1950 to 1975

H. BOYD and M. A. OGILVIE

The Wildfowl Trust began a study of the biology of the Pink-footed Goose *Anser brachyrhynchus* in 1950. The early investigations followed two main paths. Expeditions to central Iceland in 1951 and 1953 added much to knowledge of the breeding biology and distribution of the species (Scott, Fisher and Gudmundsson 1953; Scott, Boyd and Sladen 1955) and ringed some 9,000 geese. In Britain the development of rocket-propelled nets for catching geese allowed another 11,800 Pinkfeet to be ringed from 1950 to 1959. Recaptures and recoveries of the ringed geese were used to obtain estimates of population size and mortality rates and to study distribution (Boyd 1955, 1956, Boyd and Scott 1955). For a long time it did not seem practicable to make a complete census of the geese, because they were widely scattered, not all their haunts were known and it seemed to be too difficult to count the birds even when they were found. The indirect approach through ringing was expensive and gradually became less satisfactory because of sampling problems, particularly the inability to catch geese in proportion to their regional abundance, while growing acquaintance with their distribution and habits made direct counting seem feasible. After several years of trials, including extensive aerial surveys and the formation of a network of observers, a census, covering all the haunts likely to be in use at that time of year, was made in early November 1960 and has since been repeated anually.

This paper reports and discusses the November censuses for 1960-68, using less complete information from earlier years to estimate numbers in the decade 1950-59. It includes information on the proportions of young geese seen and on the mean brood size each year from 1950 to 1968. In conjunction with the total counts these data make it possible to estimate the size of the successful breeding population and the crude mortality rate from one year to another. Some account is also given of changes in regional distribution over the years, though that and other topics will be discussed in greater detail in other papers. Finally it develops forecasts for the period 1969 to 1975.

Annual census

The Pink-footed Geese wintering in Britain breed in central Iceland and east Greenland and make up a closed population rarely occurring outside those areas. Some arrive in Scotland in late September but most migration occurs in the first half of October and geese may still be arriving until nearly the end of that month. So far as is known, none overwinter in Iceland. During the winter there are extensive, though often gradual, shifts from one part of the country to another, but no emigration. In the spring the geese move back to Iceland in April and early May, some perhaps as early as March. Geese may legally be shot from 1st September to 31st January, or 20th February on the coast. In practice most mortality from this cause occurs in December and January, and very little in October.

Presumably the highest numbers of full-grown geese must occur in Iceland in August, before the migration to Britain, which in some years may cause substantial losses. Aerial surveys in Iceland in 1963 and 1964 (Boyd 1964) have demonstrated that complete counting there would be difficult, and the additional cost and logistic problems of searching in east Greenland as well ruled out the possibility of censusing at the annual peak. Thus early November is in practice the best time for a census, soon after the completion of the autumn migration. The original intention was to carry out most of the survey from a light aircraft, using a single pilot-and-observer team, but this proved unsatisfactory. Short days and frequent spells of bad weather imposed serious restrictions on flying. It was also impossible to be sure that all the Pink-

feet in an area had been detected and frequently the actual counting was found to be difficult. Aerial photographs suitable for careful checking of the observer's estimates were rarely obtainable in the gloom of a Scottish November (Eltringham 1959). Thus the alternative method was tried of deploying a large team of volunteer observers counting the geese within comparatively short distances of their homes and supplemented by a small, roving crew, to fill in gaps in the network and to deal with some of the largest and most complicated groupings of geese. Counts had to be concentrated on a week-end so that enough people could take part. The week-end chosen was normally the first or second in November, the actual dates having varied from 6th to 13th. The counters were selected from persons with prior knowledge of the whereabouts and habits of geese in their vicinity and with a keen interest in counting. Many of them had already been taking part in the monthly National Wildfowl Counts organised by the Wildfowl Trust. Counters were asked to obtain as accurate a total as possible of the geese using a particular roost, preferably by counting the birds leaving the roost in the morning or returning to it in late afternoon. In some places that was not possible and then the geese had to be found while feeding in the fields, often many miles from a roost.

For a census undertaken in such a way to be of value it is necessary to ensure that all, or nearly all, the geese are found and identified, that each group of birds is included only once in the final sum, however often they may have been seen, and that the enumeration itself was reasonably precise. Identification did not often cause difficulty. Observers were also asked to record the numbers of all other species of geese seen, the network being set up to inspect all the November roosts of Greylag Geese *Anser anser* as well as those of the Pinkfoot. The winter ranges of the Greylag and Pinkfoot overlap extensively. But it is unusual for the two species to intermingle at a roost, even if both are using the same loch or estuary, and uncommon for them to occur in mixed flocks while feeding or in flight, apart from the occurrence of isolated stragglers in a flock of the 'wrong' sort. Measures to ensure complete searching and to avoid duplication of recording varied. In some areas local organisers made detailed arrangements for the siting of observers at agreed times to achieve a single thorough check. In others, replication of counts was arranged on the same day or on successive days, either by the same or by independent observers. In Perthshire, Angus and Kinross, where the greatest numbers of geese and most complicated juxtapositions of roosts were found, the geese were counted when flighting out from each roost and also pursued to their feeding places and counted there. Whenever confusion arose the counts were repeated on different days. Thus, it was unusual for any roost tally to be the unsupported observation of a single person and many checks on the thoroughness of the searching and counting were available. The distribution of the Pinkfoot roosts in the period 1965-68 are shown in Figure 1.

Counting flocks of several thousand geese is hardly ever easy. Sometimes conflicting records could not be reconciled and sometimes fog or other mischance prevented the observations from being conducted as intended, so that the final record is still not quite complete for some years and is to some extent dependent on the personal judgement of the compilers as well as that of the counters. While it is possible to assess the general ability of observers to count geese in a test situation, for example by showing them a set of photographs (Matthews 1960), every census total is the consequence of a set of special circumstances. As such, it cannot be provided with confidence limits by any of the recognised methods.

Obviously, a single annual count on an arbitrary date, however precise, is not a suitable basis for detailed analysis of a population. But, given that a single count is all that can be afforded, it will be argued below that the index provided by the censuses carried out in 1960-68, and certainly by those in the period 1963-68, is a useful means of detecting changes in abundance and of suggesting explanations for the changes. It may be noted that most of the results can also be demonstrated by ranking the counts, first by locality year by year then nationally, and evaluating them by rank correlation methods.

Because geese are large and gregarious birds, given to roosting habitually only in sites they know well and exploring new feeding places comparatively slowly, their distribution has been plotted in considerable detail. Recent studies of local distribution which deal with occurrences throughout the winter and with comparisons between years include those of Thom and Murray (1966) on geese in Perthshire, Brotherston (1964) on those

in the Lothians, and the comprehensive national and regional accounts by Atkinson-Willes (1963). Pinkfeet occur in larger flocks, at fewer roosts, in October and November than they do later in the winter, so that complete inspection of all likely sites is feasible. In the results tabled below sites that never held Pinkfeet on the occasion of the November census are omitted, and some used only occasionally and as alternatives are grouped together under a single name (e.g. 'Firth of Inverness', 'other Midlothian'). The grouping under 36 heads has other arbitrary features too. For most inland waters there is no difficulty in naming the site, although in some cases it is undesirable to do so in the interests of privacy. On the coast (e.g. the Firth of Tay, or the Solway Firth, or the Ribble Estuary) where the geese sit on sandbanks or on the water and may be moved by the tides for several miles, the focal points are harder to specify and different recorders would doubtless classify the data in other ways.

There is similar imprecision in the four regional groupings used: 'North Scotland', 'East Central Scotland', 'South Scotland' and 'England'. These correspond to some discontinuities in distribution and in mixing between groups of geese, as revealed by ringing (Boyd 1955)

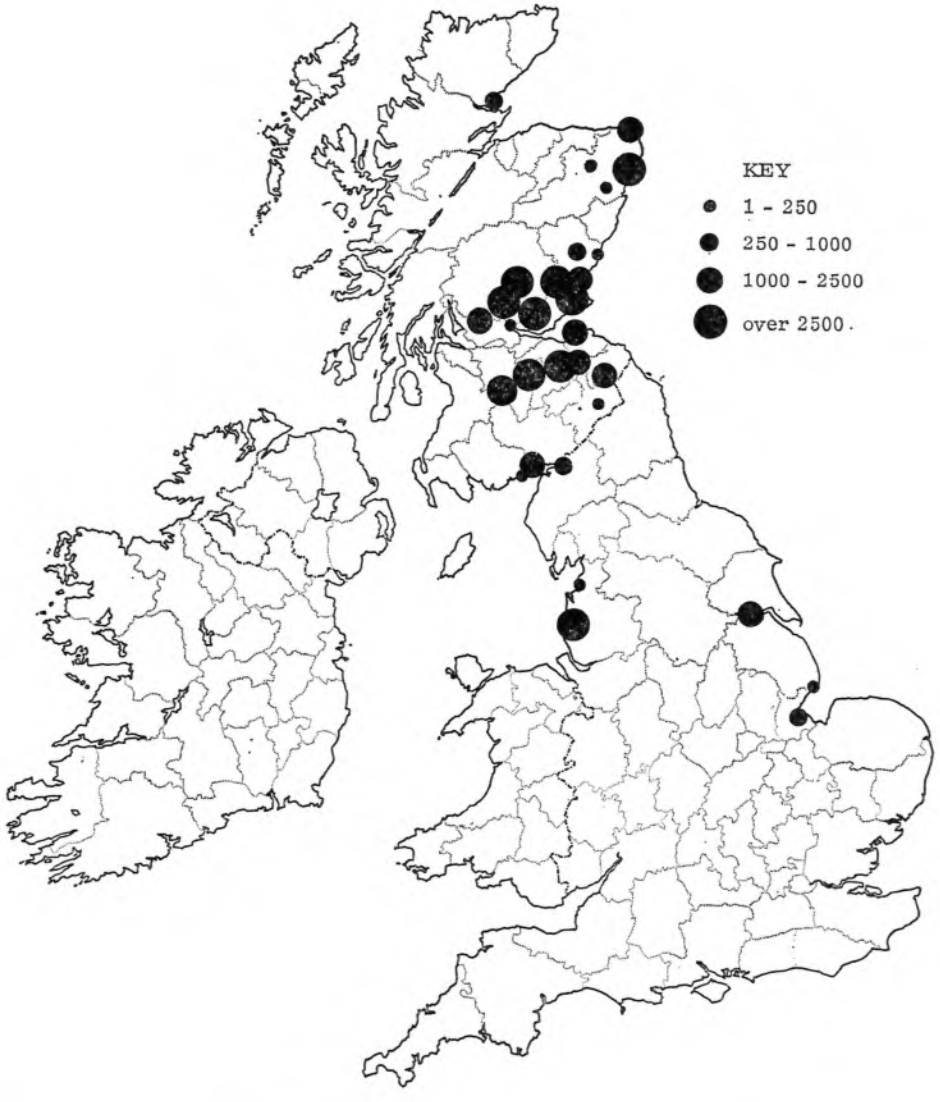

Figure 1. The distribution of roosts of the Pink-footed Goose in Britain in 1965-68.

Table I. Numbers of Pink-footed Geese counted at roosts in Scotland and England in early November, 1950-1968.

Roost	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*
Nigg							43	150			190	—	40	20	—	—	1650	—	250
Firth of Inverness					800	200		200			30	142	6	26	1	925	—	—	—
L. Strathbeg					90	200		600	1350	1110	*770*	1500	370	1650	2239	4600	2730	50	3500
Ythan				1500	1200	30	70	2000	—	—	485	218	900	1000	3300	6753	11468	15000	8340
mid-Don														—	—	—	89	130	120
L. Skene		—	19		107	—	—	—	128	—	—	—	140	—	180	290	—	—	240
Montrose				700	130			400			500	600	1050	*0*	1030	230	235	350	950
Forfar								1000			—	2050	—	600	250	750	650	—	1700
Outer Tay				5000	1200	1300		360			3140	4300	*7000*	3430	6800	4000	4635	2200	—
Inner Tay			1500	2000				4000			—	—	—	810	2000	*2500*	—	2750	11000
Strathearn				2000				2400			*4380*	11050	8240	8400	8375	15560	19320	13230	9000
Carsebreck		60	—								2090	2500	2960	1070	880	2700	1815	3000	3550
Flanders Moss		27	100	2000		1000		380			*12*	1380	660	1700	1775	*0*	650	2300	1300
Cameron Res.		350	1600	30	150	4095	4500	1150	1800	2000	4500	3200	6500	8000	6500	760	2000	3750	3500
other Fife											5	180	22	—	325	300	48	100	15
L. Leven							—	380	200		1350	50	2500	1350	3100	1000	5590	1540	1028
Alloa		75	176							183	700	179	565	320	—	42	—	—	310
Aberlady Bay				235	200	380	100	850	700	2360	1400	250	680	1380	950	255	2750	800	2200
Hule Moss	150		500	4000	2000	1410	3200	4660	4370	1100	3700	3800	3500	200	3400	3000	4200	850	13
Fala	250	1750	100	1500	—	750	—	900	10	270	600	50	2430	450	5	710	—	25	4000
Gladhouse Res.	2000	1300	4220	4000	2500	2700	3750	2550	3450	2000	680	4670	2200	4850	5500	3765	1400	7100	800
other Midlothian											480	270	133	10	11	40	80	—	—
Baddinsgill Res.				1200		2630	1980	1950	1500	530	300	5000	1450	1600	5500	330	1800	—	500
Westwater Res.											—	—	—	—	—	—	500	3800	1400
Lanark											*1700*	650	4460	3150	1040	3410	2575	*3180*	748
Roxburgh																290	450	—	—
Cree	—	—	50	20	100	10	10	12	16		—	11	—	—	80	46	—	—	—
Mersehead											*35*		270		150		290	250	—
Solway — Dumfries	2000	2000	3000		2310	4000	930	2000	2000		7000	1023	2000	6500	4300	7807	3700	1000	440
Solway — Cumberland											50	750	860	*350*	900	300	—	*2*	840
Cockerham				250	345			21		50	300	700	50	—	250	—	—	—	150
Southport			3000	350		3000	2750	3500	2800	4000	3000	4000	*3500*	1530	*3230*	2500	*3500*	1500	7910
Humber		7100	5300	850	5500	3400		6000	12000	15000	5335	5160	2140	*3000*	2000	2055	1750	3000	1500
Croft	4000	4200	3000	2000	4000	3750	6000	460	5000	3000	3400	2270	4500	4000	—	3400	60	—	—
Holbeach				600	4500	4000	4000	2000		3000	2500	3250	1420	1500	1350	1	2500	258	—
Slimbridge	60	—	70	100	120	70	70	140	40	10	110	40	54	—	—	—	—	—	—
Scattered records											55	6	—	2	19	76	5	—	—
Total	8460	16882	22635	28335	25252	32925	27403	36063	35364	34613	48737	59238	60600	56898	65440	68395	76440	66165	65304

Notes: no entry = not searched; — = no geese seen. Figures in italics are subject to question; the counts being suspected of being incomplete, or over-estimated, or selected from conflicting estimates. Rounding-off is as used by observers.

but are also influenced by the need to have classes containing several thousand birds from a variety of roosts to damp down the wild fluctuations from year to year characteristic of some groups.

Numbers in 1950-68

The only co-ordinated effort at a census in early November prior to 1960 was an unsatisfactory aerial survey in 1957, and the information for a population index for the years 1950-59 is therefore gathered from a variety of sources, including observations by the rocket-netting teams as well as by local observers. These counts have been assembled in Table I together with the census results for 1960-68. In calculating an index from the earlier counts it has seemed the best to use the census data for 1960-63 to provide a link between the estimates for the two decades. In this way too much weight is not given to the more complete censuses of later years. This first index could be based simply on the data as tabulated, with interpolations made by using the method devised by Gustav Elfving to obtain an annual population index for Tufted Ducks *Aythya fuligula* in the Finnish Archipelago from the numbers of pairs found in incomplete searches. It is described in an appendix to a paper by von Haartman (1958). Because that paper may not be widely available, an account of the method is given in Appendix I.

Table I shows that records from north and east Scotland are particularly sparse in earlier years. As numbers in the north have been rising while those further south have been steady or declining, it has seemed desirable to calculate a second and better national index for 1950-63. This has been obtained by calculating four separate regional indices and then weighting those by the regional totals observed in 1963 to arrive at a regionally weighted index. The results are presented in Table II, which demonstrates that, apart from 1957, an increase was nearly continuous from 1950. The 1957 results are quite likely to be erroneous, in a way defying correction: as noted earlier, the Scottish results that year were obtained by an aerial survey, in which the inspection of sites was probably not thorough, and the numbers of geese within large flocks were probably underestimated.

Table I also summarises the November census data since 1960. The roosts not visited at appropriate times were few and minor. More serious in their possible effects on the annual total are those figures (shown in italic type) for major haunts which, although the best available, are believed to be of low reliability, because of a high risk of duplications or omissions or because of a conflict of evidence. In order to discover whether these doubtful entries have an important effect upon the national total and, if so, whether an adjustment can be made, it is necessary to replace them by interpolations based on the row and column totals. Several procedures are available. For the sake of consistency, the method adopted here is the one that was also used with the data for 1950-59, which were far more incomplete.

The adjusted national estimates are shown in Table III which includes both the calculated indices and revised values for the totals obtained by standardising the index on 1963 (= 100), this being the first of a series of years for which the corrections produce trivial effects on the final total. Thus, when nearly all the geese were adequately searched for and counted, even substantial errors in counting at one or two major roosts have evidently not led to serious errors in the

Table II. National and regional indices for numbers of Pink-footed Geese in Britain in early November, 1950-63, adjusted to I (1963) = 100.

	1950	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*
N. Scotland				152	84	16	10	108	63	48	48	68	53	100
E.C. Scotland		5	30	53	14	57	71	42	31	38	72	96	100	100
S. Scotland	36	58	65	97	55	79	65	85	79	55	90	98	81	100
England	150	153	120	35	150	122	185	102	210	214	125	132	84	100
National	52	60	62	57	65	74	87	63	95	95	84	97	85	100

Table III. Annual counts and indices of the total numbers of Pink-footed Geese in Britain in early November, 1960-68.

	1960	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*
total count	48737	59238	60600	56898	65440	68395	76440	66165	65304
omitting doubtful entries	41840	58649	50100	53548	62210	65895	72940	62983	65304
normalised index	90.4	93.2	88.2	89.8	103.1	109.1	120.2	103.7	102.3
index standardised to 1963	100.6	103.8	98.3	100.0	114.8	121.4	133.9	115.4	114.0
adjusted total	57292	59114	55982	56950	65379	69137	76256	65720	64923

national total. In 1960-62 there were enough rejected entries to lead to appreciable changes. However, those do not affect the general picture, summarized in Figure 2, of a sustained rise in total numbers from 1950 to a peak of about 76,000 in 1966. In 1967 and 1968 there is evidence of a decline.

Population estimates for 1950-53 from captures and recaptures of ringed geese were published by Boyd (1956) using Bailey's modification of the Lincoln Index method. These were 18,200 in 1950, 52,000 in 1951, 37,200 in 1952 and 49,000 in 1953, and do not accord at all closely with the estimates from observations. Unpublished Lincoln Index estimates for 1954-58 fit even less well: 71,800 in 1954, 85,000 in 1955, 86,600 in 1956, 109,700 in 1957 and 55,100 in 1958. These and other estimates derived from more sophisticated capture-recapture methods seem to have been vitiated by incomplete mixing of the geese from different places and, as mentioned earlier, by inability to catch the geese in suitable proportions regionally.

The regional totals do not change with the simplicity of the national totals, though a rapid increase in eastern Scotland coincided with the greatest national gains. A boom in north Scotland, confined in fact to Aberdeenshire, followed some five years later. That area still holds less than a quarter of the national total while Perth, Angus, Fife and Kinross now account for nearly half. ' South Scotland ', which combines the Lothians, Lanark and Berwick with the Solway, may be an improper grouping, for the Solway has been losing in relative importance while the Lothians have first gained and then held their strength. Regional differences within England have been marked too, with great reductions in autumn numbers on the Humber and Wash in recent years. Decreases and eventual disappearances from former strongholds in Norfolk and at Slimbridge began well before 1950. Only in Lancashire have the autumn numbers remained high.

Thorough assessment of regional changes requires consideration of numbers throughout the winter, outside the scope of this paper, but it may be remarked that the November counts generally reflect the picture for the entire season.

Recruitment and fertility

The analysis of goose populations by field observations on the proportions of first-winter birds and family groups has been used for many years (Lebret 1948, Lynch

Figure 2. The numbers of Pink-footed Geese estimated to have been present in early November in 1950-68 in Britain and in different parts of the country.

and Singleton 1964). It is not easy to distinguish first-winter Pinkfeet from older birds in the field except under infrequently favourable conditions of distance and light, nor are family groups readily identifiable in November, so that samples collected annually (Table IV, Figure 3) are small compared to population size. For the years 1950-59 the bulk of the annual sample for the ratio of first-winter to older birds was made up of geese caught in rocket-nets for ringing. Unlike most trapping methods, rocket-netting does not usually collect samples biased by age or sex because the nets are concealed and bait is not used to attract geese into the catching area. It was not possible to identify family groups in the

Table IV. First-winter ratios and observed brood-sizes of Pink-footed Geese in Britain in autumn, 1950-68.

proportion of 1st w. birds			*1st w.*	*brood-size*						*total*	*total*	*mean*
Year	*1st w.*	*total*	*total*	*1*	*2*	*3*	*4*	*5*	*6*	*1st w.*	*broods*	*brood*
1950	285	583	.488	2	7	4	5	1	1	59	20	2.95
1951	205	821	.249	2	2	2	2			20	8	2.50
1952	300	1280	.234	4	2	3	4	1	2	50	16	3.13
1953	550	1651	.333	2	1	3	1	1		22	8	2.75
1954	610	1744	.349		1		2	1		15	4	3.75
1955	424	2483	.170	1	6	4	3	1		42	15	2.80
1956	238	1258	.184	1	3	1	3			22	8	2.75
1957	1157	3437	.336	3	9	2	6	2	1	67	23	2.91
1958	613	2363	.259	2	3	2	1			18	8	2.25
1959	318	1588	.200	1	1	6	2	2		39	12	3.25
1960	165	596	.276	6	16	18	7	1	2	137	50	2.74
1961	162	433	.374	12	12	11	4	7	2	132	48	2.75
1962	153	730	.209	1	7	4	1	1		31	14	2.21
1963	220	1088	.202		1			2		12	3	4.00
1964	362	1358	.266	2	4	3	5			39	14	2.79
1965	105	500	.210	2	1	2	2			18	7	2.57
1966	303	1400	.216	24	22	18	9	4	1	184	78	2.36
1967	63	585	.108	20	10	3				43	33	1.30
1968	94	804	.117	27	12	2				57	41	1.39
sum	6327	24732	.256	112	120	88	57	24	9	1007	410	2.46

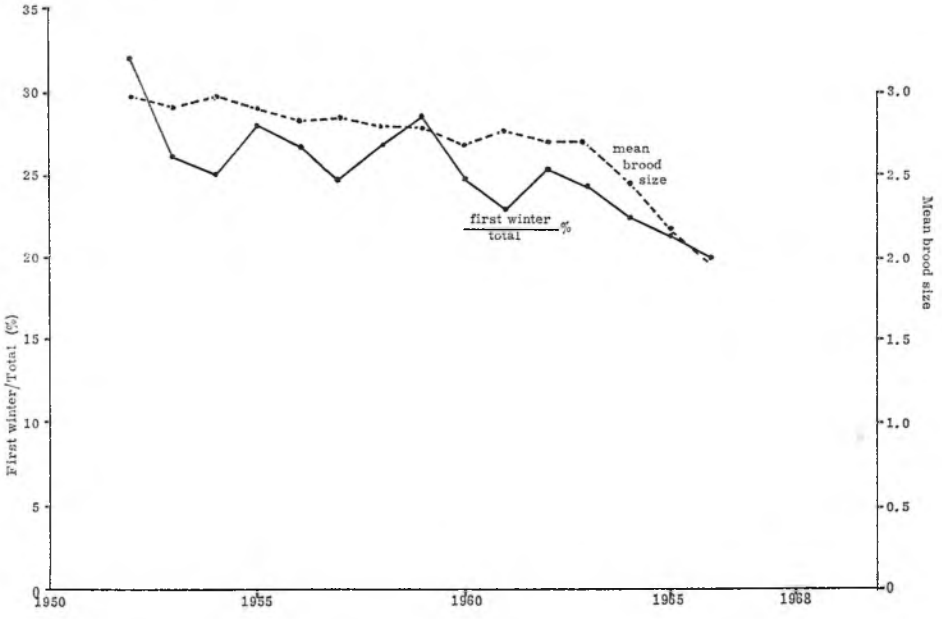

Figure 3. Changes in the mean brood size and in the proportion of first winter birds among Pink-footed Geese seen in Britain, 1950-68, shown by five-year moving averages.

Table V. A population model for the Pink-footed Goose, 1950–68

Year t	*Total Number* N_t	*1st w.* $\mathcal{J}_t$	*Parents* $(\mathcal{J}_t \times 2/b)$ P_t	*Non-breeders* $N_t - \mathcal{J}_t + P_t$	*Losses* L_t $N-(N-\mathcal{J})_{t+1}$	*Death-rate* (%) L_t/N_t
1950	29.85	14.57	9.84	5.44	4.14	13.8
1951	34.24	8.53	5.76	19.95	7.00	20.4
1952	35.56	8.32	5.62	21.62	13.89	39.0
1953	32.49	10.82	7.30	14.37	8.48	26.1
1954	36.88	12.87	8.69	15.32	1.90	5.1
1955	42.14	7.16	5.02	29.96	1.66	3.9
1956	49.61	9.13	6.40	34.08	25.41	51.2
1957	36.44	12.24	8.58	15.62	(−3.70)	(−10.1)
1598	54.17	14.03	9.84	30.30	10.80	19.9
1959	54.21	10.84	7.60	35.77	12.73	23.4
1960	57.29	15.81	11.62	29.86	20.29	35.4
1961	59.11	22.11	16.25	20.75	14.83	25.0
1962	55.98	11.70	8.60	35.68	10.53	18.8
1963	56.95	11.50	8.45	37.00	8.96	15.7
1964	65.38	17.39	12.78	35.21	10.76	16.4
1965	69.14	14.52	12.20	42.42	9.35	13.5
1966	76.26	16.47	13.83	45.96	17.64	23.1
1967	65.72	7.10	10.52	48.10	8.40	12.7
1968	64.92	7.60	11.26	46.06	—	—

All totals are in thousands of geese. The annual totals are derived from the national indices, standardized I (1963) = 100. Mean brood-sizes (b) used are: 1950-54 2.96; 1955-59 2.85; 1960-64 2.72; 1965-66 2.38; and 1967-68 1.35.

Figure 4. Changes in the numbers of first winter birds, of successful parents and of non-breeders within the Pink-footed Goose population in Britain, 1950-68, shown by five-year moving averages.

catches, so that the brood-size samples in most years are too small for effective comparisons between years.

The high proportion of young birds in 1950 was found in two different samples (from rocket-netting in south Scotland and observations at Slimbridge) and was confirmed by the presence of 48% first-winter birds in 173 geese caught in Lincolnshire in December 1950, though the latter are not entered in the table. Such a high proportion has not been approached subsequently, even though in several years the mean brood-size was apparently higher than in 1950.

Figure 3 shows the five-year moving averages for the proportion of first-winter birds and for the numbers of young geese in the country and also for the brood-size. (The averages were calculated from the cumulative sums of the data, not from the annual rates in columns four and thirteen of Table IV.) Both the age-ratio and brood-size show a significant decline over the years, though the trends are not immediately apparent from the tabulated annual values, apart from the exceptionally low production in 1967 and 1968.

In early November nearly all broods are still accompanied by both parents so that the number of successful parents can be found by multiplying the number of first-winter birds by 2/(mean brood-size). Because most samples of broods have been small, it seems better to use for that purpose mean brood-sizes based on pooled records for several consecutive years, rather than the tabulated annual values. The pooled values chosen are recorded in the caption of Table V, which summarises the calculated values for a number of the population statistics.

Figure 4 depicts the moving average values for the numbers of parents and 'adults without families' or 'non-breeders'. Both have increased. The average rate of increase of the latter (about 6.0% annually) has been only a little higher than that of parents (about 5.8%) but, starting from a high number and sustained over a long period, has led to a massive accumulation of 'non-breeders'. Most unfortunately, it is not possible to examine what processes have led to this result. To do so it would be necessary to know something of the age structure among the geese more than a year old and to see whether there are important differences between successful parents and other geese in that and other ways. No detailed investigation of the reproductive history of a group of Pink-footed Geese has ever been attempted, because the cost of doing so would be formidable by the standards of British field ecology. Scott, Boyd and Sladen (1955) did not know whether Pinkfeet might begin to breed at two years old. An examination of the ovaries of eight females marked as goslings in Iceland in 1953 and collected in Britain in the autumn of 1955 confirmed that none had yet bred, but many more known-age birds would have to be examined to answer the question satisfactorily. Work on the Canada Goose *Branta canadensis* shows that although reproductive maturity normally occurs in the third year, a small percentage of geese mature in the second year (Wood 1964).

In principle, recoveries of ringed geese could be used to model the age-structure of the population at different times but it now seems unlikely that this can be done with sufficient precision to be helpful, particularly as the Wildfowl Trust ringing programme did not overlap with the census.

Also, and perhaps more seriously, the estimates of mortality obtainable from recoveries are too high to be compatible with those derived from the observed population changes. Boyd (1956) estimated from recoveries up to 1954 of Pinkfeet marked in 1950-52 that the death-rate of geese between 4 and 16 months old was 42 $\pm$ 2.8% and that the annual death-rate of older geese was 26 $\pm$ 1.6%. Later unpublished work indicates rather lower rates.

Estimates of the crude death-rate can be obtained from the counts by subtracting the number of young from the total November population to give a figure for survivors from the previous year. Subtracting this figure from the previous year's total gives the number of deaths during the year, which can be converted to a rate by dividing by the total in the preceding year (Table V). Such an estimate is unlikely to be reliable, since it is susceptible to the effects of errors in the estimates of total numbers and of young birds, so that it is preferable, once again, to use moving averages rather than annual values to see how mortality may have varied. Figure 5 depicts the average losses and the average death-rate over the period. The smoothed values since 1960, which are derived from relatively good censuses, show very clear declines in absolute losses and in the death-rate. The most recent losses are still greater absolutely than they were ten years or so earlier, which is not at all surprising in

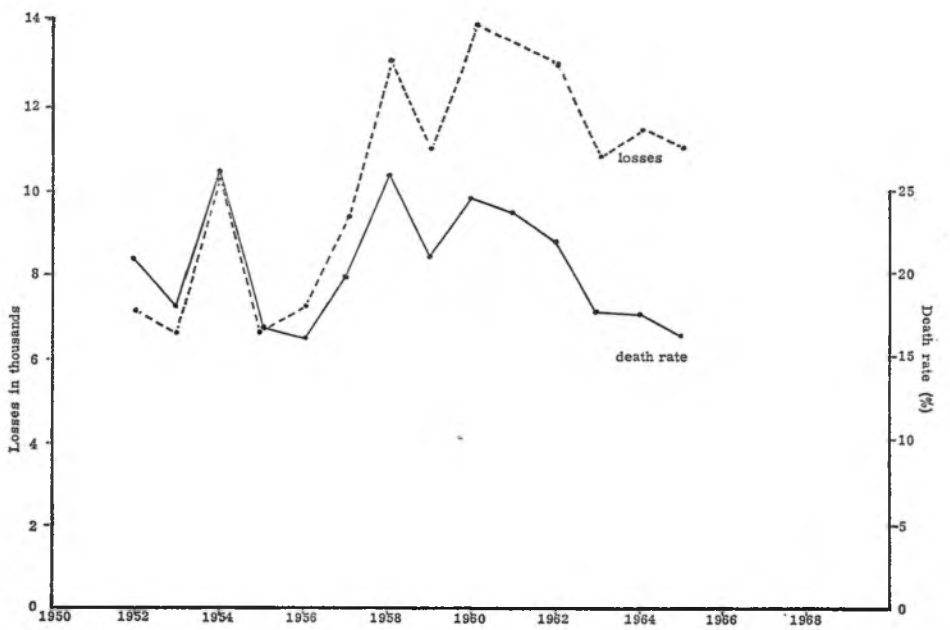

Figure 5. Changes in the annual losses of full-grown Pink-footed Geese, from November to November, and in the crude death-rate, 1950-68, shown by five-year moving averages.

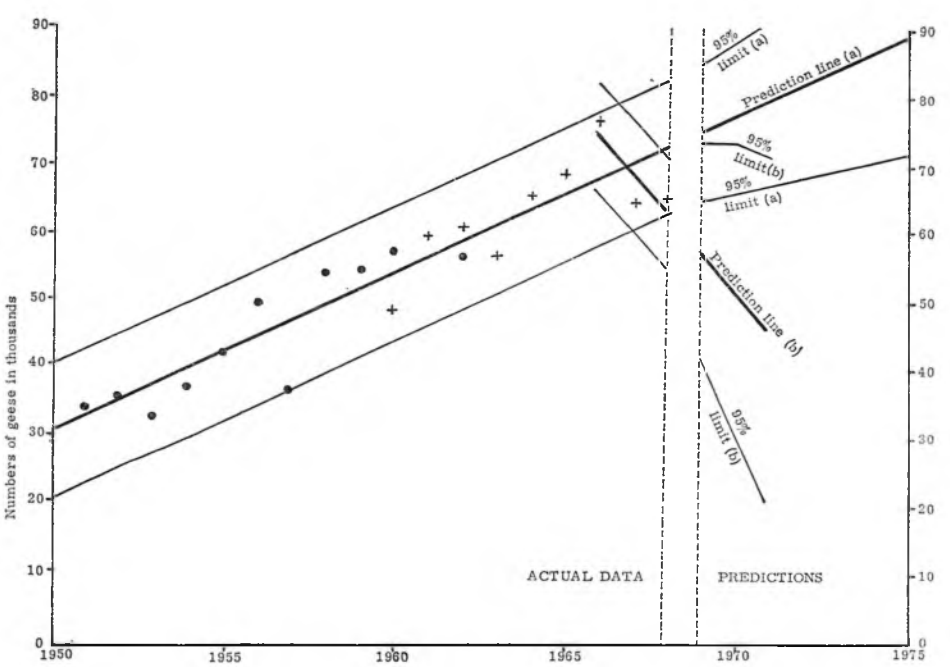

Figure 6. Forecasts of the numbers of Pink-footed Geese in Britain in 1969-75, based on the changes in the population between 1950 and 1968. Solid circles equal adjusted totals (see Tables II and III); crosses equal total counts.

view of the large increase in the number of geese at risk.

Numbers in 1969-75

The decline in 1967 and 1968 after the sustained increase in 1966 raises interesting questions about the size of the British wintering population of Pinkfeet in the future. Will its growth be resumed, will it now fluctuate about a November level of, say, 70,000 birds, or will it decline substantially? The safest answer is just to wait and see, and the most admirable one would be a convincing causal analysis. Neither is immediately attainable. But some guidance may be derived from mathematical extrapolation from the recent trends. Curve-fitting is a somewhat discredited art in those fields, such as econometrics and demography, where it has been most used but the method may still be useful in such an unsophisticated task as gross population projection.

There are two main difficulties in making informative projections. First, it is necessary to adopt a deterministic approch, making the assumption that the intrinsic and contingent factors affecting population size will continue to act and interact much as before. In most cases of real interest that is unlikely to be true. Second, it is a commonplace that when the usual mathematical trend curves are fitted to a set of data the closeness of fit is much the same within the range of the observations while the extrapolated values diverge, often widely. Thus it is necessary to find some objective method of choosing between predictors.

The trend curves usually fitted fall into two classes: polynomials, represented by the straight line or the parabola, and exponential curves where the increase at any moment is directly proportional to the size already attained. A helpful technique for selecting predictors has been introduced by Gregg, Hossell and Richardson (1964).

The data for the whole period 1950-68 are well fitted by the straight line $Yt = 27.85 + 2.35t$, where Yt is the number of geese in thousands in year t, and t_1 was 1950 (Figure 6). The 95% confidence limits, corresponding to $\pm$ 2 standard deviations, are also shown in Figure 6.

The close fit to the linear regression is to some extent spurious, particularly for the years 1950-59, because the estimating procedure for the incomplete data has the effect of smoothing out departures from the norm. But it is rather remarkable that a straight line fits the data for 1960-68 at least as well as any of the polynomials or exponentials tried, since population growth does not often appear simply additive.

The projection of the straight regression line suggests that the population would increase to about 90,000 in 1975 if conditions do not change importantly. The confidence limits for the projection diverge gradually, though not much, since the regression is based on a long run of years.

Alternatively, and pessimistically, it may be argued that the period of growth ended in 1966, the justification for doing so being that the decrease from 1966 to 1967 was not reversed in 1968, the first occasion in the whole period studied that no immediate resumption of growth had followed a check. On that view, the prospects for the future are better shown by the line of negative slope $Yt = 69.59 - 6.93t$, where t_1 was in 1966. Based on only three years data, that regression cannot properly be extrapolated beyond 1971 and even within that short period the 95% confidence limits diverge markedly. These limits, and those for the previous line, were obtained by extrapolation from the 90% confidence limits for linear trend forecasting given in Table F of Gregg, Hossell and Richardson (*loc. cit.*).

Depending on one's point of view, 1969 is either a crucial or merely an inconvenient year for which to make a forecast. From Figure 6 it can be inferred that if the population in November 1969 equals or exceeds 75,000 the long-term growth rate will have been restored. Should the 1969 total fall appreciably below 65,000 the predictor of growth must be abandoned and a new estimate of the rate of decline be calculated.

It is of some practical consequence that, even should the currently estimated rate of decline, of about 10% annually, be sustained, it may be difficult to be sure of this from one year to the next, since the annual decrement will only be of the same order of magnitude as the probable sampling error. To put it another way: because the year to year changes are likely to continue to be relatively small, it will be necessary to continue annual censuses at the highest practicable level of completeness and precision in order to have a chance of predicting how the population will change.

A consideration of some causal factors

This paper has described a population that was increasing substantially and steadily until 1966. Much of the increase,

at least since 1960, is apparently attributable to a decline in deaths amongst full-grown geese. The annual output of young tended to rise in absolute terms until 1964 but, when measured by the mean family size or by the proportion of young birds in the population in early November, it has been falling slowly since 1950. In 1967 and 1968 the number of young geese reaching Britain fell to 7-8,000, the fewest recruits since 1955, partly because of a decrease in the number of successful parents but more because of a marked reduction in brood-size. This led to a reduction in total numbers.

Unless the effective fertility returns quickly to the levels prevailing before 1960, or the adult death-rate diminishes even more rapidly than it has been doing, the total numbers must decline substantially in the next few years.

The reduction in adult mortality may have been affected by improved conditions in Britain: an enlarged food supply (Kear 1965, Kear and Rodger 1963, Atkinson-Willes 1963), or the increased number of statutory refuges provided for Pinkfeet (Atkinson-Willes *loc. cit.*). A prohibition on the sale of dead wild geese only came into effect in January 1968. These factors need further examination.

There is no evidence that conditions in Britain have contributed to the reduction in effective fertility, although it is at least possible that such agents as agricultural chemicals may have played some part. Very little is yet known of the factors controlling fertility in migratory geese. In North America there is growing evidence that the breeding success of geese nesting in the Arctic is affected not only by the state of the nesting grounds on their arrival but also by the experiences of the geese elsewhere earlier in the spring (C. D. MacInnes, J. P. Prevett, unpublished reports). The study of Pinkfeet in Britain in March, April and May might profitably be intensified.

It is certainly also true that more should be learned about the breeding biology of Pinkfeet in Iceland and Greenland, which has scarcely been looked at before late June, well after the completion of egg laying.

One possibility that might account for reduced breeding success is the deterioration in climate which started to become apparent in Iceland around 1960 and is returning the country to the conditions of the last cold spell, which ended about 1918 (Kristjansson 1969). It is unlikely that a close association between weather and success can be established on the basis of existing data, for there are few meteorological stations close to the nesting areas and standard records rarely include enough information on persistence of snow cover and other factors important to geese.

The need for fuller and up-to-date knowledge of the breeding distribution of the Pinkfoot and of the factors affecting it has been given real urgency by a proposal for a major hydro-electric scheme involving the inundation of most of Thjorsarver, the principal home of the Pinkfoot (Gudmundsson, *in litt.*). In mid-July 1953 Thjorsarver held about 8,200 adults and 10,200 goslings (Scott, Boyd and Sladen 1955). Using the mean brood-size of 4.3 observed at that time, this implies a successful breeding population of 4,700 there then. Some of those parents doubtless lost all their offspring by November, when it is now estimated that there were only 7,300 parents in the entire British-wintering population. Even so, it is likely that in 1953 more than half the effective breeders came from Thjorsarver. An aerial check of Iceland in May 1964 (Boyd 1964) confirmed that Pjorsarver had not lost its importance. Though the number of Pinkfeet breeding in Greenland has still to be determined, it is unlikely to exceed 1,000 pairs (Christensen 1967). Thus Thjorsarver is of enormous importance to Pinkfeet. The plans for the hydro-electric scheme show that the first stage would flood permanently nearly all the areas now favoured by the geese, while the second stage would immerse most of the oasis.

The evidence that, compared with the total stock, successful breeders have only increased slightly since 1955-1960 suggests that there cannot be large tracts of suitable nesting habitat waiting to be occupied. Thus the impending loss of Thjorsarver is a major threat to the future well-being of the Pink-footed Goose. But, even if the dams are never built, it looks as if in the next few years the Pinkfoot may present goose conservationists with an unusual and potentially serious problem. If the production of young Pinkfeet should continue to fall, is there anything that anyone could do about it?

Acknowledgements

Counting geese is sometimes a miserably cold and tedious business if at other times a most exciting one. We are heavily indebted to the large group of collaborators who have, at their own considerable expense, provided much of the raw material for this paper. Miss V. M. Thom and W.

Brotherston have played particularly important roles in organising the counting in two large and difficult areas and in finding out why geese behave as they do.

The Nature Conservancy and the Natural Environment Research Council have provided indispensable financial support to the Wildfowl Trust for the conduct of this and other studies of wildfowl populations.

H. Boyd is grateful to J. E. Bryant, Director, Eastern Region, Canadian Wildlife Service, for permission to devote some of his time to the preparation of a paper dealing with non-Canadian affairs.

Summary

The Pink-footed Geese breeding in Iceland and Greenland form a closed population which winters in Britain. Nearly complete censuses have been made annually since 1960 and earlier records permit less reliable estimates of total numbers to be made for 1950-59. The population increased rather steadily from about 30,000 in 1950 to over 76,000 in 1966, decreasing to 65,000 in 1968. Earlier Lincoln Index estimates of population size based on capture/recapture are shown to have been inaccurate. There have been substantial changes in different parts of the wintering range, with large increases in north-east and central Scotland and decreases on the Solway Firth and in England, except in Lancashire. Proportionate fertility has fallen slowly throughout the period, with a marked deterioration in 1967 and 1968. Mean brood-size fell from 2.96 in 1950-54 to 2.38 in 1965-66 and only 1.35 in 1967-68. The proportion of young birds to older ones has fallen similarly, though less steadily, while the numbers of geese old enough to have bred but not having done so have increased more than the numbers of successful parents. The crude death-rate of adults has been falling rapidly. Forecasts are made of future trends in numbers by mathematical extrapolation of the data. A continuing increase could lead to a population of 90,000 by 1975, but at present it seems more likely that the decline of the last two years could be continued, leading to a total of only 46,000 in 1971. In Britain conditions appear to have become more favourable, due to increases in food supplies and further legal restrictions on shooting. In the breeding range the climate is becoming more severe and a large hydro-electric project in central Iceland threatens to destroy the home of about half of the breeding population.

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Appendix I. A method for obtaining annual population indices from incomplete census records.

(Adapted, with minor textual changes, from G. Elfving: Statistical analysis of incomplete material, at pp. 9–11 in L. von Haartman (1957).)

Denote by x_{it} the number of geese at the ith roost in the year t. We make the following fundamental assumptions:

1. The number x_{it} is a random variable, with an expected value X_{it} depending on i and t. The fictitious quantity X_{it} may be interpreted as the average number of geese that would be observed, in the year t, at a large number of roosts all similar to roost number i and with a similar prehistory. The difference $y_{it} = x_{it} - X_{it}$ expresses the random component, analogous to the error in physical measurements.

2. The expected value is of the form $X_{it} = a_i b_t$, where a_i may be interpreted as the average X_{it} over a long sequence of years, while b_t is a yearly factor, exhibiting the effect of the particular conditions during the year t, including possible after effects from previous years. It seems reasonable to assume the year effect to be multiplicative, since a good year is likely to increase the population by a certain proportion, not by a certain absolute amount.

The hypotheses may be condensed into the formula:

(1) $x_{it} = a_i b_t + y_{it}$.

With this starting point, the purpose of the numerical analysis is to estimate the time series $\{b_t\}$. The series obtained from different data may then be compared among themselves as well as to other series such as, for example, those reflecting straightforward climatic fluctuations.

The estimation of the b_t is most readily achieved by an iterative procedure. Let Σ_i indicate summation over all years represented on the row of the roost number i and Σ^t summation over all roosts represented in the column of the year t. (The rows and columns used were various sections of Table I.) Applying those operations to equation (1) we have:

(2) $\Sigma_i x_{it} = a_i \Sigma_i b_t + \Sigma_i y_{it}$,

(3) $\Sigma^t x_{it} = b_t \Sigma^t a_i + \Sigma^t y_{it}$,

For a reasonably large number of terms, the last sums may be expected to be small, since the random components will largely cancel. If those sums are neglected, and if we know some approximate value for $\Sigma_i b_t$, then (2) will give us an approximation for a. Similarly, if we know $\Sigma^t a_i$ approximately, (3) will give us b_t.

Since the average of b_t is assumed to be 1 in the long run, we may start with the approximation that $\Sigma_i b_t$ be equal to the number n_i of years represented on row number i. We then have the first approximation $a_i^{(1)} = \frac{\Sigma_i x_{it}}{n_i}$. Inserting that approximation in (3) we get $b_t^{(1)} = \frac{\Sigma^t x_{it}}{\Sigma^t a_i^{(1)}}$.

The next step yields $a_i^{(2)} = \frac{\Sigma_i x_{it}}{\Sigma_i b_t^{(1)}}$, $b_t^{(2)} = \frac{\Sigma^t x_{it}}{\Sigma^t a_i^{(2)}}$ and so on.

After a few steps the b_t becomes stable, yielding the desired estimate of the yearly factor The series obtained may, if desired, be normalized to average 1.

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Grazing of wild geese on grasslands at Damme, Belgium

ECKHART KUYKEN

Introduction

Ecological investigations on the wintering geese at Damme, Belgium, have been concerned with two main problems. Firstly, there was the way in which weather and other environmental factors influence the numbers of geese present. Secondly, methods of measuring the impact of the grazing of the geese on the limited grassland areas were developed. This paper is concerned with the latter.

A better understanding of the interactions between geese and their food supply will aid the management of important wild goose reserves in the future.

The Wild Goose Reserve at Damme

Damme (51° 15′ N, 3° 17′ E) is situated in the 'Polders' of the Province of Western Flanders, only 5 km. NE of Bruges, 11 km. SE. of the North Sea and about 30 km. from the river Westerschelde (Zeeuws-Vlaanderen, Holland).

The Reserve was established about ten years ago, when, influenced by Count Leon Lippens, former President of 'De Belgische Natuur- en Vogelreservaten,' some conservation-minded hunters in the surroundings of Damme voluntarily stopped wildfowl shooting after the middle of December. An increase in the numbers of the geese year by year resulted, especially when an important haunt along the Westerschelde, 'De Braakman,' in the Netherlands, disappeared in 1961. From July 1968, the Department of Agriculture prohibited the hunting of wild geese in three municipalities: Damme, Oostkerke and St.-Kruis-Brugge (about 70 sq. km.).

In this region, the traditional wintering-grounds consist of only 350 to 400 hectares of pasture (860 to 990 acres), divided into two major parts of 135 and 100 hectares by the canal from Bruges to Sluis. Five smaller areas (between 20 and 40 hectares) around these central parts are important as buffer zones.

The landscape is very open, with only two rows of poplars along the canal and sparse pollarded willows along the many little ditches (Plate III, facing p. 48). Most of the grasslands are wet throughout the year, and sometimes partially flooded in winter. They are rather heavily grazed by cattle from early April until the end of November.

The grassland is of good quality, predominantly *Lolium perenne* and *Cynosurus cristatus*, together with *Phleum pratense*, *Poa trivialis*, *Trifolium repens*, etc. (= *Lolio-Cynosuretum* Ass.). Some lower parts, which are more often flooded, have an inferior vegetation, largely *Ranunculus repens* and *Alopecurus geniculatus*, plus *Glyceria fluitans*, etc. (= *Ranunculo-Alopecuretum* Ass.).

Occurrence of the geese

As shown in Table I, the maximum numbers increased from 2,300 birds in 1959-60 to 9,730 birds in 1966-67; during the last two winters, there was a decrease to 6,850 birds in 1968-69. These maxima are reached every year about the middle of January. In the same Table are given the average numbers of geese per day (G), calculated from rather large samples.

There is no correlation between the maxima and the average numbers each winter. This will be shown to be very important in considering the degree of grazing on the grasslands.

Recorded species

European White-fronted Goose *Anser a. albifrons*

Table I. Occurrence of the geese at Damme, Belgium, 1959-69.

Winter	*Maximum number of geese*	*Average number (per count) (G)*	*Wintering period (number of days) (t)*	*Number of counts*
1959-60	2300	804	?	22
1960-61	3000	596	120	23
1961-62	3550	1692	103	19
1962-63	(severe winter, no geese stayed in Jan. and Feb.)			
1963-64	5600	1569	100	30
1964-65	6000	2504	106	45
1965-66	5965	2477	125	62
1966-67	9730	2420	105	57
1967-68	8755	2027	128	83
1968-69	6850	1750	127	94

arrival: in the second half of November.
maximum: varying in the last five years from 5,500 to 8,650 birds in the period from 10th to 25th January.
departure: by the end of February, usually before 10th March.

Pink-footed Goose *Anser brachyrhynchus*

Damme is an important, isolated haunt for this species.

arrival: at the very beginning of November.
maximum: varying during the last half decade between 550 and 850 birds (once 1,090 birds, in 1966-67); occurring between the end of December and 10th January.
departure: almost one week before the Whitefronts.

Other species of geese

These are recorded irregularly, mostly as single individuals or in very small numbers: Greylag Goose *Anser a. anser*, Western Bean Goose *A. f. fabalis*, Russian Bean Goose *A.f. rossicus*, Lesser White-fronted Goose *A. erythropus*, Snow Goose *A. caerulescens*, Barnacle Goose *Branta leucopsis*, Canada Goose *B. canadensis*, Red-breasted Goose *B. ruficollis* and Dark-bellied Brent Goose *B. b. bernicla.*

Methods of estimating the amount of grazing

The area of the Reserve is small in comparison to the numbers of geese that regularly winter there. The part that is actually grazed does not exceed 300 hectares. Thus rather heavy grazing was expected, and an attempt was made to estimate its impact on the grasslands.

Intensity of grazing

Markgren (1963) gives a formula to describe what he calls 'actual pasturation': $\frac{\Sigma(gd)}{a}$, i.e. $\frac{(g_1\ d_1)+(g_2\ d_2)+\ldots+(g_n\ d_n)}{a}$,

where g = number of birds of a grazing flock
d = number of days on which the flock grazed in the field
a = area of the grazed field (in hectares)

This formula has been changed for present purposes (Kuyken 1967) to simplify the calculations, to give the overall grazing intensity covering the whole wintering period and the whole grazed area, by using the formula:

$$\frac{G \cdot t}{A}$$

where G = average number of geese per day (Table I)
t = total duration of the wintering period (Table I)
A = total area grazed (in hectares)

Thus, instead of the daily fluctuations, we use G, the arithmetical mean of our counts, making the assumption that this number of geese is present every day. This is reasonable only when the number of counts is a reliable sample of the whole wintering period (see Table I). The calculations from both formulae give similar results:—

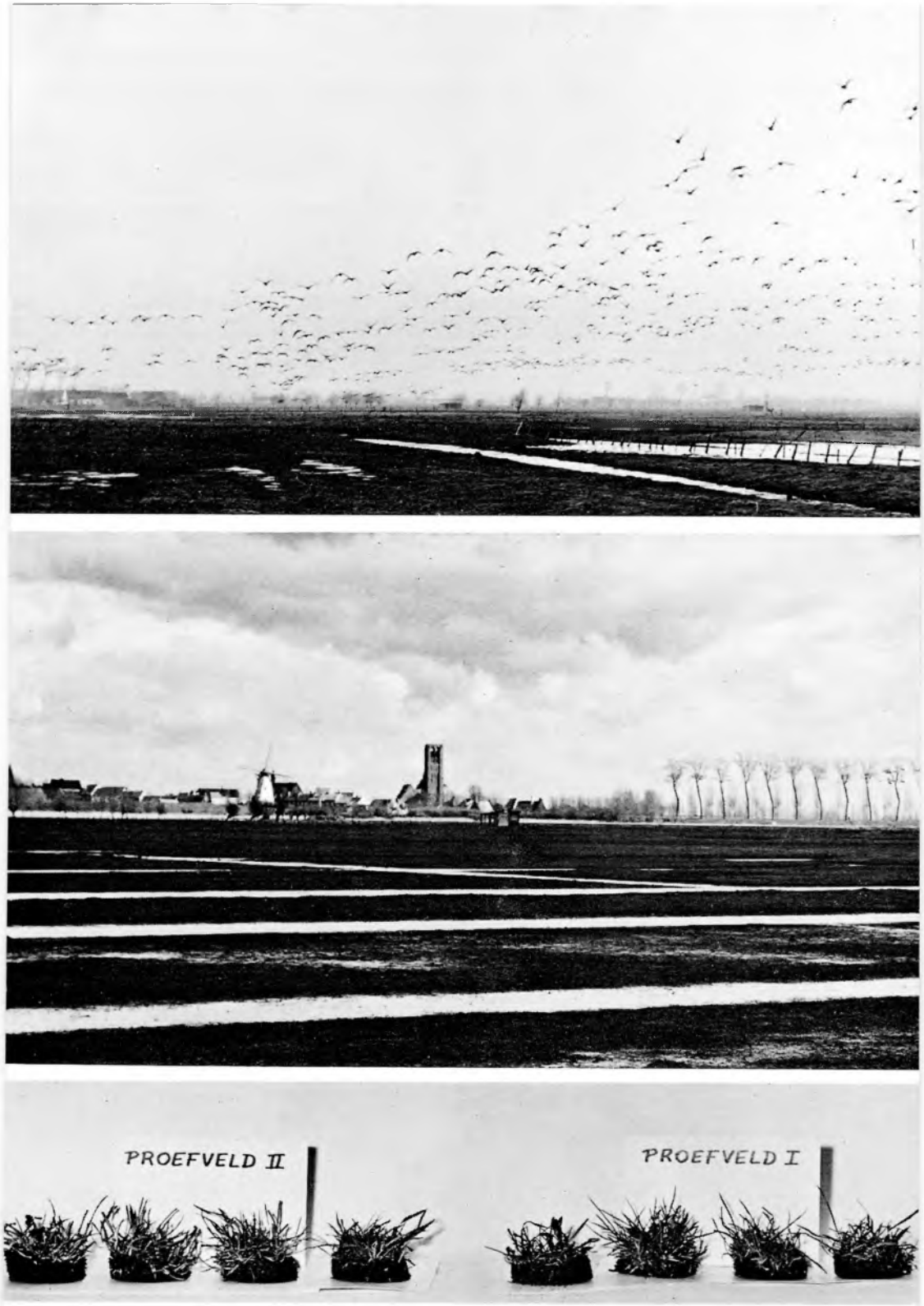
	Markgren	Kuyken
1966-67:	$\frac{245423}{290} = 852$;	$\frac{2420 \times 105}{290} = 876$
1967-68:	$\frac{284852}{300} = 830$;	$\frac{2027 \times 128}{300} = 865$
1968-69:	$\frac{219374}{300} = 731$;	$\frac{1750 \times 127}{300} = 741$

The latter figures can thus be used with confidence to express the intensity of grazing in all winters.

However, we must make one important proviso. An overall grazing intensity of 741 '*goose-days*' *per hectare*, corresponding with a coverage of $\frac{1750}{300} = \frac{741}{127} = 5.8$ *geese per hectare per day*, presupposes that on each of the 127 days each of the 300 hectares is grazed. Therefore, we can only use this (easily calculated) figure as a first theoretical approach.

Markgren (*op. cit.*), investigated winter rye fields in southern Sweden, grazed by rather small flocks of Bean Geese. He found 'actual pasturations' from 50.5 (= 'comparatively low') up to 276 (= 'very heavy grazing'). At Damme, we find much higher values, with some even exceeding 1,000. This is probably caused by the relatively small amount of disturbance in the Reserve.

Figure 1 gives the values of the overall grazing intensity during the decade 1959-68, compared with the maximum number of the geese in each winter. This shows that there is not necessarily correlation between very high maxima (often present for a short time) and the overall intensity



E. Kuyken

Plate III. The Damme Wild Goose Reserve, Belgium. European White-fronted Geese *Anser albifrons albifrons* feed in the wet pasture land. The effect of their grazing was studied (see p. 47). By the early spring there was little difference between grazed (II) and ungrazed (I) samples.

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Plate IV. (a) 'Triumph' display in a bantam-reared female Bewick's Swan *Cygnus columbianus bewickii*. The male sibling showed no such interest in Dr. Matthews.

(b) Whooper Swans *Cygnus c. cygnus* now winter on 'Swan Lake' at Slimbridge (see p. 157). Several of them had strong iron-staining on the head and neck. The Bewick's Swan *Cygnus columbianus bewickii* in the picture illustrates the main points of difference between the two species; notably length of neck and head, head and bill shape, and, more obvious, bill pattern.

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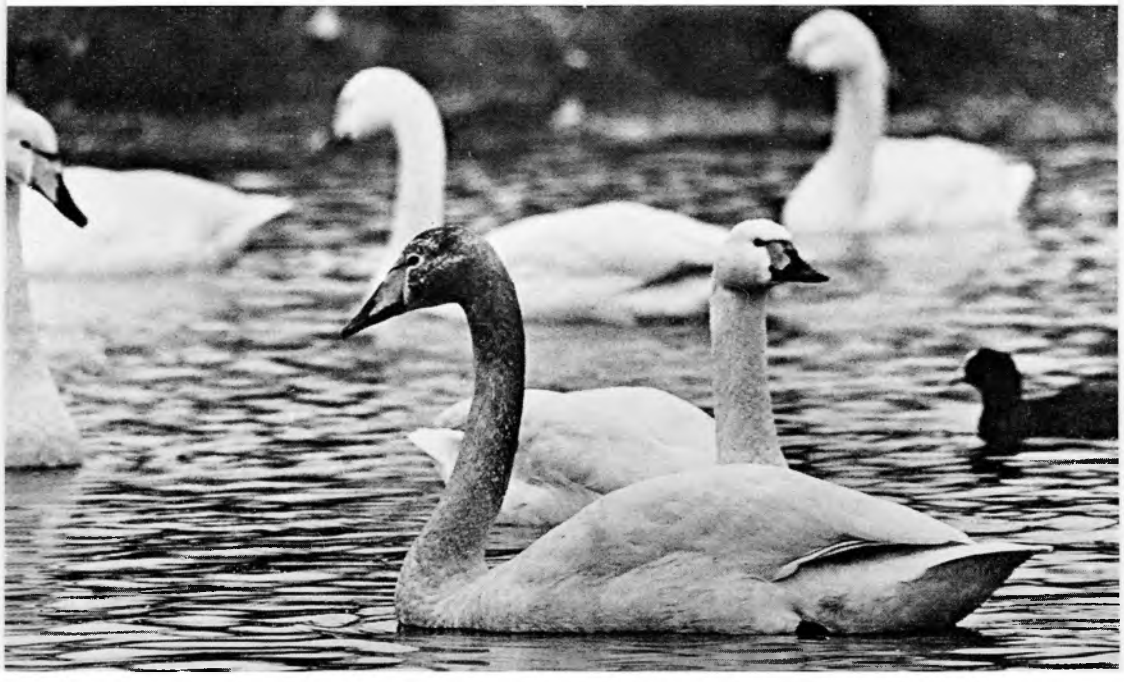

of grazing. Figure 1 shows that the intensity of grazing in 1965-66, for example, was much higher than in the following winter when we recorded the highest number of geese ever seen at Damme. The geese stayed that season for only 105 days, against 125 days in the previous one (Table I).

Grazing frequency

If the frequency of grazing can be calculated, we are able to indicate rather precisely which are the heaviest grazed parts of the wintering resort. During 1966-69 as often as possible the grazing positions of the flocks of geese were plotted on a detailed map of the reserve (scale 1 :

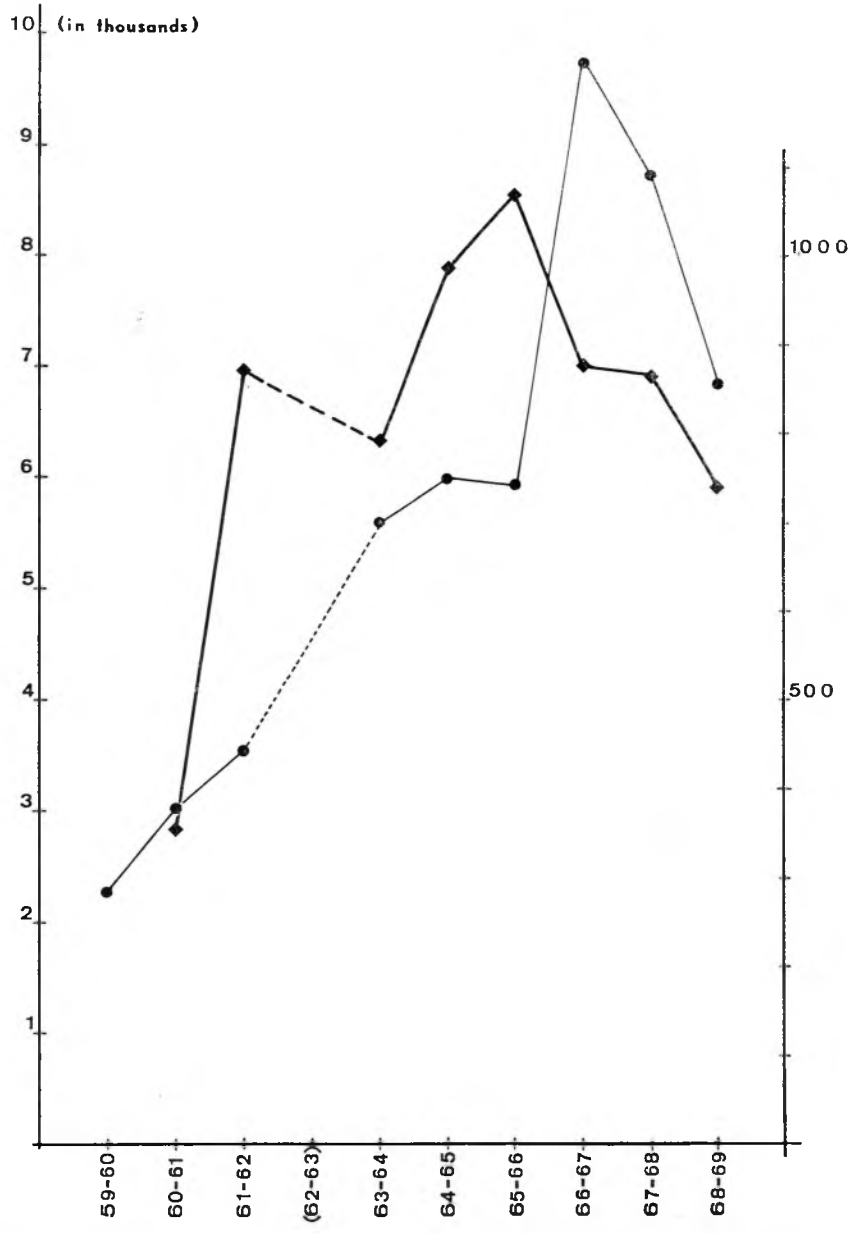

Figure 1. The maximum numbers of geese at Damme (dots, thin line, left hand scale) **compared with the overall intensity of grazing** (diamonds, thick line, right hand scale) **for the last decade.**

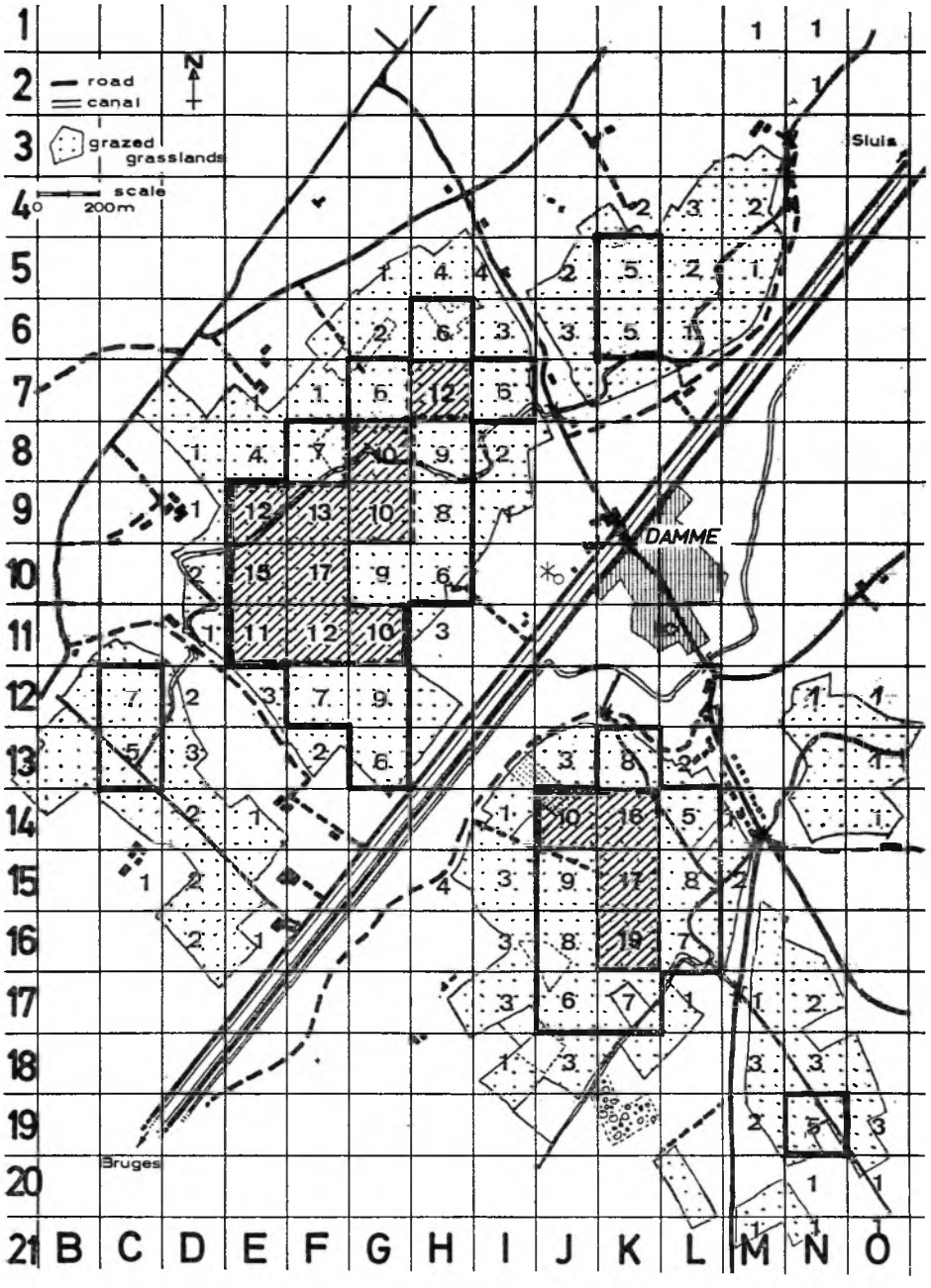

Figure 2. Map of the Wild Goose Reserve at Damme, divided into quadrats of 4 hectares. The figures indicate the total frequency of grazing per quadrat, on 52 half-day-observations in 1966-67.
Hatched area = heavily grazed.
Enclosed by the heavy line = moderately grazed.
Outside heavy line = lightly grazed.

10,000) using one map per half day. The number of the geese in each separate flock was also indicated if possible. The geese also roosted at Damme, but the positions of such roosting flocks were left out of account in calculating the grazing frequency.

To standardize these half-day sketches, the maps were divided into quadrats of 4 hectares (200 × 200 m.), each one characterized by a letter and a figure, for example D 8, K 17 (Figure 2).

The grazing frequency per quadrat was found by totalling the number of occasions on which geese were seen therein. (The actual number of geese involved is left out of account.) Figure 2 shows the situation at the end of 1966-67, based on 52 half-day sketches. In that season, 102 different squares were grazed, some of them only once, others up to 19 times. On the other hand, the sum of all grazing frequencies was 470, giving an average grazing frequency of 4.6. This index is our second approach to the problem of the impact of grazing. The higher this figure, the more likely is any possible damage.

At the end of the winter, we are able to divide the grazed area into three categories with an increasing frequency of grazing: *lightly grazed*, with grazing frequencies below or equal the average; *moderately grazed*, with frequencies up to twice the average; *heavily grazed*, with frequencies exceeding twice the average (Figure 2). With the aid of a planimeter, the exact area of these three categories of grazed grasslands was measured as 110, 68 and 42 hectares respectively from the 290 hectares of available and grazed grasslands (A in the formula on p. 000). The remaining 70 hectares were not covered in our sample.

The grazing frequency was clearly greater in quadrats situated in the centre of the area than it was in those marginal quadrats near fields, roads and farms. In the 1966-67 winter 36 different central quadrats were grazed 323 times, giving an average grazing frequency of 9.0, against an average of only 2.2 on the marginal ones (66 different quadrats, grazed 147 times).

For each period of ten days, the quadrats grazed, both marginal and central, were totalled separately and plotted into histograms (Figure 3). The average numbers of geese present in the same periods (solid line) were also plotted. Although an increase in the area grazed when geese arrive in larger flocks is obvious, this correlation is not linear. This possibly results in crowding on some central quadrats during days with maximum numbers of geese. In 1966-67 these quadrats were F 10, K 14, K 15 and K 16 (Figure 2).

Generally speaking, we may state that the central quadrats were preferred

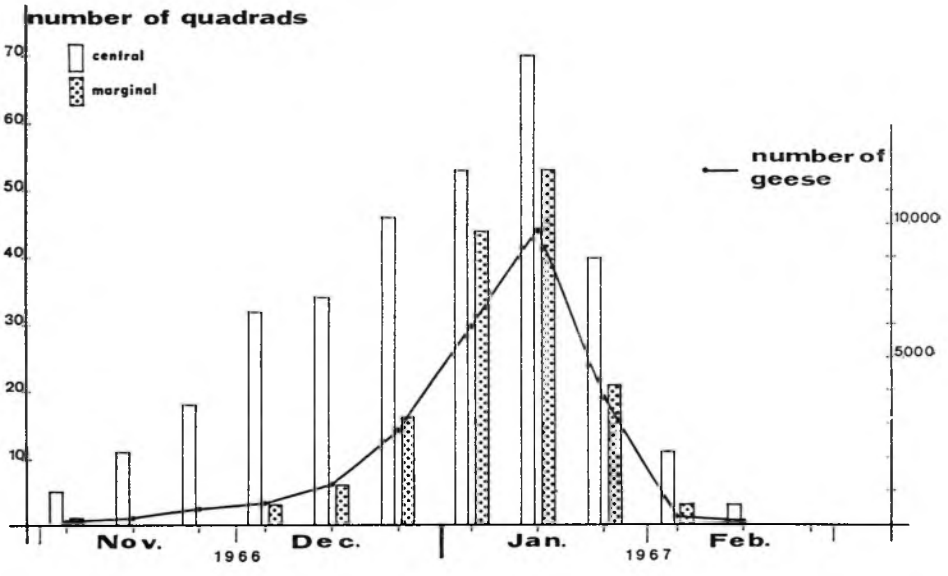

Figure 3. Relation between the numbers of geese and the numbers of grazed quadrats, per period of ten days. Marginal quadrats are only grazed at a higher rate in the middle of the wintering period.

mainly in the beginning and at the end of the winter, when the number of geese does not exceed an average of 1,000 birds per day. During the middle of the wintering period the geese themselves try to exploit the outlying grasslands. Disturbances, which usually occur on the edge of the Reserve, oblige the flocks of geese to fly to the centre of the plain. This is, we think, one of the principal causes of the crowding mentioned above.

Only on the most frequently grazed areas (42 out of 290 hectares) can there possibly be any damage by the geese. The extent of this damage, if it exists, cannot simply be assessed from the maximum numbers of geese present in a season. Moreover, to assess damage financially, it is necessary to investigate the composition and the productivity of the grasslands themselves.

The effect of grazing by geese on grasslands

In the Netherlands, van Dobben (1953, 1956) studied the grazing of winter wheat plots by captive geese. In Britain, Kear (1969) has done considerable work investigating several types of feeding grounds by means of different methods, such as artificial clipping, fences to protect crops and grazing trials with captive birds. In Sweden Markgren (1963) investigated the feeding grounds of Bean Geese, comparing grazed and ungrazed fields. While more attention has been paid to the possible damage to crops such as winter wheat, turnips, and spring cereals, most of the investigations have also dealt with grassland and concluded that usually no damage occurs. Only in exceptional situations when geese stay late in spring is there competition with domestic stock.

In 1966-67, we measured the effect of the grazing at Damme, as some farmers had complained about damage and were disturbing the geese. Areas grazed by flocks of wild geese were compared with ungrazed experimental fields. Both plots were on the same meadow, being as close together as some 100 or 150 m. In this way it was hoped that comparison would be made with two areas having very similar plant composition and productivity.

At the end of November, an area of 400 sq. m. was denied to the geese for grazing by stretching ropes across in a zigzag line, at 0.5 m. from the ground. Nets, wire-netting and the like could not be used to protect such experimental fields, since they shelter the area and can stimulate the growth of grass by up to 15%. (Ir. A. Andries, pers. com.) The area open to grazing was marked only with four small corner posts.

In December, January and February, 200 samples of the sward from both areas were taken, all vegetable matter being clipped, dried (at 105°C.) and weighed. The results are given in Table II.

Already by 19th December, before the arrival of the main flocks of geese, there was a marked difference between the two plots. This could hardly be due to the grazing of the geese and suggests that there was a difference in productivity or previous treatment of the two plots, despite their proximity.

Between December and January the yields from both grazed and ungrazed fields were reduced by a similar amount, respectively 27.5% and 30.7%. This indicates that the natural dying back and frosting of the vegetation was the most important factor. Between January and February there was a further small decrease in the yield of the grazed area while that of the ungrazed area remained unchanged. Even so the total decrease in the grazed area, 33.8%, was so similar to that of the ungrazed area, 30.4%, that the difference cannot be considered significant.

Grazed and ungrazed experimental fields were again sampled on 5th May. (Eight samples, each of 5 sq. m., were clipped by means of a mowing machine. This could not be done in winter as the vegetation was much too short.) This last sample could not therefore be compared directly with the previous series. However, taking the ungrazed value as 100%, the grazed area now yielded 108%, instead of, on 15th February, 81% of the

Table II. The grassland productivity on experimental fields at Damme, 1966-67. Figures indicate total yields (dry weights) expressed as a percentage of the ungrazed yield in December. Figures within brackets express the grazed yield on each date as a percentage of the December value for that area.

Date	*19th December 1966*	*23rd January 1967*	*15th February 1967*
I ungrazed	100.0	69.3	69.6
II grazed	85.2 (100.0)	61.9 (72.6)	56.4 (66.2)

ungrazed value at that date. The point at which the yields became equal is obviously of great interest, since if it were before the cattle were put out, the farmer would have no justification in claiming damage. If it were after that date, and the stock had to be kept inside for several days and artificially fed, then there would be a clear case for compensation at the local rate of about 5/- per beast per day.

Unfortunately the present data do not permit the decision on the date when yields became equal to be made with any assurance. If the undoubtedly erroneous assumption were made that the closing of the gap between grazed and ungrazed yields proceeded in a linear fashion, a graphical method would indicate 11th April as the break-even date. On the other hand, when samples were taken on 21st March there was already no visible difference between those from grazed and ungrazed areas (Plate III, facing p. 48). Moreover, as these detailed measurements of grassland productivity were carried out in only one wintering period, we cannot generalize any conclusions

It is possible, however, to get some idea of when the grass starts growing in any particular year and hence, by checking when the geese depart, determine whether they could be reducing the valuable 'early bite' grass.

In Holland, Jagtenberg (1966) pointed out that grass starts growing when the summed mean daily temperatures (°C.) from 1st January reach a total of 200 (only positive temperatures are considered in calculating this 'warmth-sum'). This moment of growth is compared for the last five years with the mean departure of the geese from Damme in Table III.

Table III. The sum of mean daily temperatures related to the departure of geese from Damme. Grass growth begins when the sum is 200.

	Sum of temperatures (from 1st January) in °C		
Winter	*First departure*	*Latest record*	*Average departure*
1964-65	128.0	155.7	141.8
1965-66	226.3	373.3	299.8
1966-67	131.1	171.0	151.0
1967-68	89.7	270.7	180.0
1968-69	205.6	235.1	220.4
Average	156.1	241.1	198.6

The first decrease in numbers generally occurred before the grass started growing. The averages show that usually the main flocks of geese have also left Damme before the growth of the pastures started. In only two years, 1965-66 and 1968-69, did geese stay for a longer time, and could have reduced the early yield on some areas of heavy grazing. The last geese often remained later than the point at which the 200 sum was reached but then only numbered at most some hundreds of birds.

Lastly, it is frequently alleged by farmers that geese pull up grass plants by the roots. Van Dobben (1956), Markgren (1963) and Kear (1966) agree that this did not occur, or only very occasionally after periods of frost. Sterbetz (1967), reviewing investigations on goose damage in Hungary, does not mention such a harmful feeding behaviour.

In the course of the present studies, large samples of goose droppings were examined, and only once were remains of some small roots found among the fragments of grass leaves. Thus, we think that geese either do not like these roots, or that they are not able to pull up plants out of the sward.

Acknowledgements

I am grateful to Professor Dr. J. Huble for advice and criticism, and to Ir. A. Andries for his essential help in our grassland investigations.

Thanks also go to my friends G. Burggraeve and W. Suetens who provided me with complementary counts at Damme.

This study was supported from October 1967 until December 1968 by a grant from the 'Institut tot Aanmoediging van het Wetenschappelijk Onderzoek in de Nijverheid en de Landbouw' (IWONL —Brussels).

I am greatly indebted to the staff of the Wildfowl Trust for discussing problems and for correcting the language of the manuscript.

Summary

The effects of grazing wild geese on grassland were investigated at the Wild Goose Reserve at Damme, Belgium. A high maximum of geese did not always mean a high intensity of grazing. The average number staying each day, and the duration of the wintering period were more

important. A formula to calculate the overall intensity of grazing for the whole reserve was proposed.

Samples of the daily distribution of grazing flocks led to calculations of grazing frequency. There was a preference for the central pastures, with marginal fields being subject to grazing only when larger flocks were present. Three categories of increasing grazing frequency were drawn up. Heavy grazing only occurs in the most central parts.

The effect of grazing is measured by sampling the sward on grazed and ungrazed experimental fields. Decrease of the yield through the winter was very similar on both fields, indicating that factors other than grazing by geese were most important. The date in spring when yield of grazed fields were wholly comparable with those for ungrazed ones would be of importance in determining whether any financial compensation is justified. The time when grass growth begins, depending largely on the warmth of the season, usually occurred after the large flocks of geese have left the reserve, and damage to 'early bite' was therefore unlikely.

Finally, it was concluded that the geese do not pull up grass by the roots.

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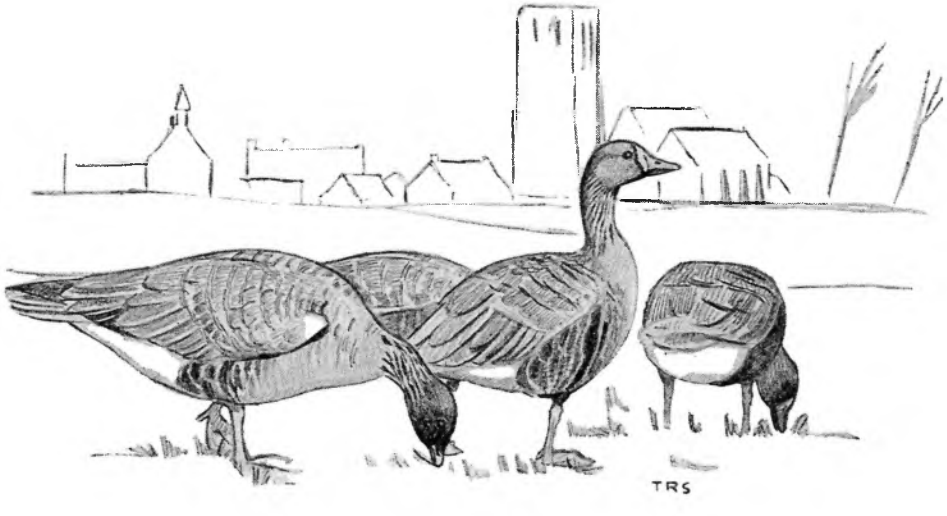

Potential Dangers of Exotic Waterfowl Introductions

MILTON W. WELLER[1]

Introduction

The emigrations of man have resulted in redistribution of much of the world's fauna, both accidentally and intentionally. Early intentional movements of desirable species of birds often were due to a desire to bring a little of the 'old home' to the 'new home', or to introduce a 'known quality' as opposed to an 'unknown'. More recently, these introductions have been for sporting purposes and have emphasized gallinaceous game birds. The Ring-necked Pheasant *Phasianus colchicus* and Gray Partridge *Perdix perdix* have proved especially successful in the wild in North America and certain countries in the southern hemisphere as well. These successes seem to reflect the occurrence of niches created by man as a result of his destruction of niches of native game birds (Gullion 1965). Such introductions of game birds have induced demands by sportsmen for more foreign species, with a resultant investment in time and money which has been questionable (Grinnell 1925, Leopold 1938, King 1942). Such releases have been questioned on other scientific and aesthetic grounds as lucidly presented by the above - mentioned authors.

Currently, at least in North America, interest is switching from gallinaceous game birds to waterfowl. This includes not only much expanded interest and efforts in aviculture but also the desire by sportsmen to have harvestable populations of waterfowl regardless of the species or the origin of that species. This interest apparently has been aroused by dwindling numbers of waterfowl, and more specifically, from the feeling that the south-eastern states have few resident species and little diversity for harvest. I also *suspect* that the sportsmen's desires for new ducks as targets stems from experience with certain species such as Muscovys which are easily harvested in large, dramatic 'shoots'.

Whatever the original incentive, several South American species now are under consideration by south-eastern states for possible introduction: Rosy - billed Pochard *Netta peposaca*, Yellow-billed or Chilean Pintail *Anas georgica*, Bahama Pintail *Anas bahamensis*, Ringed Teal *Anas leucophrys*, Brazilian Teal *Amazonetta brasiliensis* and Muscovy *Cairina moschata*. In fact, small numbers of Muscovys have already been released in Florida. My own experience with some of these species in Argentina (Weller 1967, 1968), and my concern over the biological and professional implications of such introductions, have prompted me to summarize my own observations and opinions on introductions of exotic waterfowl. I have chosen a journal of international scope because this is a widespread and significant problem. My remarks concern mainly introduction of waterfowl into the wild for the establishment of self-reproducing, harvestable populations, but certain types of avicultural practices also should be evaluated.

Previous introductions of waterfowl

Aviculturists or zoological gardens have on numerous occasions imported and released free-winged waterfowl after the stock has become conditioned to the pond or pen facilities. In such cases, free-flying birds associated with waterfowl flocks have not presented problems of dispersal because the food and water as well as the captive waterfowl flock formed a 'centre of attraction' and presumably provided all the needs of the birds. Moreover, such facilities often have been associated with urban or rural areas not suitable for establishment of wild breeding populations. However, small feral populations have become established: Mandarin Ducks *Aix galericulata* in England (Atkinson-Willes 1963), and Mute Swans *Cygnus olor* in New Zealand and Australia (Frith 1967). The Black Swan *Cygnus atratus* from Australia became extremely numerous in parts of New Zealand within a few years of being introduced. It now has to be strictly controlled (Miers and Williams 1969). Canada Geese *Branta canadensis* have survived on a substantial scale in England (Ogilvie 1969) and in New Zealand (Williams 1964, Imber and Williams 1968). Apparently these have created no serious problems with native species, although they have come into conflict with agricultural interests.

The situation for the aggressive and adaptable Mallard *Anas platyrhynchos* is

[1] Journal Paper No. J-6247 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1504.

somewhat less satisfactory. It was introduced into both New Zealand and Australia. In New Zealand, its habitat utilization, nest success, and relatively lower death rate, probably due to greater wariness, have resulted in a gradual increase in numbers of Mallard over the New Zealand Grey Duck *Anas superciliosa* (Balham and Miers 1959). Although this may have increased the total harvestable waterfowl, the real issues are hybridization and competition between the two species.

Hybridization

Possibly because of their elaborate courtship behaviour, their recent and dynamic evolution, and their forced concentration in water areas, waterfowl have shown greater propensity toward hybridization than any other group of birds (Gray 1958, Johnsgard 1960). Although much hybridization has occurred under the conditions of confinement, such crossing has shown that there are few genetic limitations and that most hybrids are fertile (Gray 1958).

Hybridization in most birds is limited to intrageneric crosses but waterfowl hybrids are both intergeneric and intertribal. The observations of Dilger and Johnsgard (1959) on species identification suggest that the interactions of two species not normally in contact may result in abnormally high rates of hybridization. Hence, the North American Wood Duck or Carolina *Aix sponsa*, a member of the tribe Cairinini, has hybridized with 26 species including 16 species of dabbling ducks (tribe Anatini), 5 species of diving ducks (Aythyini) and one shelduck (Tadornini) (Dilger and Johnsgard *loc. cit.*).

It is impossible to forecast the significance of this hybridization to wild populations of species not normally in contact, but the single dramatic example of hybridization of Mallards and Grey Ducks should produce hesitancy on the part of anyone concerned with the preservation of a native fauna: both the New Zealand subspecies (Sage 1958) and the Australian Black Duck *Anas superciliosa rogersi* apparently hybridize freely with Mallards and are being genetically swamped (Frith 1967). This could mean the elimination of these species if the Mallard continues to expand its range.

Of the species in question, the Rosy-billed Pochard has commonly been kept in captivity. It has been known to hybridize with both diving ducks and dabblers in captivity but there is an example of a wild hybrid with a Yellow-billed Pintail (Weller 1969). The possibility of hybridization of Rosy-billed Pochards with Redheads or Canvasbacks, is a frightening if remote possibility because the status of both North American ducks is already poor due to loss of habitat.

Movements and habitat selection

Waterfowl are renowned for their powerful flight and long distance migrations. Even tropical and sub-tropical waterfowl not influenced by seasons move long distances in response to water availability (Frith 1959). Both Rosy-billed Pochards and Yellow-billed Pintails are strong flyers and migrate long distances (Weller 1968). Rosybills move mostly to seek suitable water conditions but southern populations of Yellow-billed Pintails have a clear-cut annual migration in response to dramatic seasonal climatic changes in Patagonia. The other species under consideration for importation are sub-tropical in distribution and the movements have not been observed or at least reported.

The introduction of any species into a new climatic and habitat situation may produce unpredicted results. The introduction of waterfowl into any southern state is an introduction to North America and potentially to the entire northern hemisphere! Thus, the desires of a small group of individuals may influence the faunal picture for large groups of people who have no choice in the situation.

Competition

Competition of introduced and native species is more probable than not, especially considering the fact that most species evolve well-defined preferences in nest site and food selection. The fact that a habitat does not exist in the area where the species in question lives is no measure of the duck's response to a situation where that habitat does exist. Rosy-billed Pochards in Argentina normally nest over water in marshes similar to those of the western or south-eastern United States but these potholes differ little from the prairie pothole marshes of the midwestern United States and Canada. With the known migratory potential of this species, and exposure to a new dramatic seasonal climatic change, what will prevent this species from moving to any and all water areas in the northern and especially western United States where they might compete directly with Redheads and Canvasbacks for territories, nest sites and brood-rearing habitat?

Competition for nest sites by hole-nesting species may be of even greater significance because, in the case in question,

several *probable* hole-nesters are involved. Species like Ringed Teal and Brazilian Teal probably nest in holes as they do in captivity, but we know very little about them. Muscovys certainly do. Hole-nesters might compete directly with North American Wood Ducks, about which there is already grave concern due to loss of habitat (Trefethen 1966). Can we take a chance to produce further competition or is the native species of too little significance to have our concern or investment?

Chronology of nesting

A somewhat unique characteristic of southern anatids not restricted by clear-cut climatic seasons is their flexibility in time of nesting. Many species nest in response to water in Australia (Frith 1959), and those in Argentina may nest in rainy autumns or winters rather than in dry springs because of water availability (Weller 1968). How they will adapt to North American conditions is a moot question. Normally, southern species adapt to northern time cycles when brought to the northern hemisphere. However, we are unable to predict the responses to variable water conditions and temperature by species not normally influenced by light cycles. If birds were introduced which subsequently nested in the autumn in the southern United States rather than in the spring, this could create great complication in timing of hunting seasons. Hypothetically, this could reduce rather than increase potential waterfowl harvest in a given area!

Diseases

Introduction of diseases which may influence native species is a possibility which demands consideration regardless of its likelihood. (See Warner (1958) who deals with the problem in relation to the extinction of Hawaiian avifauna.) The diversity of parasites and diseases in waterfowl and variations in mortality dependent on stress seems a potential danger in introducing tropical forms into less tropical climates.

Some professional and ethical considerations

When considering introductions of waterfowl into an area lacking significant numbers of waterfowl, several basic questions must be asked. First, what is wrong with the habitat in question? Why doesn't it contain more duck species and why aren't resident species more successful? Does the area really have the food resources and other needs to be highly productive of waterfowl? It is possible that the general rule of great diversity of species in the tropics infers lower productivity of any given species? Are we trying to feed ten ducks in a pond large enough for only two or three? If so, can added species do anything but add competition or reduce the least adaptable of birds? Although we cannot answer these questions at present, they do provide 'food for thought'.

Professionally, should wildlife managers proceed in such endeavours when the welfare of native species is in question? Sometimes the best management is none. Always, understanding and evaluation of values and needs must precede action. Too often, 'do something' managers have a long tally sheet of efforts but with little measurable progress. If the role of wildlife managers is only to release targets, then any method is fair. If, however, they are applied ecologists with interests in conservation of native fauna as well as sensible utilization of that fauna for food and recreation, they cannot and will not encourage experimental releases because the outcome is scientifically unpredictable by current methods.

Even if an intensive investigation is made of the species in its native habitat or in captivity, can we predict what will happen when it is introduced to the wild? Captive birds do not behave as do wild ones, and climatic conditions are only a gross clue to the evolutionary history of the birds in its native range. Add new variables and the situation is unpredictable. Moreover, there is no such thing as a 'local' experimental release. Any release of free-flying birds designed to study species interactions and habitat usage is a *release*, not an experiment! It may prove impossible to control.

Perhaps the most serious matter in concerning ourselves with the search for the perfect duck to satisfy all our waterfowl problems is that we continue to avoid the facts concerning management problems of native waterfowl. We avoid encouraging hunters to face facts by responding to their pleas for cure-alls. Might it not be better to develop hunter interest in and ability to identify under-harvested species —rather than always leading them to 'greener pastures'?

Even if an exotic species is established, is not harmful, and is a 'great success' for sportsmen, there are aesthetic and ethical questions which cannot be ignored. There are many biologists who feel that man already has sufficiently modified the fauna that he should not endanger additional

native species. Others feel that the situation is now so unnatural that there is little need to retain or protect the native forms. Indeed, they believe that any species that can survive in harvestable levels is desirable. Regardless of one's personal convictions concerning introductions of birds to certain locales, waterfowl introductions do differ from those of other game birds. These birds are strongly migratory and no citizen of the United States has the right to introduce migratory birds into Canada — or England — or Russia. And no biologist can predict where an introduced species will become established once it is brought across the equator. Do we have the right to make this decision for others? This is an international issue of great importance to those interested in their natural avifaunas.

Summary

Many South American waterfowl species are being considered for release in the south-eastern United States. There are serious dangers in such action, including hybridization and competition with native species. Such dangers must be recognised before introductions are made.

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The ecology of tapeworm parasites in wildfowl

R. A. AVERY

Introduction

The Anatidae, like most groups of vertebrates associated with freshwater or marine environments, are likely to be infected with a wide range of metazoan parasites. Of these, the tapeworms (Cestoda) are amongst the most abundant and ubiquitous. In a search of the literature, Lapage (1961) recorded more than 100 species of these worms. Many of these species may be synonyms, but nevertheless the total number must be very large. Individual birds may be heavily infected —burdens of 20-30 worms were found quite commonly in wild Mallard *Anas platyrhynchos* at Slimbridge, Gloucestershire (Avery 1966b), and Mallard and Canvasbacks *Aythya vallisneria* have been recorded as carrying exceptional infections of 15,000 and 40,000 worms respectively (Avery 1966b, Cornwell and Cowan 1963).

The purpose of this paper is twofold: to review advances in knowledge of the ecology of tapeworms in wildfowl since Lapage's paper, and to describe some experiments which were carried out at the Wildfowl Trust, Slimbridge, on the ecology of some of the commoner tapeworms of ducks. No attempt has been made to include work on the parasites of domestic ducks and geese, except where this is relevant to the ecology of wild birds, or to the problems of keeping wild birds in captivity.

Review of the literature

United Kingdom

Miscellaneous records of tapeworms from Anatidae have appeared in the literature for many years. Menzies and Venn (1952) and Venn (1953) recorded species which they considered to have caused the deaths of wildfowl at Slimbridge. Soulsby (1958) gave a more detailed list. This work was extended by Avery (1966a,b) who listed tapeworms and other parasites found in 123 Slimbridge birds which died in 1960 and 1961, and in 30 wild Mallard caught in the decoy. The most comprehensive account is that of Beverley-Burton (1964), who examined nine species of ducks from Nacton Decoy, Suffolk, St. James' Park, London, and Silwood Park, Buckinghamshire, and recorded and described 25 species of tapeworm parasites.

Europe and Asia

There have been no comparable attempts to list the tapeworms of wild Anatidae in Western Europe. In eastern Europe and the U.S.S.R., however, there has been a considerable amount of work on the parasites of animals of economic importance, and more than 40 papers a year have recently been published on the parasites of ducks and geese. Most of these are surveys of the incidence of infection in domestic birds, or of methods of control of infection by pharmacological or husbandry techniques. They also include surveys of infection in wild birds carried out with the primary aim of determining whether the worms carried by these birds represent a potential threat to domestic poultry: for example Sultanov (1958), Kotelnikov (1962, 1963, 1964), Parukhin and Truskova (1963) and Dansan (1964). Recent papers on the infection of wild Anatidae with tapeworms include those of Macko (1961), Zajicek and Pav (1963) and Rysavy (1966) for Czechoslovakia; Korpaczewska (1963) for Poland; Sultanov (1963) for Uzbekistan; Maksimova (1963) for Kazakhstan; Gerasimova (1964) for Omsk; Khuan (1962), Oshmarin (1963) and Rizhikov (1963) for the far east of Siberia; and Tsimbalyuk (1965) for Komandorskye Island. Handbooks on parasites of domestic Anatidae and their control have been written by Czaplinski (1960b) and Rizhikov (1967), and there is a chapter by Shevtsov (1966) in I. N. Gladenko's book on farm stock and poultry.

North America

Recent studies on the helminth parasite fauna of North American Anatidae include those of Hanson and Gilford (1961), Buscher (1965, 1966) and Threlfall (1968). A particularly valuable contribution has been made by Cornwell and Cowan (1963). These authors examined 180 Canvasbacks and made a careful study of differences in the parasite fauna of birds of various ages and from several localities. They correlated the differences with changes in the feeding habits of the hosts. Ducklings were more heavily infected than adult birds, although worm burdens varied considerably, even between ducklings in the same brood. The adult ducks tended to lose their parasites during the summer moult, when they were feeding mainly on vegetable material.

Life cycles of the parasites

The life cycles of most of the commoner tapeworms found in wildfowl are well

known. They involve a larval stage, called a cysticercoid, which is parasitic in the haemocoel of crustacea such as copepods and ostracods, and more rarely in cladocerans, and also in leeches or molluscs. A specimen of the copepod *Cyclops strenuus* harbouring two cysticercoids of the tapeworm *Sobolevicanthus gracilis*, is shown in Figure 1, as is an infected ostracod.

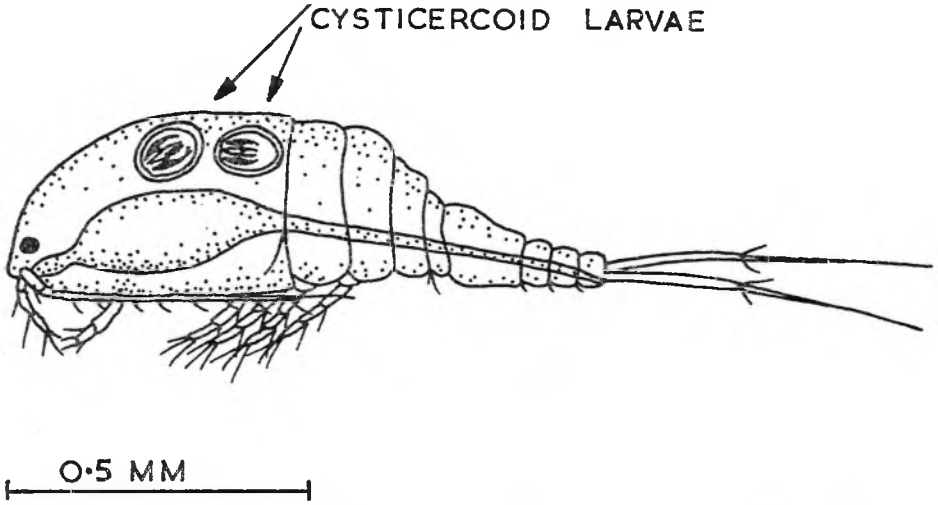
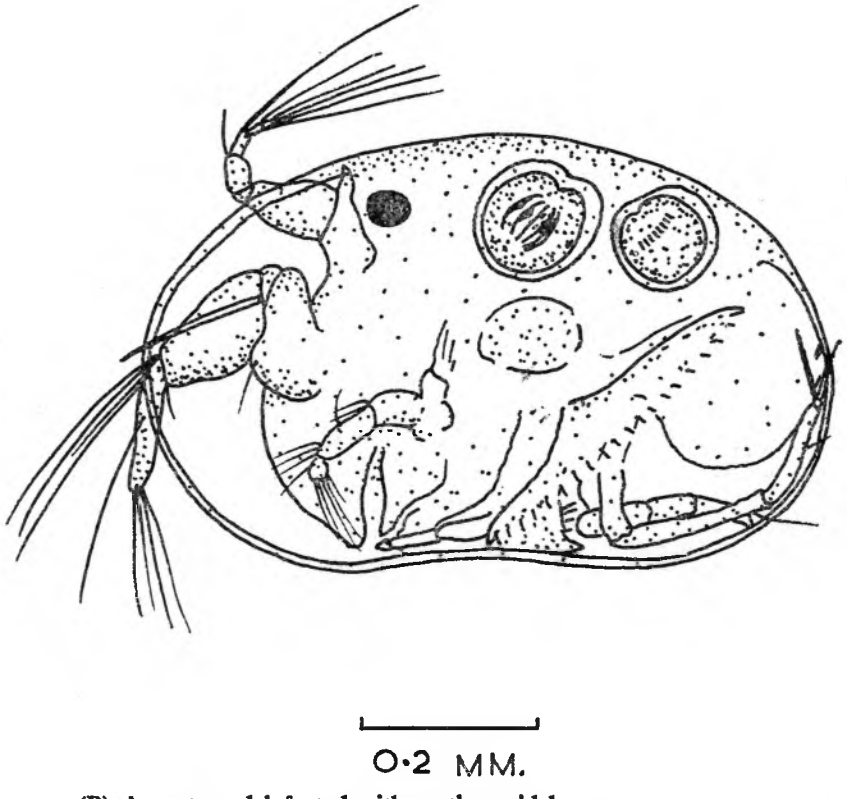


Figure 1. (A) A specimen of the copepod *Cyclops strenuus* infected with two cysticercoid larvae of the tapeworm *Sobolevicanthus gracilis*.



(B) An ostracod infected with cysticercoid larvae.

Polish workers have in recent years added to our knowledge of these life cycles, as part of an ecological survey of parasitism in the Mazurian Lakes (Rybicka 1958; Jarecka 1958, 1960, 1961; Rysavy 1961). The time which these larvae take to become infective depends on the temperature, but is usually two to three weeks (Petrochenko and Kotelnikov 1959; Czaplinski 1960a; Rysavy 1960 and others).

At Slimbridge, larval cestodes have been found in the copepod *Cyclops strenuus* and in the ostracods *Cypria ophthalmica* and *Cypridopsis vidua*, all of which are abundant in the ponds. The species whose larvae have been found in these hosts are shown in Table I. No larvae were found in water fleas (cladocera) or in the water louse *Asellus*, which also occur in the ponds.

The biology of the parasites

General

Much of the work on tapeworms in Anatidae is descriptive, limited to listing the parasites, giving their numbers, or discussing their pathological effects. Little is known about the biology of the worms: it is not known how long they live, how many eggs they produce, or what their nutritional requirements are.

A number of experiments carried out at Slimbridge were designed to investigate some of these problems, in particular: 1) the growth rates and longevity of tapeworms in ducks infected under laboratory conditions; and 2) the ways in which tapeworm populations would develop in flocks of Mallard exposed to natural infection for extended periods of time.

Growth rates and longevity of tapeworms

Khaki Campbell ducklings were reared in the laboratory on bitumen-floored pens where they had no opportunity to acquire tapeworm infections, and at 27-34 days of age were fed 20 cysticercoid larvae by gelatin capsule (Parke Davis no. 5). Four birds were killed every three days and their tapeworms measured and weighed.

Two such experiments were performed: in Experiment 1 the birds were fed larvae of *Dicranotaenia coronula*, and in Experiment 2 those of *Sobolevicanthus gracilis*. These two species were chosen because they have larvae which are easily recognised under the low power of the microscope—the former species has a ring of several dozen small (20-30 microns) hooks on the rostellum, while the latter have only eight hooks which are comparatively long (80 microns) and of a characteristic shape (Figure 1). These larvae were obtained by collecting large numbers of planktonic crustacea from the Slimbridge pens with an aquarium net, examining the animals in batches under the microscope, and selecting those infected with larvae of the required species.

The results of these experiments are shown in Table II. Both species of tapeworm grew and matured rapidly; they began producing eggs nine days after infection. At this time the largest worms were 230 mm. long and weighed 345 mg. If early growth is assumed to have been exponential over this period, these specimens of *D. coronula* doubled their wet weight in less than nine hours and their length in less than 19 hours.

After day 9, eggs continued to be produced until the worms were eliminated.

Table I. The species of tapeworm larvae found in crustacea from the Slimbridge ponds.

Tapeworm species	*Host species*		
	Cyclops strenuus	*Cypria ophthalmica*	*Cypridopsis vidua*
Fimbriaria fasciolaris	+	+	+
Sphenacanthus sp.	+	+	—
Hymenolepis spiralibursata	+	+	+
Sobolevicanthus gracilis	+	+	+
Diorchis nyrocae	+	+	+
Nematoparataenia southwelli	—	+	—
Dicranotaenia coronula	—	+	+
Diorchis stefanskii	+	—	—

Egg production by *S. gracilis* in two birds was measured by putting the ducks in wire-mesh floored cages, collecting the faeces over a period of one week, making a suspension of the faeces in water, and counting the eggs in aliquots. The estimated totals were 24,000 and 36,000 eggs per worm per day. Elimination of whole worms with the faeces began on day 11 and continued until the infections were lost. The last specimens of *S. gracilis* were found 36 days after infection, and the last *D. coronula* 42 days after infection.

An unexplained feature of these results was the considerable variation in growth rates of worms. Within the same host, the biggest worms were often ten times heavier than the smallest. This was not due to a 'crowding effect' since the retardation of smaller worms was just as great in birds with light infections as in those with heavy ones. Further investigation of these phenomena was defeated by the technical difficulty of keeping a sufficient number of uninfected birds in the laboratory, and in obtaining viable cestode larvae in sufficient quantities at the appropriate times.

Tapeworm populations in small Mallard flocks.

Flocks of wild-type Mallard were reared under tapeworm-free conditions a mile from the Wildfowl Trust and then put into a pen at the western end of the Slimbridge enclosures. This pen contained a pond about fifteen feet in diameter. The birds picked up infections with tapeworms by feeding on infected crustacea in the pond. These infections in the crustacea derived from wild birds visiting the pond both previously and during the experiment. Seven species of tapeworms were acquired by the birds. Each species occupied a characteristic zone of the alimentary canal; shown diagrammatically in Figure 2. Some of the Mallard were killed at intervals to determine the number and condition of their tapeworms. Two such experiments were performed.

Experiment A. (Figure 3).

Twenty-four 5-7 week old uninfected ducklings were put into the pen on 25th June 1961. Three further birds were dissected to check that they were indeed free from tapeworm parasites at this time. Four ducklings were removed from the pen after 17 days and dissected the following day. Thereafter samples of three birds were removed and dissected in cycles of 3, 9, and 27 days until day 118, when the two remaining birds were examined. The rate at which parasite populations might be expected to change was not previously known. The sampling intervals were therefore arbitrary and compromised between observing short-term population changes and providing long-term data.

Of the cestode species acquired by the birds during this experiment, three occurred only sporadically. The two commonest species, *Sobolevicanthus gracilis* and *Diorchis stefanskii*, were found in respectively 12 and 17 of the 24 birds examined. The pattern of infection with

Table II. Growth and longevity of tapeworms in Khaki Campbell ducklings.

	no. of worms	*length (mm.)*		*weight (mg.)*	
		mean	*range*	*mean*	*range*
Sobolevicanthus gracilis					
day 3	14	12.5	6- 14	0.5	0.2- 0.9
day 6	18	62.5	45- 90	41.2	14.9- 75.4
day 9	10	69.0	30-105	91.5	59.4-126.4
day 12 to day 33	44	59.7	20-125	34.0	1.2- 79.2
day 36	2	60.0	25- 85	29.5	3.3- 55.2
day 42	0				
day 48	0				
Dicranotaenia coronula					
day 3	6	6.8	5- 9	0.2	0.1- 0.3
day 6	10	97.0	85-120	41.9	29.5- 62.8
day 9	6	160.8	80-230	168.1	29.8-345
day 12 to day 33	25	221.4	35-440	255.2	0.9-691
day 36	0				
day 42	2	157.5	50-265	107.5	7.0-208
day 48	0				

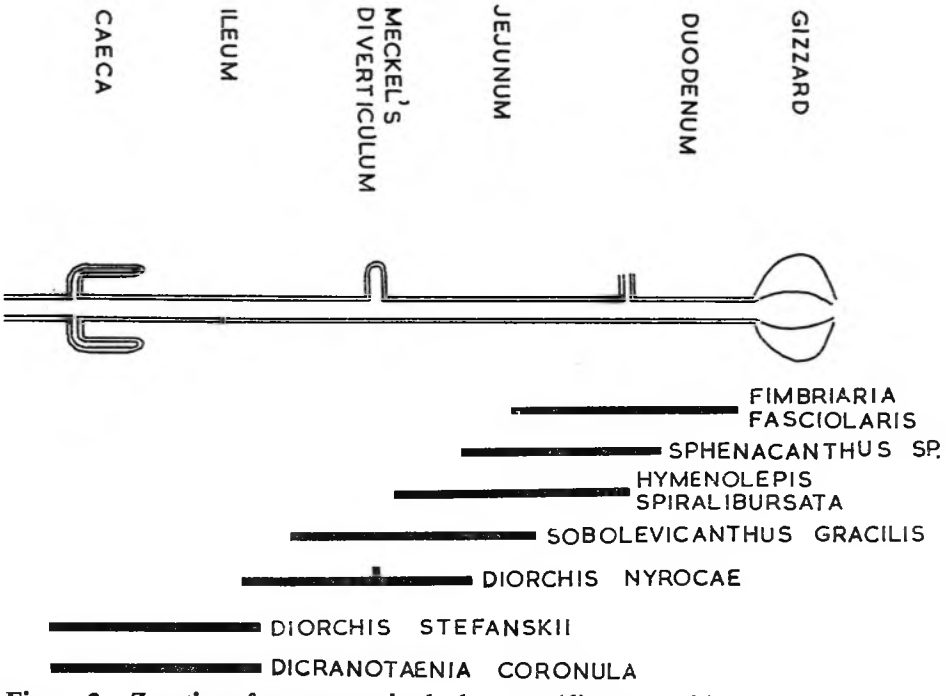


Figure 2. Zonation of tapeworms in the host gut (diagrammatic).

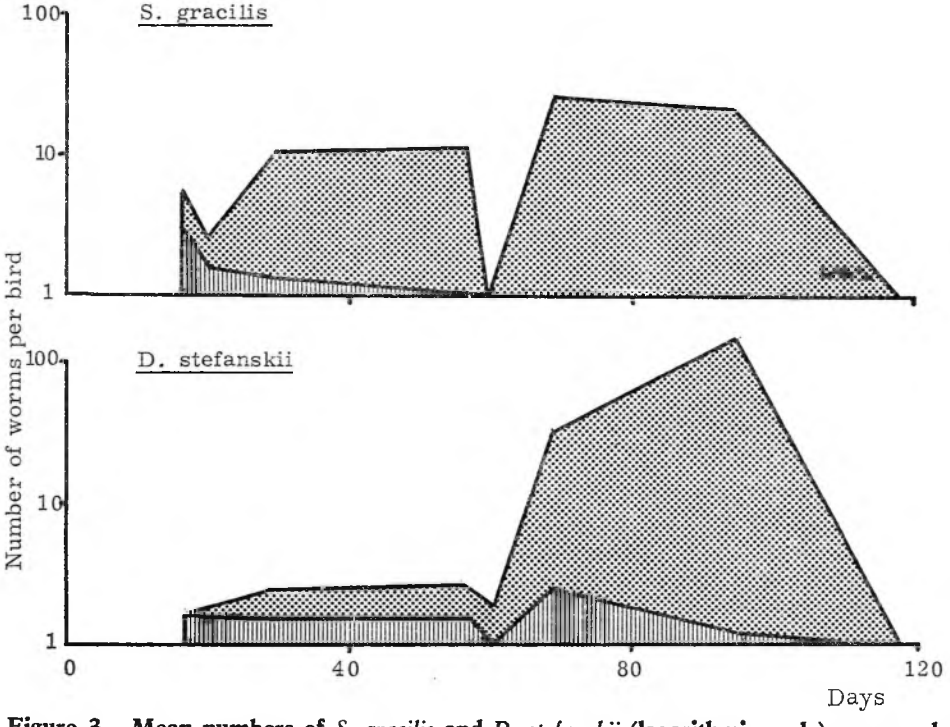


Figure 3. Mean numbers of *S. gracilis* and *D. stefanskii* (logarithmic scale) recovered from birds in Experiment A.
Vertical bars — mature tapeworms
Stippled — smaller immature tapeworms

both these worms was the same. A small number of large mature worms up to 190 mm. in length were found on days 17 and 20. The mean level of infection then rose, and this process accelerated by day 60. At the same time the size of the worms decreased so that most were small, stunted and immature. By the end of the experiment the mean levels of infection had fallen. These changes are shown in Figure 3, and mean lengths of specimens of *S. gracilis* in relation to the number of worms in each host are shown in Figure 4. In the other cestode species changes in infection levels and worm condition followed a similar pattern, in so far as their sporadic occurrences allowed the detection of changes.

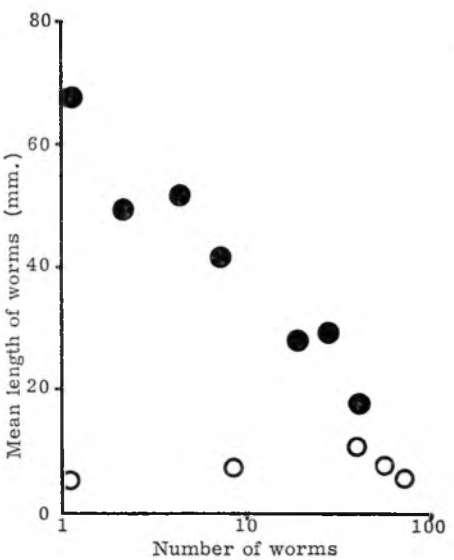


Figure 4. Experiment A. Mean lengths of *S. gracilis* from different hosts.
Black dots — 18-56 days after the birds were put in the pen
Open dots — 68-95 days after the birds were put in the pen

Experiment B. (Figure 5).

The objects of this experiment were:
i) to investigate the relationship between intermediate host populations and adult tapeworm infections in a wild-type Mallard flock over a whole summer, and
ii) to provide further information on the stunting phenomenon. The design of this experiment was more complex. A large number of uninfected birds were put into the same pen as before on 18th June 1962 and kept over the hard winter of 1962-63. On 27th February 1963 (day 258), and thereafter at 21-day intervals until 4th September, samples of four birds were put into cages in the laboratory. Their faeces were collected for 7 days, examined carefully to see if they contained any pieces of tapeworm, and then used for counts of tapeworm eggs by the dilution method. The birds were then killed and dissected. Some of the birds did not settle under these conditions and these were killed after 2-3 days without faeces having been collected.

To simulate breeding in a host flock, 22 uninfected ducklings were added to the pen on 3rd July 1963. They were accepted by the adult flock (at that time 12 birds) and became an integral part of it. Samples of four of these juvenile birds were killed after 7, 14 and 21 days, and then at the same 21-day intervals as the adults until 4th September: the remaining two were killed on 25th September. As it had been found that tapeworms could mature very rapidly in young birds, the ducklings were examined at once and not kept for faecal examination.

At the same times as each sample of ducks was removed, estimates were made of the total populations of crustacea and their parasites in the pond. This was done by sampling crustacea at four depths, using a perspex box of 500 cc. capacity, closeable at any depth. The numbers of parasite larvae were estimated by collecting crustacea with an aquarium net and counting the numbers of cysticercoid larvae of each species in 1,000 *Cyclops strenuus* and in 200 *Cypria ophthalmica*. Statistical analysis of replicates showed that the crustacea were estimated with an accuracy of ± 10%; no similar assessment of the accuracy of the cysticercoid estimates could be made.

Seven species of tapeworms were found during the course of this experiment, and all of them were found in more than a quarter of the birds. The commonest species, *S. gracilis*, was found in 39 of the 56 birds examined.

The four birds in the first sample of adults, which had been in the pen for eight months when they were removed on 27th February, were heavily infected with a mean burden of 120 worms (of 4 species) per bird. At this time it was estimated that there were 750,000 *Cyclops strenuus* and 10,000 *Cypria ophthalmica* in the pond and that the levels of cysticercoid infection in both were less than 0.5%. Subsequent changes in levels of infection of ducks and crustacea with three species of tapeworms and their larvae are shown in Figure 5. During the

summer the levels of infection in ducks remained constant, but the infection of *Cypria* with larvae of *S. gracilis* and *D. coronula* increased. By 3rd July there were 1,349,000 *C. strenuus* and 354,000 *C. ophthalmica* in the pond. The infection level in *Cyclops* was still less than 0.5% but in the ostracod *Cypria* it had risen to over 30%. Nearly all of the adult worms found in the ducks were small stunted individuals only a few millimetres in length. None of the faeces from the 20 birds kept in cages contained eggs, and even after the hosts had been in the laboratory for seven days the worms were still very small, showing that both growth and reproduction remained inhibited.

Because of the high populations of larval cestodes present, the ducklings put in the pen in 1963 quickly acquired heavy burdens of several hundred tapeworms per bird. Initially many of these worms were large mature specimens up to 100 mm. in length, but after three weeks the worms found were more and more stunted, and after six weeks were only a few millimetres in length, as were those in the adult birds. This pattern of events was similar to that observed in experiment A.

The increased input of eggs into the pond from the mature worms in the ducklings raised the level of infection until more than 50% of the *Cypria* carried cysticercoids. Since the presence of such a larva castrates the ostracod, this had a disastrous effect on the population of the latter which was decimated from 354,000 on 3rd July to 31,000 on 14th August. This explains the drop in cysticercoid numbers which can be seen in Figure 5. *Cyclops* were much less heavily infected; by 4th September the infection rate had only risen to 1%, giving a cysticercoid population of 25,000 larvae in the pond.

These experiments demonstrate inhibition of the growth of tapeworms. This develops after ducks have been continuously exposed to a high level of infection. The maturation of worms picked up by ducklings at a time when those in adult birds were stunted shows that factors in the external environment such as the nature of the food supply were not responsible. Detailed analysis of the data for *S. gracilis*, the commonest tapeworm species, support this hypothesis. The mean lengths of worms from each host in Experiment A are shown in Figure 4. At first there was a linear relation between mean worm length and the logarithm of worm number; this was observed from day 18 to day 56 and is represented by black dots in the Figure. At this period there would seem to be a 'crowding effect' due to competition between the worms in the gut. This phenomenon is now well known in tapeworm infections in both mammals and birds (Read and Simmons 1963). After day 56 all worms

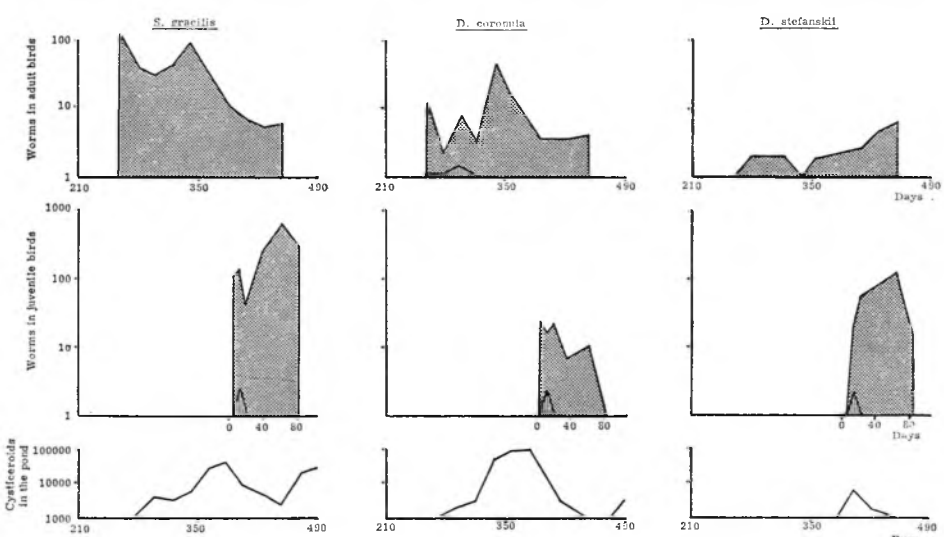


Figure 5. Experiment B. Mean numbers of *S. gracilis*, *D. coronula* and *D. stefanskii* in adult and juvenile birds, and total numbers of cysticercoid larvae of the same species.
Vertical bars — mature tapeworms
Stippled — smaller immature tapeworms

became stunted, at both high and low population densities; this is represented by open dots in the Figure. The same result was obtained for worms from the juvenile birds in Experiment B, except that at the higher population densities in this experiment, inhibition was more rapid and became marked after day 21. In the adult birds in Experiment B there was no relation between size and numbers of worms—all were stunted and no mature specimens were found.

The mechanism of this inhibition is not understood. It has often been reported that the presence of adult tapeworms in rats and other mammals may inhibit the development of any further worms which may be acquired. This phenomenon is called premunition (Roberts and Mong 1968). Since inhibition is also maintained in adult ducks with long standing infections of small worms, some kind of host response may be involved. It is very difficult to separate effects due to premunition from host response effects (for example, immunity), but this has been done in an ingenious experiment by Tan and Jones (1967). These authors surgically implanted into mice, tapeworms previously exposed to X-rays; because of the irradiation, these survived for only a few days. On reinfecting the mice with normal worms, they found that development was retarded, compared with controls, showing that the previous infection had changed the suitability of the host for tapeworm growth.

The considerable differences in growth rates of worms in ducks infected under laboratory conditions (Table II) may also be explained in terms of a host response. Worms reaching maturity in 6-14 days complete their development before a response is provoked. Slower-growing worms have not reached maturity by the time the host response occurs, and under the subsequent sub-optimum conditions are unable to satisfy the enormous energy requirements for egg production. This is entirely speculative, but demonstrates the need for further research.

Although the cause of inhibition is not known, we can consider its significance in the interaction of host and parasite populations. Wildfowl are highly mobile animals which often congregate in large numbers at certain times of the year, and disperse at others. If the fecundity of their tapeworm parasites is such that their populations can be maintained when the hosts are dispersed, then their populations would increase rapidly when the hosts congregate. Most cestodes of Anatidae are large parasites in relation to the size of their hosts, therefore great numbers may be detrimental to the birds, and hence, in terms of survival, to the parasites themselves. Inhibition of growth therefore provides a mechanism for reducing the effects of high densities of parasites on their hosts. It also limits the rapid increase of cestode populations which would otherwise occur when the hosts congregate, by reducing the egg laying rate and increasing the time a generation takes to reach maturity. It is not known how long inhibition is maintained when parasite populations fall, and this is a first priority for further research.

Wisniewski, Szymanik and Bazanska (1958), also noted a 'crowding effect' amongst tapeworms of wild duck caught in Poland. They generalised this as a 'formation of a population structure', i.e. of tapeworms within the Anatidae of a particular region—and they speculated that this could be regarded '. . . as a form of defence of parasite and host, the population structure (being) convenient for both, and may be accounted for as reflecting a full accommodation of both'.

The results from sampling crustacea and their parasite larvae also showed some interesting relationships between populations of parasites, hosts and intermediate hosts. The decrease in cysticercoid numbers in midsummer, due to castration of the ostracods by the parasites themselves, is an additional mechanism by which tapeworm numbers may be regulated when the hosts are crowded.

At times when both copepods and ostracods were infected with larvae of tapeworms such as *S. gracilis* and *H. spiralibursata*, the ostracods were much the more heavily infected. This was probably a consequence of their bottom-living habit, since tapeworms eggs sink rapidly in water. Cysticercoids of *D. stefanskii* were found only in copepods; ostracods do not appear to be a suitable host for this species. The numbers of cysticercoids of *D. stefanskii* in the pond were consequently very much smaller than those of the other species (Figure 5). However, the populations of adult parasites of this species in the ducks were as large as those of others, for example *D. coronula*. This suggests that copepods are a more efficient intermediate host than ostracods, perhaps because they occur at all depths and are therefore more likely to be eaten in numbers by ducks dabbling at the surface.

Estimates of the relative infection efficiency of cysticercoids from the two types

Table III. Relative infection efficiency of tapeworm larvae. Ducklings in Experiment B.

Tapeworm species	*hosts of larvae on 3.7.63* *ostracods*	*copepods*	*relative infection efficiency (per cent)*
D. nyrocae	+	—	<0.01
H. spiralibursata	+	—	0.01
D. coronula	+	—	0.01
F. fasciolaris	+	—	0.07
D. stefanskii	—	+	0.11
S. gracilis	+	+	0.22

of intermediate hosts were made by comparing the mean numbers of tapeworms in the ducklings killed on day 7 in Experiment B with the cysticercoid numbers in the pond one week earlier. The results are shown in Table III. Relative infection efficiency was defined as

$$\frac{\text{number of tapeworms per bird} \times 100}{\text{number of tapeworm larvae in the pond.}}$$

It can be seen that uptake was more efficient in those two species utilising copepods. From the data for infection of ducks and ostracods with *D. coronula* it was estimated that at least 12 ostracods must have been eaten each day; this is equivalent to the filtration by each duck of three-quarters of a litre of water per day. These are of course only very rough estimates, calculated on the unreal assumptions that the crustacea are evenly distributed in the pond, and that all the cysticercoids which are eaten become adult tapeworms.

Although many of the birds in Experiment B were carrying infections of 200-300 worms, none of them showed obvious signs of any resultant ill-effects. This does not mean of course that tapeworms are never of pathological significance in wildfowl, they may well become so when the host is subjected to abnormal stress. But the present experiments have shown that the effects of the worms on their hosts under a variety of conditions need further careful experimental investigation.

Acknowledgements

I am grateful to the Nature Conservancy for the award of a Post-Graduate Research Studentship; to the Wildfowl Trust for facilities at Slimbridge, and to the staff for their co-operation; and to Dr. J. Green for identifying the ostracods.

Summary

Recent work on the incidence of tapeworm infection in Anatidae and on the life cycles of the parasites is reviewed. Experiments carried out at Slimbridge on tapeworm parasites in Mallard showed that in a primary infection some of the worms may grow very rapidly to a large size, but they do not survive in the host for more than 42 days. In flocks of Mallard exposed to continuous re-infection, worm numbers built up to high levels but their growth was inhibited. The mechanism of this inhibition is not known; it probably acts as a density-dependent regulator of the total worm population. Some numerical relationships between numbers of crustacea in a pond, numbers of tapeworm larvae parasitising them, and numbers of adult tapeworms in ducks feeding on them, are described.

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Some notes on the Paradise Shelduck

MAURICE FITZGERALD

In WILDFOWL 19, Dr. Kear, commenting on D. S. Wintle's article on Versicolor Teal, said that his 'observations show how much of scientific interest can be achieved by an aviculturist with even a small collection of wildfowl. We hope that others will be encouraged to study the behaviour of their birds in a similar way'. I was so very fortunate to be personally encouraged by Dr. Kear on her all too brief visit to my home in New Zealand in January 1969. I then determined to place on record my perhaps unique experience of the Paradise Shelduck *Casarca variegata*. As my 86th milestone is just around the corner, I thought I had better get on with the job.

My first aviary was a disused W.C. in the backyard of our Wellington home during the 1890's. It was not until I returned from the First World War and acquired a home of my own that I was able to ask the Department of Internal Affairs to arrange for the Southland Acclimatisation Society to send me half a dozen Paradise Ducks. When they arrived they were in full moult, showing not a single feather on their heads. On making enquiries about sexing I was informed by those who should have known better that it was impossible to sex the breed until after their first moult. In due course they all turned out to be males. They must have been adults too. This experience probably challenged me to get at the facts in my own way, as I did.

Breeding

My experience with their nesting habits is limited to the mob which is centred on Rotomahana Lake near Rotorua where they assemble during December to go through their annual moult. They disperse over the pumice plateau as far north as Tokoroa, 34 miles away, at breeding time. Usually the parties to arrive comprise one female accompanied by several males. Within a few days just one pair remain—probably the lady of last year and her old mate, if he be still as fit as ever. Years of observation lead me to believe that all pairs of that clan commence laying on the same day. One pair which nested year after year in a rock cavity overlooking a stream quite close to a farm house always took their newly hatched brood to a nearby lagoon formed by damming the stream for the purpose of generating electric power. They were under constant observation. When the chicks were able to fly the whole family departed—presumably to the tribal home at Rotomahana—before the adults started to moult.

On one occasion, when the clutch of eggs was still fresh, ten Indian Runner eggs were given the birds in exchange for their own. These were duly hatched and reared on the lagoon. About the end of November the adults, who apparently felt the urge to leave, spent days of anxious effort to teach their family to fly. In the end the parents left, leaving the near flightless Indian Runners on the lagoon.

The following year the pair returned to the same area but selected a new nesting site. The male died as a result of bashing into a farm wire fence, and the nest was destroyed. Within a short while the female made friends with a tame pinioned male in the farmer's garden and went to nest in another position. Someone robbed that nest and frightened the bird away. All that day she flew over the farmhouse shouting what were understood to be curses at a husband who had failed to warn her of the approach of strangers. She vanished for a day or two but returned with a new follower and is believed to have had a third nest that season, though I have no evidence one way or the other. This experience enhanced my scepticism for assertions that suchlike birds mate for life. It seems probable that the young female is first to lay claim to a nesting territory and that (as I have heard it said) she selects a mate from her retinue. Next season it is she who is first on the spot to lay claim to her established rights and, if he be there, it is her mate of last season who feels that the other males are intruders and acts accordingly.

Several old writers have asserted that both sexes share the duty of incubation. I have seen no evidence of this. Mid-afternoon the female comes off her eggs and flies to a favourite spot for a feed, a thorough bath and preen. On the way there she is joined by her mate who spends most of the day grazing on a high place overlooking the area of the nest. The pair then circle their territory a few times before the female drops down to the nest and the male returns to his observation post.

Our Paradise does not form crêches as the Common Shelduck *Tadorna tadorna* appears to do, but one experience of mine is worth relating here. A Muscovy

hatched out five or six Paradise eggs in a small chicken coop. When they were about three days old the chicks got out during the night or early morning. I found them accompanying a tame Paradise female who had never had a mate nor ever laid an egg. I promptly released the mother Muscovy but the ducklings stuck to the maiden lady who successfully reared the lot.

Development of sex differences

The adult male, when showing annoyance at some intruder, or even when greeting his keeper, holds his head close to the ground with bill horizontal, and rushes forward honking in a deep voice. The female, when calling, holds her head high and flicks her bill up at each call. The male ducklings, when only a few days old, adopt that 'hangdog' stance of their fathers when running about. I once sorted a dozen babies on that basis—giving six, believed to be males to one foster bantam and the remainder to another hen and kept the two lots apart. The result was 100% right.

Charles Darwin was very struck with the unique manner in which this bird completely reversed sexual colouration. First feathers appear alike in both male and female—mainly dark grey body with clear black head and neck. The males remain like that but some will have two or three small white feathers among the black on their heads, which used to be very misleading. The females, while still flightless, begin to change to their adult colours of warm brown with pure white head and neck. With some clutches the females show a slight tinge of brown on breast as soon as those feathers come out of the quills—age about five or six weeks. At seven or eight weeks old the female head, which was black at first, shows white feathers against the bill. Within a week this is a complete white band about $\frac{3}{8}$th of an inch wide and rings of white are beginning to show around the eyes. At two months the head is about 50% white and at six months the head and neck are completely white. Laidlay, who has bred these birds, tells us that the females eclipse to the extent of reverting to the grey body at moult. I have occasionally observed a tendency towards that behaviour.

Broken wing display

Dr. Kear, when walking along the margins of shallow water on which parents and ducklings were floating, witnessed the broken wing display by the male who came ashore and tried to lure her away landwards. She sought my opinion as to how that habit could be inherited in a land that never had endemic mammals. I have never experienced such a sight, probably because my approach to young broods has either been where the birds were near farmhouses and accustomed to human beings who took little notice of them, or along small stream beds running along narrow cuts through the pumice plateau so that any dry-land antics by the male would be out of my vision. There would be no point in the act if I were arriving by row boat. Other people such as Buller, Guthrie-Smith and Douglas have reported seeing the display performed on land, and Mr. Explorer Douglas' dogs seem to have been the cause of some 'predator distraction' behaviour. If the broken wing behaviour be an inherited characteristic it may be traceable to the extinct eagles which once inhabited this land. Dr. Kear is inclined to think the large extinct rail *Aptornis* might be responsible, but I feel that this bird wasn't large enough. Human beings have inhabited the land for nigh on 2,000 years, though few, if any, were in the mountainous parts of the south island which is the principal habitat of the Paradise. In any case, man is not fooled into thinking that the bird is really injured, he merely realises that it has young; so in relation to him, the display is more likely to have been a disadvantage and quickly eliminated. Wild pigs, which certainly might take young, have been here for less than 200 years. There is the possibility that Paradise learned the device from experience and that those of today have learned by precept. That would rule out heredity. When approaching a brood by boat the parents will yell an alarm and skitter along the water in order to induce the chicks to dive or hide in nearby water weeds—something they are constantly doing when harrier hawks, or even the predacious Black-backed Gulls, are about.

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While WILDFOWL 20 was in press the Editors received the sad news that Mr. FitzGerald died on 4th August 1969.

The behaviour of the White-backed Duck

A. CLARK

Introduction

These observations on the White-backed Duck *Thalassornis leuconotus* were undertaken to check and extend those which Johnsgard (1967) made on captive birds, because of the apparent lack of information on this species in the wild. They were made on ducks which were present for varying periods at three dams and one natural pan situated in the vicinity of the Witwatersrand, Transvaal, South Africa. The waters were relatively shallow, with maximum depths varying from two to six feet. Although sedges and other aquatic plants provided suitable nesting sites, no breeding took place during the period of observation, i.e. July 1968 to April 1969. The names of the various comfort movements described are taken from McKinney (1965) and for the movements associated with threat and copulation the names are taken from Johnsgard (1967).

Resting or sleeping

The birds rest or sleep on the water in groups, invariably with the beak tucked into the scapulars, the distances between individual birds varying from one foot to two yards. At such times the tail is inconspicuous but sometimes it is raised slightly off the water. At Spaarwater where the greater portion of the water surface was choked with mats of grass stalks and other aquatic plants, they preferred this area and were never seen very near the shore nor resting in open water. This seems to be the general pattern, but at Impala Park they had to move very close to the shore to get anchorage of this type and would sometimes sleep in open water where, like the Maccoa *Oxyura maccoa*, they would drift in the wind. Although Clancey (1967) states that Whiteback repair to dry land for rest, I would consider this exceptional for the study area.

Frequently a bird may be seen sleeping with one expanded webbed foot visible, sometimes with both feet sticking out on either side like fins, and this habit may explain their preference for the anchorage provided by stalks of aquatic plants.

During the daytime most birds sleep for three to four hours in the late morning with casual shorter spells at other times. The greater part of the day is spent sleeping, giving the impression that the birds are inactive. Although they are apparently sleeping, they push their heads up instantly when a Marsh Harrier *Circus ranivorus* flies near, or move away from an approaching Coot *Fulica cristata.* Maccoa, Southern Pochard *Netta erythrophthalma* and Red-billed Pintail *Anas erythroryncha* have also been seen amongst the White-backed Duck. Often when disturbed from their sleep the latter push their heads up and will often Wing-flap. The sequence, Nibbling - preen, Shake and Wing-flap is not unusual at this time and Leg-wave, Wing-and-leg-stretch and Head-scratch may also be seen.

The break up of sleeping parties takes place gradually. Single birds or small groups will leave and go on their way to feed. Flights just above the water surface for distances of ten feet to fifty yards are occasionally taken. There are often short swimming movements with little apparent purpose. These involve direction changes, movements away as though avoiding, movements towards as though asserting and much pausing with head partly raised and held stiffly.

Feeding

The White-backed Duck feeds by diving to the floor of the water and sifting food from the mud or debris resting there. Although Clancey states the birds dive with a leaping action and Johnsgard confirms this, all the Whiteback under observation made a smooth plunge like the Maccoa except that the birds made a splash dive when avoiding a Coot. The Fulvous Whistling Duck *Dendrocygna bicolor* lifts part or the whole of its body clear of the water when diving but may frequently feed by 'up-ending.' The Whiteback does not move far laterally under water when feeding. In water approximately one foot deep I have recorded 12-14 seconds under water and 4-6 seconds between dives above. At Spaarwater where the depth was two to three feet, time under water varied from 15-20 seconds, time on surface from 5-10 seconds. At Tweefontein Dam where the water had an estimated depth of six feet, I recorded 25-30 seconds under water and 7-12 seconds above. Feeding from the surface is unusual. The times under water agree closely with those given by Johnsgard but he gives a more extended period on the surface between dives.

Whilst on the surface between dives I have seen birds tread water, the feet

pushing water downwards, not backwards as when swimming. This behaviour is evidenced in the slight rocking movement of the body and the movement of the surrounding water. As a result of the treading action the body is lifted noticeably and the breast prominently displayed. The treading continues until the birds dive again and it is possible that they behave in this way when they are feeding in rather shallow water, the slight lift of the body facilitating the dive.

As the water level at Spaarwater dropped, the birds occasionally fed where the surface water was matted with grass. Here they had to struggle to surface properly and sometimes the head only came out. Before diving again they would lower the beak on to the breast. Occasionally when a bird surfaces it carries a string of weed in its beak which it makes no attempt to swallow. Sometimes the head is blackened by debris the bird has stirred up in feeding. At Spaarwater Coots frequently fed in the wake of a diving bird.

The main observed feeding times are from dawn to shortly after sunrise and in the late afternoon until sundown. At Spaarwater they mainly chose the areas where the surface water was free of vegetation and the birds joined together in groups of varying sizes. Once feeding commenced the birds continued steadily and some fed for 60-80 minutes without a break. Sometimes they would cease for a period and then continue feeding.

Flight

The Whiteback seldom flies during the day and when it does, like the Maccoa, it has difficulty in getting airborne and paddles the surface for 10-20 yards before rising clear. For this reason it usually takes off into the wind and prefers windy days. Its wings beat steadily and it appears to have little manoeuvreability. It flies with legs to the rear protruding beyond the tail. Before landing, its legs are lowered and the webs of the feet fanned out, as if as air brakes, before being moved forward to take the impact of the water. Even so the bird usually ploughs into the water with its breast. I have not seen them come down on land.

To reach another bird, or to feed, some take short flights of ten yards just skimming the water or longer flights in a direct line at a height of approximately four feet. Protracted flights of a more formalised nature, by two or more birds, occur in the afternoon when they rouse themselves prior to feeding. These flights, which seem to have no other purpose than exercise, take place at from 5-30 feet and the birds keep over the water.

Two typical instances of pre-flight behaviour were recorded as follows: 'Six birds swam off in single file. After a short distance they mostly turned to face the wind with heads up. There was a pause and I saw one bird Shake and two Wing-flap. After another pause I saw one lateral Head-shake. There was another brief pause and they all flew off and did a figure-of-eight over the pan.' 'Two birds with heads up faced the wind. They turned and swam with the wind. After a short distance they turned to face the wind, hesitated and then swam again with the wind. They repeated this movement a third time before facing the wind to take off.'

It is evidently important for the Whiteback to have a good stretch of water in front before attempting to fly. I have seen a bird swim 100 yards with the wind to enable it to get into a position to take off into the wind. The Head-shake is not often used and when it is, is not necessarily repeated by other birds in the group. Pre-flight behaviour is mainly recognised by birds gathering, hesitating with their heads up and facing into the wind. Flight is not always simultaneous. Quite frequently after flight I have seen birds rest with beak in scapulars.

Voice

The main call of the Whiteback consists of a double note which sounds like 'Tit-weet,' reed-like, with the second longer note lower than the first. When on the water the bird puts its head right up to call. Single birds may call between dives, or during a pause in swimming or during a break from sleep, but occasionally others will join in. The call is sometimes given during a take-off, during flight or immediately after coming down on water. The double note is often repeated several times and I have heard one bird repeat the call at intervals over a period of 50 minutes when it seemed to have no signal value. It is also sometimes heard after disturbance occasioned by people or an aggressive approach of another bird. The 'Tit-weet' call carries well and can readily be heard at a distance of 100 yards or more. Johnsgard also records a 'conversational' or contact call consisting of three to five notes uttered on a rising series of soft whistles.

Comfort movements

The Swimming-shake or Shake begins with the wing feathers being slightly

raised and shuffled, followed by the head being lifted and the breast raised off the water to give a brief shake. In the final position the beak is often pointed upwards. There is no forward movement. The Swimming-shake may be seen during a break in sleep, following disturbance and during the bathing and preening periods which follow feeding. Sometimes the Tail-wag precedes the shuffling of the wing feathers but because of the short tail it is not easy to see. The Tail-wag may be performed on its own during preening or swimming. The lateral Head-shake may occur before or after flight but it can be seen also during preening periods.

The Wing-flap behaviour of the Whiteback differs little from the pattern common to dabbling ducks. The body is, however, often lifted clear of the water when the treading action of the feet can be seen. On these occasions the body is nearly erect and the flapping may be protracted for ten or more seconds. The movement may occur during a break in sleep when several birds will perform in succession. It also occurs after disturbance, after flight and during preening.

During sleep on the water the feet are usually hidden under the wings. Occasionally a foot will be brought out and waved before being returned to its resting place; this Foot-shake is also seen in the Maccoa Duck. In the Whiteback, however, the foot may be left exposed. Wing-and-leg-stretch behaviour may be seen during a break in sleep and also during preening. Scratching of the head or neck with the foot occurs mainly during preening periods.

Invariably after an extended feeding period the Whiteback bathes and preens often for 10-15 minutes at a time. Bathing begins by the bird dipping its head and withdrawing it quickly to throw water over the back. Shoulder-rubbing is often combined with bathing and performed when the head is thrown backwards. Then follows Wing-thrashing usually with both wings together. On one occasion only have I seen a bird do a partial somersault. I have not seen Dashing-and-diving. Preening and oiling follows bathing when much attention is given to the breast feathers, tail and underside of the wings. Shoulder-rubbing is frequently seen. During preening the bird may Head-shake, Shake, Wing-flap, Tail-wag, Scratch head or shake the wings. Wing-thrashing may also be seen. Nibbling-preening may occur at any time during the day and at Spaarwater the birds would get on to a Coot's platform and concentrate on cleaning their breast feathers.

Threat

Threat display seems to take place mostly after pair formation. When swimming one member of a pair will drive away another bird. The following patterns have been observed: (1) One bird would swim towards another with its head on its shoulders and the other bird would retreat sometimes by diving. At times the bird approached would not retreat but pushed its head up and slightly backwards in the Head-back posture. The approaching bird would do the same and the two birds would pause for a few seconds side by side often looking in opposite directions. Occasionally they would remain in this rather statuesque position for more than a minute. (2) One bird would take a flight of 3-4 yards towards another, often paddling all the way. The other would dive in retreat or push its head up and the two would adopt the side by side head-up position. (3) The aggressive bird would swim quickly with beak open and attempt to grab the other bird which would retreat quickly. (4) One bird would swim towards another with head forward. The other bird would go to meet the threat and as they reached each other they would rear up with head high on extended neck and breast off water. There would be no contact but they would pass over each other's shoulders and resume their normal swimming posture. I have seen the aggressed bird dive after such an encounter.

Pair formation

The following incident, which I believe to be typical of paired birds, was recorded in the late afternoon. 'Two birds swam forward, side by side, with heads partly up and held stiffly. One bird, which I think was the drake, seemed bigger than the other and its breast was more prominent. The smaller bird dived and swam underwater. The other bird swam to join it as it surfaced. The smaller bird dipped its beak as if to feed from the surface. The other did the same and again both immersed their beaks. Both birds then swam off in a dignified way with head erect and joined other birds to feed.' On another occasion the birds swam round in a circle about 5 feet diameter, dipping their beaks frequently. I have seen no especial male courtship display.

Copulation

Copulation was seen at Spaarwater, a natural pan, on three occasions in August between 16.20 hrs. and 17.10 hrs. and followed feeding. The number of birds present on the pan varied from 20 to 24 and threat action was most frequently seen at this time. If other birds were near the pair they were threatened and moved away. On two occasions the pairs involved swam away side by side with heads up and breasts slightly raised for a short distance when Bill-dipping commenced. The female commenced first on one of these occasions. Bill-dipping during which the head is almost completely immersed, was repeated once on one occasion and twice on another, by both birds. On the third occasion copulation was preceded by the birds swimming round in a circle with head and neck on water, and body low. Immediately following Bill-dipping behaviour the female swam low in the water with head forward. On one occasion she swam thus round the male. Copulation followed with some splashing caused by the beating of the male's wings.

Only two post-copulation displays were seen, one display being interrupted by a Coot. On these occasions both birds performed the Step-dance, treading water with bodies erect and one wing fully displayed. Observation was made at a distance but it would appear that the wing away from the other bird was raised. On one occasion, whilst treading water, the male bowed forward three times, almost touching the water with his beak. The female may have done this also. In one case both birds remained motionless with heads up for ten seconds following treading. Then the female was seen to Wing-flap and Preen. Eventually they swam away side by side with heads erect. These observations confirm those on post-copulatory behaviour made on captive birds at Slimbridge by Johnsgard. In one apparently unsuccessful copulation sequence he recorded Bill-dipping by the male only, so further observations are necessary to confirm that both birds perform in this way in typical pre-copulatory behaviour. Once I saw the female Whiteback Bill-dip twice and stay prone soliciting copulation but the male nearby remained with his head up.

Johnsgard indicates a relationship of the White-backed Duck to the whistling ducks. I have seen the complete copulation behaviour in the Fulvous Whistling Duck once only. Only the male dipped his beak several times without completely immersing his head. Meanwhile the female remained with head up on extended neck and moved as though to hinder the male so that his dips alternated from one side of her to the other. I have seen similar behaviour in the White-faced Whistling Duck *Dendrocygna viduata* but copulation did not follow.

At the time of these observations the pan was not more than two feet deep at any point and the incidents took place more than forty yards from the shore. It would seem that the conditions were suitable for breeding but it was the dry season and the pan level was dropping. During September the numbers present dropped steadily and by the middle of October, when the water was not more than nine inches deep, the Whiteback had all left.

Summary

The habits and behaviour, characteristic of the White-backed Duck *Thalassornis leuconotus*, are described including features associated with resting, feeding, flight, the voice and comfort movements. Types of threat display are described as well as limited observations on copulation.

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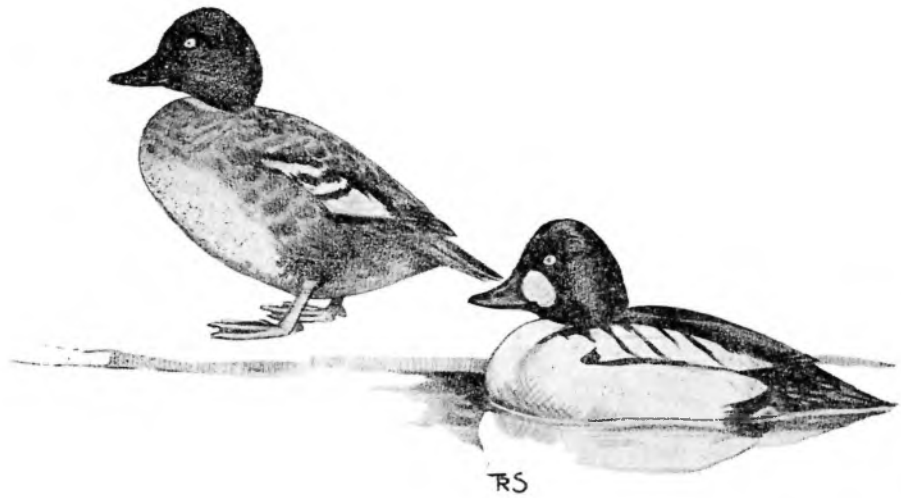

Pre-dusk and nocturnal behaviour of Goldeneye, with notes on population composition

S. E. LINSELL

King (1961) drew attention to the flocking of European Goldeneye *Bucephala clangula* at the approach of dusk. His observations were made in March and April on reservoirs in Somerset, but he quotes J. W. Campbell as having observed the same phenomenon at Abberton Reservoir, Essex. The present situation there was therefore examined and observations extended throughout the night at full moon periods. The birds were observed from the relative comfort of a car overlooking a bay on the main Reservoir.

Bispham (1945) wrote that the record number of Goldeneye on any inland water during the period 1924-1936 was about 50, and he regarded the count of 200 at Abberton on 23rd February 1945 as phenomenal. But on 16th March 1966 there were 510, 14% of the total counted throughout Britain, and three days later the numbers peaked at 765. Unfortunately there were fewer birds in the subsequent two years when the most intensive observations were made. The peak in 1967 was 641 on 1st March and in 1968 only 252 on 13th March. An increase in numbers on the Essex coasts probably contributed to the diminution at Abberton. In 1969 the position was restored, no fewer than 720 Goldeneye were present on the official wildfowl count day, 16th March. In fact, for the first time Goldeneye were the most plentiful duck on Abberton.

In the three years of observations no pre-dusk gatherings were observed in November, December or January, birds remaining as scattered as by day into the first three hours of darkness. Small gatherings were observed about the middle of February and they became marked in March (Table I).

A substantial but variable fraction of the total population had thus gathered into one flock by sunset. Birds often swam considerable distances, over 400 yards, to join the flock but were seldom observed flying to it. The shape of the raft of birds was typically spoon-like, a long straggling line ending in an oval mass. In 1966 observations were maintained each night until three hours after sunset, using 10 × 70 binoculars in bright moonlight. No further accretions to the raft were

Table I. The sizes of Goldeneye rafts on Abberton Reservoir, Essex

Date	*Total count on Reservoir*	*Main congregation 1 hour before sunset*	*At sunset*
1966			
March 4	574	204	274
5	596	335	460
6	587	262	338
7	594	297	389
1967			
March 25	273	60	96
26	267	57	86
1968			
March 13	252	46	76
15	202	41	73

observed but courtship behaviour, other than Neck-dipping by the female (Johnsgard 1965), continued.

During the four moonlit nights in 1967 and 1968 observations were carried right through until one hour after sunrise, using 22 × 80 binoculars. On all these occasions further accretions to the flock were seen in the two hours following sunset, the maxima reached being respectively 130, 126, 104 and 94, until roughly half the population was in a single raft. Activity ceased between 23.30 hrs. and 23.50 hrs. by which time all the birds appeared to be in the sleeping attitude with head tucked in the back.

A little later the most remarkable form of behaviour was observed. Two 'brown-heads' were seen to leave the oval end of the raft and swim its entire length, one on either side. On reaching the last bird they turned about and swam back to the oval end. The 'patrolling' was carried out, always by two 'brown-heads', at regular intervals of about a quarter of an hour throughout the night. The first 'patrol' was recorded at 00.15, 00.20, 00.48 and 00.15 hrs. on the respective nights and the last at 05.40, 05.35, 05.57 and 05.55 hrs. There may have been an earlier 'patrol' than the first recorded on 13th March 1968 because the moon was obscured until 00.30 hrs. and, with choppy water conditions, close observation was not possible. Indeed the second 'patrol' on 15th March began at 00.33 hrs. Attempts were made to ascertain whether the same two individuals carried out the 'patrols' throughout a night. However, the birds at the oval end of the raft, although apparently asleep, continually changed their relative positions as they slowly rotated on the spot or drifted a short distance. Coupled with the eye-strain, this made it impossible to keep one's eyes fixed on one of the 'sentries' for more than a few minutes after its return.

As far as is known, comparable behaviour to this regular 'patrolling' has never been observed before and it would be most interesting if workers elsewhere could observe nocturnal flocks of Goldeneye and of other ducks. The present limitation to bright moonlit nights is undesirable. It is perhaps worth recording therefore that when, during a dark overcast spell, the car headlights were shone for 10 minutes on a raft about 100 yards distant, not a head was raised and no other disturbance was noted. Probably, however, the use of an infra-red telescope would be the best, if expensive, solution.

It is certainly tempting to seek an explanation of the behaviour by analogy with the patrols of human sentries around a sleeping encampment. But, one may ask, against what are the patrols directed? It is not impossible that the behaviour subserves some different function.

To complete the nocturnal behaviour study, it can be said that the awakening of the flock followed an essentially similar pattern on all four nights in 1967 and 1968. Birds started to wake, in the oval end of the flock first, within a few minutes of 06.00 hrs. and coincident with the first calls of Sky Lark *Alauda arvensis*, Lapwing *Vanellus vanellus* and Redshank *Tringa totanus*. Fifteen minutes later all were awake and swimming about but not diving or taking to the wing. Head-throwing by drakes commenced but evoked no response from the females. By 07.00 hrs., when observations ceased, about half the flock would have dispersed, with the rest well scattered over the bay.

In the course of these and other intensive observations on the Goldeneyes, it became clear that age and sex of the 'brown-heads' could be determined with a considerable degree of certainty, at least during March and April. The Goldeneye frequently swam to within 15 yards of the observer seated in a car on one of the causeways. Young birds have brown or greyish tips to the bill instead of the adult's pinky-yellow. Their eyes are whitish, greyish or dull brown instead of the bright golden yellow of the adult. Both these characteristics are distinct in sunny conditions up to 400 yards. In flight the young birds' wings lack the conspicuous black bars and show much less white, it being confined to the secondaries instead of extending to the greater and median coverts. At rest, the white seldom shows on young birds as it invariably does on adults. The clean-cut white collar of the adults and the contrasting appearance provided by their greyer upper-parts are also lacking in the young.

Adult males, of course, present no problem and, as generally reported in Britain (Nilsson 1969), they were in a distinct minority. Over the three years 32 counts, made when total numbers exceeded 100 in March and April, gave median values of 13%, 17% and 15%. In the last two years the above criteria were used for the detailed analysis of the 'brown-heads' on 18 occasions in the same two months. The results are set out in full (Table II) so that the reliability of the technique may be judged. The median

Table II. Composition of the Abberton Goldeneye population by age and sex.

Date		*Adult* ♂	*Adult* ♀	*Young* ♂	*Young* ♀	*Total*
1967						
March	1	101	487	5	48	641
	3	91	372	1	48	512
	8	92	320	1	25	438
	15	81	258	4	27	370
	21	71	211	9	44	335
	22	59	182	6	51	298
	29	43	181	9	22	251
April	1	34	157	15	57	263
	5	32	142	16	68	258
	7	40	178	11	59	288
	15	20	110	11	44	185
1968						
March	1	33	173	2	25	233
	8	29	187	0	29	245
	13	37	180	1	34	252
	15	24	160	0	18	202
	22	41	153	0	15	209
	29	51	158	2	23	234
April	4	21	87	1	9	118

values for the proportion of adult females were 63% and 74% of the total population. The heavy preponderance of females (median ratios of 4.1 and 4.7 per male) confirms a differential migration of the sexes to Abberton. From January onwards young males have begun to show some whiteness around the facial spot and/or along the flanks and their identification is clinched when they indulge in Head-throws. On these criteria the imbalance of the sexes is even more extreme in the young birds, median values (with a wide scatter) for the same periods as the adults being 5.4 and 12.5 females per male.

It will already have been noticed that the proportion of young birds of both sexes is low. In March the median proportions were 10% and 11% in the two years. Unless there had been particularly bad breeding seasons, these figures would indicate a differential migration by age as well as by sex. It would be interesting to know whether the remaining young birds had travelled further, or less far, than the adults. The latter certainly appear to start leaving Abberton earlier, for as numbers fell in April the proportion of young rose to around 30% in 1967, and probably to a similar figure in 1968 though the small total numbers then made the analysis of uncertain value.

Acknowledgements

I would like to express my grateful thanks to the late Major General C. B. Wainwright, C.B., founder and Director of the Abberton Ringing Station, and to his assistant, Roy King, for every considerable encouragement and assistance. Mr. Kenneth Aldridge, Resident Engineer of the South Essex Waterworks Company, kindly allowed me to bring my car within the reservoir boundaries. Dr. G. V. T. Matthews gave me much help in the compilation of this paper.

Summary

Up to 460 Goldeneye *Bucephala clangula* studied at Abberton Reservoir, Essex, gathered into flocks at dusk in March. Night-long observations in 1967 and 1968 revealed regular 'patrolling' by 'sentries'. Differential migration by age and sex is shown by the heavy preponderance of adult females on the reservoir.

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The proportion of yolk in the egg of the Maccoa Duck

W. R. SIEGFRIED

Lack (1968b) has presented information on the proportion of yolk in the eggs of waterfowl, but no data were given for the Oxyurini in which the egg-weight/body-weight ratio is greatest (Lack 1967, 1968a). Nor does Lack (1968a) give information on the body-weight of adult female Maccoa Duck *Oxyura maccoa*.

Fresh eggs, each from a different clutch, were taken from wild Maccoa nesting at Uitenhage and Stellenbosch in the Cape Province, South Africa (I am grateful to Mr. P. N. F. Niven for collecting those from Uitenhage). The eggs were then hard-boiled and weighed as described in Lack (1968b). Shown in Table I are figures expressing the proportions, by weight, of shell, yolk and albumen. It is clear that the yolk forms about two-fifths of the weight of the egg in *Oxyura maccoa*, thus confirming Lack's (1968b) contention that the proportion of yolk does not vary significantly in waterfowl eggs of different size proportionate to body-weight.

The weights of three adult, non-breeding female Maccoa were 565 gm., 580 gm. and 516 gm., giving an average of 554 gm. This suggests a figure of 15.9% for the egg relative to body-weight, which is high even among Oxyurini (Lack 1968a, see Appendix 15). Indeed if, like Lack, we took Schönwetter's (1960-66) egg-weight datum (calculated from the linear measurements of 19 eggs), a figure of 17.4% would be obtained. Even using the lower percentage, a clutch of six eggs which is the mean value given by MacNae (1959), is equivalent to 96% of the female's body. Large clutches of more than 10 eggs, which are frequently reported, are almost certainly the result of intraspecific parasitism.

Table I. Weight and proportionate constituents of Maccoa Duck eggs.

	Weight (fresh)	Percentage of weight formed by: shell	albumen	yolk
	gm.	%	%	%
	98	11	50	39
	87	14	49	37
	84	12	49	39
	97	12	49	39
	73	13	49	38
Average	88	12	49	38

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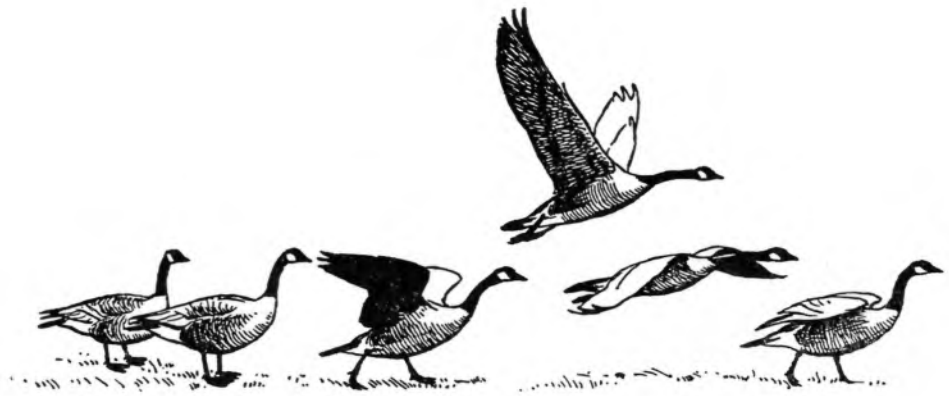
Note. Six unincubated eggs of the Ruddy Duck *O. jamaicensis*, examined at the Wildfowl Trust in 1969, gave the following average figures for constituent parts: weight, 79 gm.; percentage of weight formed by: shell, 11%; albumen, 51%; yolk, 38%. These again confirm that the proportion of yolk does not vary significantly between waterfowl species. (J. Kear.)



The status of the Canada Goose in Britain 1967-69

M. A. OGILVIE

Introduction

The Canada Goose *Branta canadensis* was originally introduced into this country from North America in the seventeenth century. Successive introductions have taken place since, the birds being released mostly on private waters both for their sporting value and as ornamental waterfowl. Little is known of the early history of the species in Britain, nor is it the intention of this paper to explore the matter. Potentially as interesting, but equally obscure, are details of the origin of the introduced birds. It is generally accepted that the British population is identical with the nominate race *B. c. canadensis* which inhabits the eastern parts of North America (Delacour 1954), and certainly this population would have been the most accessible to would-be exporters. It has recently been suggested (Kear 1966) that some of the British birds share characteristics with the Giant Canada Goose *B. c. maxima* as described by Hanson (1965), notably large size, a tendency for the white cheek patch to have a backward pointing hook at the top, and tameness, but this has not been fully investigated.

Although there is no information on actual numbers brought to Britain, it is reasonable to suppose that they would have totalled only a few hundreds even over a long period. It was not until 1953 that any attempt was made to count the British population. In that year a census was organised through the British Trust for Ornithology and the results published in considerable detail (Blurton Jones 1956). The total for July 1953 was found to lie between the limits of 2,200 and 4,000 birds. Blurton Jones noted that the geese were distributed in discrete, localised sub-populations, each with a rather restricted range, and little or no movement between them.

It was at about this time that the conflict between the Canada Geese and agricultural interests began to become more obvious. A resident flock of geese can do much apparent and a certain amount of real damage to crops, and it is therefore not surprising that farmers should have regarded this grazing species as a competitor with their stock and a reducer of grain yields. Some landowners had long been controlling numbers on their estates through removal or pricking of eggs. The 1954 Protection of Birds Act made this an offence, though it is doubtful whether this had much effect. However, other means of control were sought.

One method which rapidly gained favour was the reduction of flock size by the bodily removal of birds to other waters. Canada Geese are comparatively easy to catch in quite large numbers. When flightless during the annual summer moult they can be herded off the water and into a corral of netting. During the years 1953-57 the Wildfowl Trust undertook a number of round-ups at waters where flocks had become too large. There was little difficulty at first in finding places to release the surplus birds. Landowners with lakes but no Canada Geese were often willing to take them, and a number of wildfowling clubs also took birds in the hopes of establishing flocks which would provide sport. The Wildfowlers' Association of Great Britain and Ireland largely took over the catching and disposal of surplus Canada Geese

in the late 1950s. The full details of the movements and numbers involved are not the concern of this paper, and in any case it is more than doubtful whether complete records exist. The Wildfowl Trust moved at least 700 birds over five years, and the Wildfowlers' Association probably about the same number.

Nearly all the transportations resulted in the successful establishment of a new breeding flock, though some birds wandered, and a small proportion managed to return home, sometimes from distances of over a hundred miles. Dealing with sedentary birds a fairly high success rate was to be expected. Hine and Schoenfeld (1968) record that recent attempts to extend the winter range of migratory stocks of Canada Geese in the U.S.A. by transporting birds have nearly all been failures, despite the moving of about 20,000 geese. The ability shown by some British geese to home was rather surprising as the species was not known to move far under normal circumstances. To digress, this sedentariness might also be regarded as strange, in view of the long seasonal migrations between breeding and wintering areas undertaken by most populations of the species in North America. This could be a further prop for the suggestion that the original stock was drawn from the virtually non-migratory Giant Canada Goose population. History does not record whether any of the early introductions to Britain failed because the birds set off on migration. However, even if the original stock was migratory, in a species such as the Canada Goose, which has strong family bonds and the adult birds literally lead their young on migration, it would not take many generations for a sedentary tradition to be established. This process would be hastened by food supplies and climate remaining adequate throughout the year. The recent development of a moult migration in one sub-population in Britain, also a normal habit of some wild stocks in North America, is mentioned later. In general newly established flocks, where they were geographically isolated from other Canada Geese, have tended to form further discrete sub-populations.

Blurton Jones mentioned that there was plenty of apparently suitable Canada Goose habitat in the country not being utilised by the birds, and he suggested that the rather circumscribed movements of each sub-population would act against their discovering new waters, even though the latter might be quite close to their normal range. Therefore it follows that the programme of transporting surplus birds to new waters was almost bound to lead to an increase in population. This in fact took place along three complementary lines. Firstly there was the movement of birds to new waters where they were encouraged to settle down and breed. Secondly there was an increased amount of wandering, by the transported birds, which gave rise to a number of spontaneous colonisations. And thirdly the colonies whence birds had been removed recovered quite quickly to their former strength, unless further transportations were carried out.

The next stage in the recent history of the Canada Goose in Britain might well have been foreseen. The point was reached when there were no more suitable waters, or at any rate not with willing landowners, on which to release surplus birds. So, despite the fact that there were, and still are, birds for disposal in quite large numbers, transportation of them virtually stopped in the early 1960s. The problems that this is causing and some possible palliatives will be discussed later.

With all the moving of birds round the country, reducing some populations and starting others, the census details of 1953 rapidly became out of date. However, it was not until 1967 that any attempt was made on a national scale to census the geese again, though one or two individual studies were made on some sub-populations. In July 1967 a partial census was organised by the writer, and this was followed by a much fuller one in July 1968. The results are set out below.

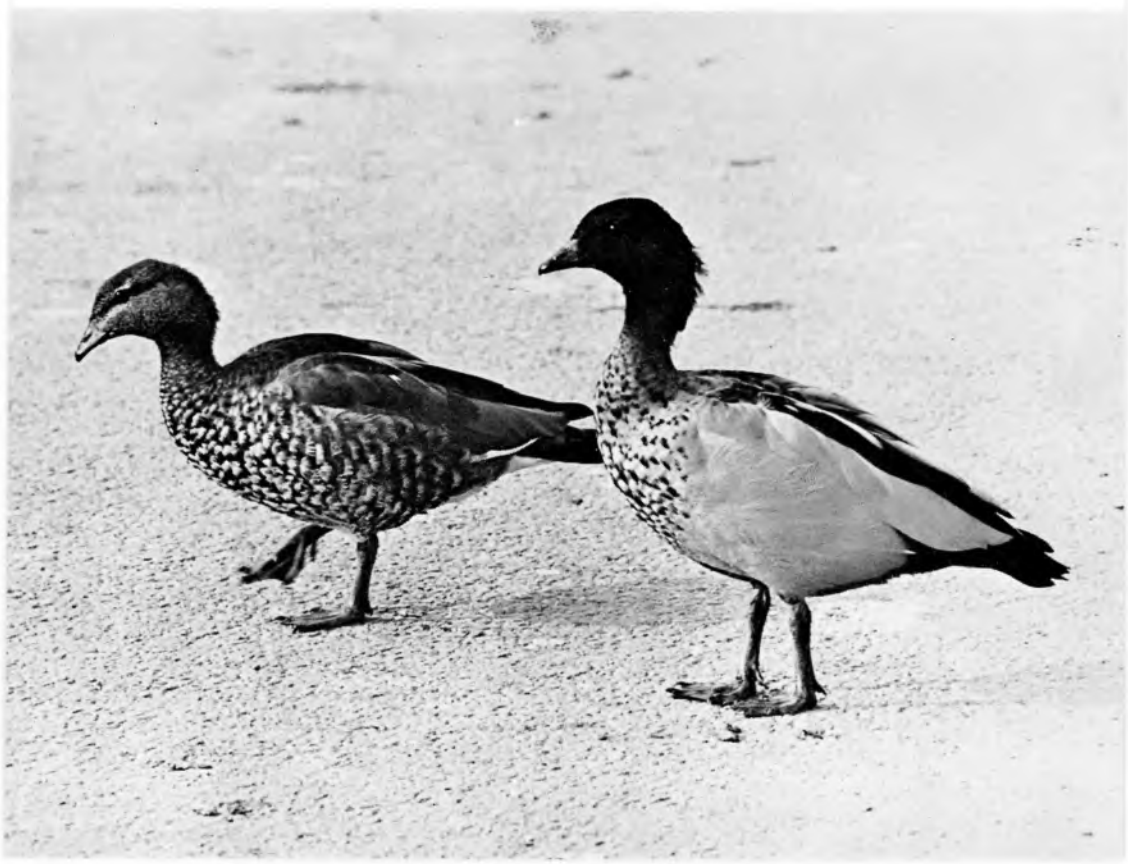
Numbers of Canada Geese in Britain, July 1967 and July 1968

In July 1967 a complete count was made of the Canada Geese inhabiting the North and West Ridings of Yorkshire as part of a study being carried out there. These birds were known from ringing to form a discrete sub-population. The count was made early in the month and the total of 1,100 was obviously a substantial fraction of that for the whole of Britain. It was therefore decided to extend the cover, and wildfowl counters and bird watchers who regularly visited major Canada Goose sites were asked to try and make a count of their local water before the end of the flightless period, which rarely extends beyond the end of July. Despite the short notice, the response was excellent, and gave a total count of 5,269. This was recognised as being only a partial census and a more complete one was held in July 1968, giving a total of 7,906.

Philippa Scott

Plate V. (a) A pair of Chiloe Wigeon *Anas sibilatrix* standing on a frozen pond.
(b) A pair of Maned Geese *Chenonetta jubata.*

Philippa Scott



Philippa Sco

Plate VI. (a) An unusual view of the Rushy Pen at Slimbridge showing the crowded ' Swan Lake ' overlooked by the great windows of the Hon. Director's studio, the Swan Observatory and the newly-erected Office Block.

(b) A winter scene on ' Swan Lake '. All the birds in the picture are wild visitors, either Bewick's Swans *Cygnus columbianus bewickii*, or Pintail *Anas acuta.*

Philippa Sco

Gaps still existed, even in the 1968 census, particularly in areas where the geese are very scattered during the breeding season. In such cases it was often found that winter counts gave a more complete picture, when the geese were gathered in flocks. The advantage of July censuses was the relative immobility of the geese leading to a minimum risk of flocks being counted twice, which is not the case in winter. Nonetheless it was found possible to use winter information to supplement the summer censuses, provided the boundaries of the various discrete sub-populations could be delineated. An additional factor is that the July count will be close to the maximum that the population will reach, just after the breeding season, whereas by January shooting and natural losses will have led to some reduction in numbers.

The results of the censuses are given in Table I by sub-populations. Geographical details of the latter are given below in further detail. Also shown in the Table are the numbers of geese counted in each of the three mid-January International Wildfowl Censuses held in 1967 to 1969. These involved a greater cover of waters in the country than do the normal monthly national wildfowl counts. The cover, and thus the total count, was much reduced in January 1968 because of restrictions on access imposed during the foot and mouth epidemic. The last column gives an estimated total for each sub-population based on the counts and censuses. This, where possible, is the result

Table I. Numbers of Canada Geese in Britain, 1953 and 1967-69.

		Counts and censuses					*Estimated*
Sub-population area	*Total 1953*	*Jan. 1967*	*July 1967*	*Jan. 1968*	*July 1968*	*Jan. 1969*	*Total 1967-69*
South Devon	—	X	223	90+	208	38+	220
South Dorset	—	192	X	100+	140+	162	180
South Hampshire	—	43+	X	X	83	46+	80
Sussex and south Surrey	23-50	295	X	279	73+	42+	290
South Kent	—	X	X	12+	27	X	30
North and central Kent	—	X	X	147+	337	280+	340
London	—	66	X	126	48	X	130
Berkshire, Hampshire, etc.	133-163	566+	346+	570+	276+	169+	570
Wiltshire, north Berkshire	30-62	19+	X	17+	X	42+	50
Gloucestershire	—	80	X	90	X	110	100
Monmouthshire	—	20	X	20	X	20	20
Pembrokeshire	—	32	X	32	37	X	40
Warwickshire, east Staffs	84-104	329	376	18+	378	550	380
Derbyshire	376-437	766	893	X	703+	832	890
West Staffs, east Salop	—	585	75+	X	480	494	480
Central and west Salop	—	148+	X	71+	289	117+	290
North Salop, south Cheshire	506-598	768+	416+	186+	490+	20+	490
Montgomeryshire	68-84	150+	X	X	X	400	400
North Cheshire	165-219	103+	144+	X	550	X	550
West Cheshire	165-219	87	X	100+	69	113+	110
Anglesey	—	200	X	X	X	71+	200
Essex	—	34+	50+	55+	141	96+	140
Suffolk	—	42	X	31	12	32	30
North Suffolk, south Norfolk	157-225	X	X	X	X	296	300
North Norfolk	350-500	372	780+	114+	747	320+	760
Norfolk Broads	350-500	30+	22+	X	121	X	120
Cambridgeshire	—	35	X	X	X	X	40
Northants, Leicestershire	181-229	143	125+	130+	150	178	180
Lincolnshire	—	280	330	340	355	211+	340
Nottinghamshire	173-200	263	163+	87+	455	194+	460
South Yorkshire — Hornsea	—	24	36	38	0	36	40
South Yorkshire	107-127	87+	X	101+	131	202	200
Central Yorkshire	330-398	X	1290	X	1324	X	1310
Lancashire	115-156	40+	X	X	174	X	170
North Lancs, Westmorland	—	10	X	81	X	136	140
Northumberland	—	19	X	27	X	X	20
Scotland	119-194	X	X	X	62+	X	100
N. Ireland	47-120	65	X	75	46	2+	70
Totals	2954-3866	5892	5267	2937	7906	5709	10260

— = sub-population did not exist in 1953
X = no count made
00+ = known to be incomplete count

of a complete simultaneous count of the sub-population, or the mean of more than one, though means are only used where these are of either summer or winter counts, but not a mixture of both. Some slight marrying of figures has been necessary in areas where it is apparent that complete counts have not been made, but this only amounts to 90 birds in three sub-populations. The totals for 1953, extracted from Blurton Jones (1956), are also given for comparison. Most of the sub-divisions used by Blurton Jones hold good today, though of course several new populations have come into being since.

Totalling the sub-population estimates in Table I, and making allowance for the small numbers of birds undoubtedly missed in some areas, it is found that Britain in the period 1967-69 had a population of approximately 10,500 Canada Geese. This represents the late summer, post-breeding total, i.e. the maximum. It is believed that the figure may be accurate to within 5%. Losses during the autumn and winter will reduce it by perhaps 15-20% in this lightly shot species. There seems little doubt that there has been a three-fold increase since 1953.

Distribution of Canada Geese in Britain

The various sub-populations are now dealt with, the areas being given by county, or part county. Most of them accord with the divisions used by Blurton Jones, though there are several new ones, and some others have extended in area. The 1953 and 1967-69 totals are given for each, extracted from Table I.

South Devon: River Exe valley and estuary.
1953: 0; 1967-69: 220.

The headquarters of this group is Shobrooke Park, near Exeter. Some other smaller waters in the neighbourhood are also used. In winter many of the birds are found on the Exe Estuary.

South Dorset: Poole Harbour and Crichel Lake.
1953: 0; 1967-69: 180.

Many geese breed on Brownsea Island, but also scattered round the harbour. The most complete counts are winter ones. Up to 15 birds are regularly found on Crichel Lake, but are almost certainly linked with the Poole Harbour flock.

South Hampshire: Needs Oar Point.
1953: 0; 1967-69: 80.

Sussex and south Surrey: Pulborough floods, Knapp Castle, Warnham Mill, and others.
1953: 23-50; 1967-69: 290.

A scattered population, which may consist of several discrete flocks, but from winter evidence probably not. A single flock of 240 on the Pulborough floods in January 1968 was far larger than the sum of either of the summer counts in the area.

South Kent: Dungeness.
1953: 0; 1967-69: 30.

North and central Kent: gravel pits and lakes near Sevenoaks, Maidstone and Tunbridge Wells.
1953: 0; 1967-69: 340.

These birds were put down in the area by wildfowlers in the 1950s and have flourished.

London: Hyde Park, some use of River Thames near Kew.
1953: 0; 1967-69: 130.

Breeds in Hyde Park, possibly elsewhere.

South Berkshire, north Hampshire, west Surrey, south Buckinghamshire: lakes and gravel pits in Aldershot-Reading-Newbury triangle, Chertsey lake, waters in Windsor Great Park, and Wraysbury gravel pits.
1953: 133-163; 1967-69: 570.

A large and complex group inhabiting at least eighteen waters, though not breeding on all of them. The actual total is probably higher than that given, which is the largest simultaneous count available. Many of the waters used are gravel pits which have greatly increased in the area in the last twenty years.

Wiltshire and north Berkshire: Stourhead, Wilton Water, Broad Water, Buscot Lake.
1953: 30-62; 1967-69: 50.

Small numbers occur at all four places and are probably separate flocks.

Gloucestershire: Frampton gravel pits.
1953: 0; 1967-69: 100.

This population was introduced in 1953. Considerable control has been exercised in recent years, by the removal to other areas of the majority of the young. Natural control in the form of an endemic renal disease has also been a limiting factor.

Monmouthshire: Newport area.
1953: 0; 1967-69: 20.

Pembrokeshire: Fowborough.
1953: 0; 1967-69: 40.

The west Midlands:
1953: 961-1,139; 1967-69: 2,530.

The counties of Warwickshire, Staffordshire, south Derbyshire, Shropshire and south Cheshire hold a large, complex population of geese. Blurton Jones tentatively split it into four, though acknowledging that they might well be linked. Since then many waters in the areas

between have become colonised and it is no longer possible to draw definite boundary lines to separate them. Extensive ringing in the area in the last three years is also indicating some occasional links between possible groups (Dr. C. D. T. Minton, pers. com.). Movements to other areas, notably Yorkshire, were recorded recently but only a handful of birds have been involved so far compared with the many hundreds ringed. Fortunately the whole area has been quite thoroughly censused in the last two years and so the population total can be given with some confidence. Five sub-divisions within the area are tentatively detailed below but subsequent information may prove that they are not fully discrete.

a) *North Worcestershire, Warwickshire, and south and east Staffordshire:* many waters and park lakes around Birmingham, gravel pits near Tamworth and Burton.

1953: 84-104; 1967-69: 380.

Ringing has shown considerable movement between various sites around Burton and Tamworth and to a lesser extent south Birmingham. Ringing also indicates a link with flocks to the north-west of the city, dealt with under (c).

b) *Derbyshire:* park lakes at Kedleston, Osmaston, Allestree, Locko Hall, etc.; some make use of River Trent floods in winter.

1953: 376-437; 1967-69: 890.

The main water in the area is Kedleston Hall where about 800 birds live. There is a probable link with the previous sub-group (a), as flocks from both tend to resort to floods in the Trent valley in winter. However, the Kedleston flock remains fairly constant in numbers indicating rather little interchange.

c) *West Staffordshire, east Shropshire:* various park lakes and reservoirs.

1953: 0; 1967-69: 480.

Ringing indicates a connection with sub-group (a).

d) *Central and west Shropshire:* numerous small waters round Shrewsbury and Oswestry.

1953: 0; 1967-69: 290.

This probably doesn't qualify as a sub-group but its exact relationships are obscure. There are bigger populations on larger waters to the east (c) and to the north (e).

e) *North Shropshire, south Cheshire:* Ellesmere group of waters, plus Combermere, Barmere, Shavington, and many smaller waters.

1953: 506-598; 1967-69: 490.

This area was split into two by Blurton Jones, but this no longer seems justified. The number of different waters in the whole area makes complete counts difficult to achieve and it is probable that the figure used is an underestimate. There was a count from most of the waters of 768 in January 1967, but this could have included birds which had moved from some of the waters covered in (d).

Montgomeryshire: Welshpool area.

1953: 68-84; 1967-69: 400.

Maximum numbers are present in winter, in the Severn valley near Welshpool. The full summer distribution is not known, though obviously scattered for the most part. There could be links with Shropshire birds.

North Cheshire: Rostherne, Tabley, Tatton and other meres.

1953: 165-219; 1967-69: 550.

Another difficult group to census as the geese are usually spread over several waters. The figure given is the best that could be obtained during the period under review.

West Cheshire: Aldford, Eaton Hall, River Dee marshes.

1953: 80 (part of south Cheshire group); 1967-69: 110.

Believed to be a discrete group, breeding on waters in the area, and found on floods in winter.

Anglesey: various waters on the island.

1953: 0; 1967-69: 200.

Essex: Hanningfield Reservoir, and on farm reservoirs and waters in the north and north-west of the county.

1953: 0; 1967-69: 140.

There may be two separate flocks here but there is some evidence of mixing in the winter.

Suffolk: Minsmere.

1953: 0; 1967-69: 30.

North Suffolk, south Norfolk: Breckland waters.

1953: 157-225; 1967-69: 300.

There is some evidence that there is a connection with the population centred round Holkham, north Norfolk.

North Norfolk: Holkham Park and nearby waters.

1953: 350-500; 1967-69: 760.

This population was much larger a few years ago, with counts of 1,700-2,000 in 1965. It has clearly undergone a drastic reduction.

Norfolk: Broads.

1953: 40 (part of Holkham flock); 1967-69: 120.

Connection with Holkham flock more doubtful.

Cambridgeshire: various gravel pits and the Ouse Washes.

1953: 0; 1967-69: 40.

Northamptonshire and Leicestershire: Blatherwycke and Deene Lakes, Stapleford Park and various reservoirs and gravel pits.

1953: 181-229; 1967-69: 180.

Some of these may be discrete groups, but there is insufficient evidence to be sure.

Lincolnshire: Grimsthorpe Lake.

1953: 0; 1967-69: 340.

Possibly connected with the previous area, but fairly constant figures indicate a separate flock. Recent ringing here may soon confirm this.

Nottinghamshire: the Dukeries.

1953: 173-200; 1967-69: 460.

Main waters are Clumber, Thoresby, Worksop and Welbeck. Their general proximity suggests a single sub-population.

South-east Yorkshire: Hornsea Mere.

1953: 0; 1967-69: 40.

South Yorkshire: various lakes and reservoirs around Barnsley.

1953: 107-207; 1967-69: 200.

Ringing has shown a slight connection with the very large population north of Leeds.

Central Yorkshire: numerous park lakes and reservoirs from Leeds north to Masham.

1953: 330-398; 1967-69: 1,310.

A study is in progress of this sub-population which has led to a full cover of waters and accurate counts. It is from this area that the moult migration takes place to the Beauly Firth. The origin of the moulters was not discovered until 1963 (Dennis 1964), though the migration had been going on for about fifteen years before then. At first involving only 20 birds, there were about 250 in 1968. Further work is in progress on discovering the age structure of the moulters and other aspects of the sub-population.

Lancashire: park lakes in and around Liverpool.

1953: 115-156; 1967-69: 170.

North Lancashire and south Westmorland: Lune valley.

1953: 0; 1967-69: 140.

This isolated group winters in the Lune Valley south of Kirkby Lonsdale, breeding on reservoirs between there and Sedbergh.

Northumberland: Colt Crag reservoir and nearby waters.

1953: 0; 1967-69: 20.

Scotland: various.

1953: 119-194; 1967-69: 100.

There appear to be only four places in Scotland where Canada Geese can regularly be found. About 50 birds live at Kinmount, Dumfriesshire; there is a small population on Colonsay of 30-50 birds; a few pairs in Renfrewshire; and a very few pairs breed in Perthshire.

Northern Ireland: Strangford Lough.

1953: 47-120; 1967-69: 70.

There is a single population centred on Strangford Lough, Co. Down. Apart from that only stragglers are recorded.

Conclusions

It seems altogether unlikely that the Canada Goose will continue to increase in numbers as fast as it has done in the last fifteen years. The artificial spreading of birds to new waters has virtually stopped. Removing birds as a control measure is only successful if it is repeated at intervals, and in relieving pressure at some points, it creates new problems elsewhere. Other methods of control, particularly egg removal or pricking, continue, and those sub-populations based on private waters will probably be held at a reasonable level by the landowners concerned. However, increasing numbers of geese are now breeding on gravel pits and reservoirs. Unless steps are taken these groups of birds will continue to increase. A further factor in their favour is the constant increase in these types of wetland habitat.

Control of Canada Goose numbers in this country is recognised by all relevant bodies as being necessary. There seems no reason why the interests concerned should not come to terms with the Canada Goose though methods of maintaining a satisfactory balance are mostly crude, both in technique and in results. The most acceptable form of control would be winter shooting which combined a check on numbers with a strong element of sport. Unfortunately one of the biggest disappointments has been to landowners and wildfowlers trying to turn the species into a provider of sport. Time after time this has been the intention behind the starting of a new colony of birds, but with a very few exceptions it has not succeeded. The main difficulty appears to be to get the geese to become at all wild. They often do not adopt any regular daily flighting patterns. Frequently they can walk from the roosting water on to a feeding field, and even when they do fly it is usually at tree-top height or lower, thus not presenting a sporting shot. Certainly they can be and have been shot under these conditions as a control measure but not for sport.

Various control methods were reviewed by Matthews (1965) but as this report was

for restricted circulation the main conclusions will be repeated here. Egg destruction, which is quite commonplace, can be effective but unless it is correctly timed the geese will lay a second clutch. In any case it has a rather slow effect on numbers, working at the wrong end of the 'population pyramid', and gives no immediate relief from damage. As already mentioned mass winter shoots have been tried and these are undoubtedly successful in controlling both numbers and damage. However, the accusation of causing damage is more often laid against the geese during the spring, after the end of the shooting season. Out of season culling by shooting, or by killing of flightless birds, has, it is thought, been carried out on a number of occasions in this country. The legal position is not very clear. The 1954 Protection of Birds Act allows for the killing of birds in the close season in order to prevent serious damage to crops, but it is generally held that this only covers killing whilst the damage is actually being done, catching the birds *in flagrante delicto* as it were. There appear to be somewhat similar powers under the Agriculture Act of 1947 for action against birds causing damage. A further difficulty is the actual proof of damage. Detailed experiments have shown that what appears to be serious damage to, say, a field of growing cereals in early spring, is not necessarily reflected in lessened yields at harvest (Kear 1965), though this may not hold true for later heavy grazing.

There would appear to be sufficient latitude under the existing law for this sedentary species to be controlled by shooting if those concerned really tried. There is also little doubt that in most cases control measures already being undertaken would be more effective if related to actual numbers present rather than, as is often done, removing a set number of eggs or birds each year. However the flock size at which complaints start varies enormously from place to place. Whilst one farmer, used to having geese around, may only become aggrieved when the flock reaches 200, another may regard 20 as intolerable. The whole question is essentially a series of local problems requiring local solutions. Certainly it is unnecessary for this fine bird to be declared a pest species, by placing it on Schedule II under the 1954 Act, along with crows and the like. Finally it may be pointed out that if the Canada Goose causes problems in some parts of Britain this is just another example, among so many, of the dangers of introducing a species into an area outside its normal range.

Acknowledgements

I wish to thank all the very many observers who kindly counted Canada Geese for me, sometimes at very short notice. I am grateful to Mr. G. L. Atkinson-Willes for making available to me the results of the mid-winter International Wildfowl Censuses. Dr. G. V. T. Matthews made some helpful criticisms of the first draft of this paper.

This investigation was carried out whilst holding a post financed by a grant from the Natural Environment Research Council.

Summary

The Canada Goose *Branta canadensis*, introduced from North America in the seventeenth century, was first censused in 1953 when the population stood at 2,200-4,000 birds. It was found to be divided into several discrete sub-populations. Removing birds from localities where there were complaints of agricultural damage and releasing them on new waters was extensively carried out in the 1950s. This was ineffective as a control measure and led to a rapid rise in overall numbers. Censuses in July 1967 and 1968 revealed a population total of about 10,500 birds. The distribution in the country is reviewed in detail. Various control methods are discussed.

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Weights and measurements of Greylag Geese in Scotland

G. V. T. MATTHEWS and C. R. G. CAMPBELL

Introduction

Our text is a quotation from Giles (1963), 'one of the most-taken but least used observations by wildlife investigators is total body-weight. The field-notes of hundreds of workers are filled with thousands of weight observations of animals but rarely are these presented in reports or used in research conclusions'.

Taxonomists have generally disregarded body-weight as being too widely variable within the population to serve to separate racial groupings. Their requirements are met by linear measurements, those of the wing and, particularly in the case of geese, of the bill. Pathologists also tend to be wary of total weight as a sole indicator of the state of health, although the medical propaganda against over-weight in humans might lead us to think otherwise. It is the rise of interest in bioenergetics, the study of the flow of energy in biological systems, that has refocused attention on animal weights. For a full study, the weights of the different organs and the proportions of fatty and other tissues must be determined. The gross body-weight is thus only a starting point, but one needed for many practical studies as well as academic ones. It, and its variations, must be known if we are to give good answers to such questions as how much will a flock of geese eat; what will be the effect on an aircraft of collision with a goose in flight.

Beer and Boyd (1962, 1963) published extensive data on the Pink-footed Goose *Anser brachyrhynchus* and European White-fronted Goose *Anser albifrons albifrons* in Britain. In the case of the Western Greylag *Anser anser anser*, Elder (1955) published the weights of 259 geese rocket-netted during ten days in November 1953. These gave weights which were surprisingly low when compared with records extant in the British shooting literature. While recognising that his sample was taken early in the season and contained a large proportion of young birds, Elder was inclined to believe that his results indicated the existence of lighter sub-races. The need for further weight samples taken at other times during the winter was clear.

Material and methods

The Wildfowl Trust's rocket-netting programme had concentrated on the Pink-footed Goose since this proved the easiest to trap in the large numbers needed for the capture/recapture method of population estimation. Greylag fly in smaller flocks and do not land so thickly. The flock size, moreover, becomes smaller as the season progresses. Accordingly, when sufficient recoveries of ringed birds had been accumulated to indicate clearly the migratory patterns and mortality estimates from the British-wintering population, the expensive activity of rocket-netting this species ceased. Only about a hundred more weights from this source are thus available to add to Elder's series. However, with the establishment of a National Nature Reserve at Loch Leven, Kinross, and of a Wildfowl Trust research team there, we had access to the bags of the shooting parties, through the courtesy of the landowner. Commercial shooting in Britain came to an end in 1968 by legislation in which the Wildfowl Trust had not been unconcerned. Advantage was therefore taken of the last two seasons before the new law became effective to examine the birds stored temporarily in the cold room of one of the largest game-dealers in Perth. Finally, a small number of unpublished weights from Greylag adults rounded up while flightless in Galloway (Boyd 1966) were added.

The total sample available is set out in Table I. Besides weights (to the nearest 10 gm.), measurements of wing-length (the cord of the closed wing without flattening of the primaries) and bill-length (exposed culmen) were taken (to the nearest mm.). Not all the birds had all measurements taken, the actual sample sizes being as indicated in the appropriate sections. Sex was determined by cloacal eversion, age by the presence or absence of notched tail-feathers in the autumn and of other juvenile feathers (particularly the wing coverts) later in the season. Besides listing the minimum and maximum measurements encountered, the calculated means are given together with two statistics based on the dispersion (standard deviation) of weights about the mean. The standard error of the mean (s.e.) is derived from (standard deviation)/(square root) of the number of observations. By taking sample size into account as well as dispersion, it enables us to determine whether differences in means are large enough to be statistically significant (at the 5% level). The coefficient of variation (V),

being (standard deviation × 100)/(mean), takes unit size into account and so enables comparison of dispersion between samples of dissimilar weights or indeed of dissimilar units, for example weights and wing-lengths.

Variation in weight by age, sex and season

The full data are set out in Table II. In common with earlier studies, these show that males are consistently heavier than females and that this distinction holds in However, there is a considerable overlap in both cases and weight alone is not diagnostic of sex — nor, indeed, of age, young males frequently being heavier than adult females.
first winter birds as well as in adults.

Of more interest is the clear demonstration of seasonal variation in weights. All sexes and ages are at their lowest weights in October, when they have just arrived on migration from Iceland. They then increase to a maximum weight in December, feeding on the ample supplies of harvest-wasted grain and potatoes, supplemented by grass. In January, when the principal food is exhausted and the birds turn predominantly to grass (not then at its most nutritious) plus some winter wheat, the weights in all classes fall back

Table I. The total sample of Greylag measurements available and the means by which it was obtained.

Source	*Locality*	*Years*	*Ad.* ♂	*Ad.* ♀	*Juv.* ♂	*Juv.* ♀	*All*
Rocket-netting	Solway Kinross	1953, 1959	121	121	61	52	355
Shooting bags	Kinross	1966-69	67	70	54	46	238
Game-dealers	Perth	1966-68	138	89	109	94	430
Moulting	Galloway	1964-66	36	30	—	—	66
			362	310	224	193	1089

Table II. Weights (in gm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Oct.	42	3030	3454	3790	38	7.12
Nov.	110	2890	3480	4400	29	8.78
Dec.	52	2740	3793	4250	48	9.04
Jan.	94	2600	3509	4560	31	9.78
Feb./Mar.	13	2850	3469	4040	32	11.53
June	36	3200	3692	4300	41	6.74
Adult females						
Oct.	45	2540	3039	3470	29	6.49
Nov.	105	2080	3101	3770	27	8.98
Dec.	25	2070	3170	3960	74	11.64
Jan.	75	2160	3108	3800	32	8.79
Feb./Mar.	7	2900	3323	3500	131	10.44
June	30	3000	3237	3600	33	5.33
First winter males						
Oct.	9	2730	2900	3170	60	6.19
Nov.	63	2580	3075	3690	32	8.32
Dec.	21	2540	3297	4250	58	8.12
Jan.	82	2160	3083	4160	37	10.97
Feb./Mar.	1	—	3420	—	—	—
First winter females						
Oct.	8	2430	2722	2990	64	6.61
Nov.	60	2120	2866	3440	31	8.42
Dec.	22	2810	3174	3540	44	6.57
Jan.	52	1980	2726	3220	40	10.55
Feb./Mar.	8	2460	2772	3120	91	9.26

to the November or even October level. February is one of the hardest months in Scotland, with frequent snow-cover and March often shows little improvement. However, as the shooting season ends on 31st January, only a few weights are thereafter available from birds shot, under licence, for other research purposes. No definite conclusion can therefore be drawn, but it looks as if there is, overall, little change from the January weights. It would be of great interest to get more weights at this end of the season, and especially in April when a re-building of reserves may occur prior to the long migration. As we indicated earlier, a full-scale rocket-netting attempt is unlikely to be economical at that season. Possibly smaller cannon-nets might, in some circumstances, produce a sufficient sample for our purposes.

The seasonal variation in the various classes may be more easily compared if the peak in each is taken as 100 and the other mean weights expressed as percentages (Table III). As would be expected, the first winter birds show slightly steeper rises to their peak. They are still growing as well as, presumably, replacing reserves used on migration. The fall in their weights in January is also marked (the November - December - January rise and fall are statistically significant on the original data). This is in contrast with the findings of Raveling (1968) on Canada Geese *Branta canadensis interior*. His young birds showed no changes in weights through the winter, whereas the adults did show a late-winter drop. Raveling could not satisfactorily account for this surprising difference, which suggests that adults were at a disadvantage in obtaining food supplies. One possibility he did not consider was that the lighter young birds might be eliminated early from the population, through competition, thus keeping up the mean weight which would otherwise have fallen. In our case no such involved explanation is necessary, a definite drop in young birds' weights did occur. However, there is a much greater dispersion about the means (as measured by V in Table II) in January, suggesting that selection for food-gathering ability is making itself felt when supplies are low.

A very similar, and significant, rise and fall in mean weights also occurred in the adult males. The trace of such a peak is apparent in the adult female figures, but is not statistically significant. On the present evidence it would thus seem that the adult females are better at exploiting such food sources as are available. This clearly would be advantageous to the species. The adult females may also actually regain their weights quicker in the early spring, but the few suggestive figures available are insufficient for proof. We do not, unfortunately, have any weights for Greylags in Iceland to show what weights are achieved just before breeding. The small number of weights collected after the breeding season, in June in Galloway, are, rather surprisingly, similar to the December high, the mean for males being 98% and that for females 102% of that peak. Some caution must be exercised here for, although the Galloway birds are of Icelandic/British stock, they are feral in origin and non-migratory in habit. They might therefore have become somewhat larger. This point is taken up again when we consider linear measurements. The other point is that these birds were captured when flightless in the moult. If captured early in this stage, they might be expected to have plenty of reserves, if late these would have been largely exhausted. These variations have been studied for the Canada Goose by Hanson (1965).

Table III. Seasonal variation in mean weights of Greylag Geese expressed as a percentage of the peak.

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb./Mar.*
Adult males	91	92	100	92	91
Adult females	95	98	100	98	(105)
First winter males	(88)	93	100	93	(104)
First winter females	(86)	90	100	86	(87)

Variation in weights between samples

It is axiomatic that samples of geese obtained by shooting will be unbalanced as regards ages, the young birds being much more likely to be shot. It is less generally accepted that one sex is more likely to be shot than the other. Certainly the male:female ratio is near to unity in the long series of geese, Pink-footed as well as Greylag, which the Wildfowl Trust has caught by rocket-netting without baiting. This is exactly so in the sample used in the present discussions

(Table I). It was therefore surprising to find that the adult shot birds collected at the Perth game-dealers should have such a high proportion (61%) of males, whereas the adults shot at Loch Leven were, again, near unity as regards the sex ratio (49% males). However, Imber (1968) has now found that adult male Canada Geese in New Zealand have a significantly higher hunting mortality than females and he demonstrates that studies in North America indicate a similar conclusion. Differences in conditions may affect the sex ratio in geese caught by baited cannon-nets. Thus Nass (1964) normally had a 50:50 sex ratio in catches of Canada Geese. But catches made when natural food was very short resulted in 1,039 adults being caught, of which 62% were males. Similarly, different shooting techniques may explain the difference between the present two samples of Greylags. The Loch Leven birds were mainly shot for sport as they returned to the roost. The Perth birds, being shot for commercial gain, might well have been obtained by less scrupulous methods. Very heavy kills can be made by shooting over decoys in certain weather conditions. It is quite possible that adult males decoy more readily than females. This is a fascinating subject, with implications for the population stability of a species which is essentially monogamous. However, we cannot pursue it here, the main object of the discussion being to show that unbalanced sex ratios in a sample *could* occur without selection for the market.

This latter possibility had worried us, because it might imply that the shooters were selecting the heaviest birds for sale, resulting in a preponderance of big males. Our conclusions on mean weights for the population would then be biased. To check the point further, the two shot samples were compared for the period of the main shooting season, November to January (Table IV). Although the Perth birds were slightly heavier in many of the categories, none of the differences between means have statistical significance. Moreover, if there were selection against small birds, it should fall most on the smallest category, the first winter females. Instead we find their Perth sample had a mean weight identical with that of their Leven sample and showed more variation (V) instead of less (which it would have done if one end of its range had been removed). We may anticipate here the finding of the wing measurements which also indicate no difference in size between geese in the two samples. We also ascertained that the dealer purchased geese by the bird, not by weight.

We therefore conclude that it was proper to incorporate the Perth game-dealer's sample and yet have a representative sample of weight ranges in the various age and sex categories. By the same evidence in Table IV we can reject the possible criticism that the geese held in cold-store at Perth would be lighter than normal because of water loss. We ascertained that geese were normally held for only a few days (our measurements were accumulated over a series of visits) and, in any case, water loss would be slow in a bird of this size.

It is much more difficult to make any meaningful comparison between the weights of Greylag in our present shooting samples and those in published game-bag records. These do not specify age and sex nor, of course, dispersion within the categories. Those which at least specify sample size and mean weight are Beveridge (1918) — 300 birds, mean 3,370

Table IV. Weights (in gm.) of Greylag Geese, shot November to January, from two sources.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Leven	50	2540	3586	4100	55	10.87
Perth	125	2600	3639	4560	31	9.65
Adult females						
Leven	60	2070	3087	3740	45	11.43
Perth	65	2080	3166	3960	37	9.52
First winter males						
Leven	32	2250	3062	3650	68	12.50
Perth	81	2160	3163	4250	42	11.86
First winter females						
Leven	26	2120	2865	3440	58	10.41
Perth	63	1980	2864	3540	44	12.12

gm.; and Ogilvie (1920) with 50 birds and Popham (1943) with 83, both with means of 3,400 gm. These are all higher than the overall mean for the Perth sample (3,285 gm., s.e. = 25, V = 13.8, for 334 birds). We may allot standard errors to the older means by first making the assumption that they had the same coefficient of variation as the Perth sample. We then conclude that the difference between their mean weights and that of the Perth sample is not significant for the Ogilvie sample and only just reaches significance for the other two. It is therefore not very profitable to seek to explain the differences when so many variations in sampling may have been concerned. In the bad old days with spring shooting, heavier birds might be expected to have been included. However, it should be noted that Beveridge was concerned with North Uist, and thus with another non-migratory population. Certainly it is most desirable to obtain some data from the Outer Hebrides at the present time.

The weight of the 'average' Greylag

Having laboriously assessed weights in categories of age, sex and season it may appear paradoxical to conclude by lumping them into one 'average' figure. But, as explained in the introduction, such an 'average' is often called for as a 'practical' requirement.

We must obviously confine ourselves to the winter half of the year, October-March. The means for this period in Table II, if lumped regardless of sample size, would give for 311 adult males — 3,531 gm.; for 257 adult females — 3,105 gm.; for 176 first winter males — 3,119 gm.; for 150 first winter females — 2,864 gm.; and for the whole sample of 894 — 3,213 gm. This figure must obviously be adjusted on several counts and we make the following assumptions, that a) sexes are equal in number, b) the mean monthly weights are representative of each category, and c) the proportion of the young is 20%. This latter is a compromise figure. The data on age-ratios accumulated in ten years of November counts from 1958 to 1967 by H. Boyd and M. A. Ogilvie (unpublished) gave a mean figure of 28.9% of first winter birds. However, we also know that these have a much higher mortality rate than adults, because of their vulnerability to shooting. The proportion of young in the population will thus decrease through the winter. The data available do not permit a precise estimation of a mean figure for the winter, but that chosen would appear to be reasonably realistic. It is unfortunate that we were not sufficiently skilled in cloacal probing to be able to separate out yearling (second winter) birds from full adults, as has been done by Hanson (1962) for Canada Geese. It is probable that, as in that species, yearlings are distinctly lighter. Their varying proportion in the population would, therefore, also affect the average adult weight.

Making the specified assumptions, we arrive at the winter weight of the 'average Greylag-in-the-field' as 3,270 gm. (7 lb. 3 oz.).

The weights of sheep vary widely, of course, but we are advised that 60 kg. is likely to be a fair average. This is 18 times the weight of our 'average' Greylag and gives some idea of the relative amounts of food that might be eaten by each animal. However, we must caution against assuming a straight relationship between weight and consumption. Differing efficiencies of digestion and differing calorific requirements are likely to reduce the sheep: goose ratio. Again it is stressed that it is only at certain times that sheep and geese are in direct competition (Kear 1963).

It has been shown experimentally (McNaughton 1968) that damage to aircraft by bird impact is proportional to the mass of the bird and to the cube of the speed. The Air Registration Board requires that windscreens and engines must be safe against birds up to 4 lb. weight collided with at the aircraft's maximum speed. It is thus distinctly hazardous to site airfields near a goose roost.

Variation in wing-lengths

The basic data are set out in Table V. They confirm the size relationships between the various age group categories as determined by the weights. Their main use will be in making comparisons with other races of Greylag. In this connection it should be noted that the coefficient of variation (V) is much smaller than in the case of weights, the measurement is less subject to fluctuation, and is more representative of its particular category.

In view of the disquiet occasioned by the preponderance of adult males in the Perth sample, it is reassuring to find (Table VI) that the Leven males were, if anything, just marginally larger as measured by wing-length. The other categories were almost identical in this respect. This confirms that there had not been selection of large birds for the market at Perth.

Table V. Wing-lengths (mm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males	191	436	467.4	500	0.83	2.46
Adult females	157	417	447.2	480	1.06	2.98
First winter males	122	418	450.0	482	1.20	2.95
First winter females	119	390	432.6	466	1.38	3.48

The other point that emerged from the study of wing-lengths was that the young birds showed no appreciable growth in this respect over their first winter. If we divide their sample into measurements taken October-December and those taken January-March the means for 69 and 50 females are exactly the same (432.6 mm.). The males show a slight increase from 59 with a mean of 448.4 mm. to 63 with a mean of 451.4 mm. However, with standard errors of 1.62 and 1.76 the difference is not significant.

Variation in bill-lengths

The length and configuration of the bill has been frequently used in attempts to separate races within goose species. The length of exposed culmen was therefore measured in sufficient birds to give a representative sample and the results are set out in Table VII.

Again males and females show a significant separation of their means both in adult and first winter birds, but again there is too much overlap for the sexes to be separable on this count alone. Boyd (1966) sought to quantify the finding of experienced observers that they can distinguish males from females on head size and shape. To this end, for the Galloway sample, he also measured the height and width of the bill at the base and the length and width of the head. It was hoped that a simple discriminant function, using two or three measures would suffice. However, with the measurements made this was not found to be so.

As in the case of wing-length, there was little growth in the bills of young birds during their first winter. Both showed a slight increase between the means of the October-December and January-March samples. In the case of the males the increase was from 58.8 mm. (55 birds, s.e. 0.49) to 60.2 mm. (30 birds, s.e. 0.43) and this is just significant. In the females the increase, from 55.2 mm. (61 birds, s.e. 0.38) to 56.4 mm. (31 birds, s.e. 0.54), just fails to reach significance. In both cases the second figure is virtually identical with that of the adult. Thus the

Table VI. Wing-lengths (mm.) of Greylag Geese, from two samples.

	Adult males		*Adult females*		*First winter males*		*First winter females*	
	No.	*Mean*	*No.*	*Mean*	*No.*	*Mean*	*No.*	*Mean*
Leven	114	470.7	80	446.9	36	451.1	34	433.0
Perth	77	465.2	77	447.5	86	449.4	85	432.4

Table VII. Bill-lengths (mm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Leven/Perth	125	54	60.0	66	0.24	4.43
Galloway	63	54	63.3	69	0.37	4.69
Adult females						
Leven/Perth	117	47	56.2	62	0.24	4.71
Galloway	51	53	58.6	66	0.40	4.83
First winter males						
Leven/Perth	85	49	59.3	66	0.36	5.53
First winter females						
Leven/Perth	92	44	55.6	64	0.32	5.45

bill is fully grown in the first winter although the body size (as specified by the weight and wing-length) remains well below that of the adult of the same sex. Presumably it is more important, in terms of survival, for the feeding instrument to reach full size quickly. In a way, we have here a quantification of the gawky look of first winter geese.

The values of V indicate that bill-length is much more variable within a population than is wing-length. While less useful for specifying the population, it may be more readily modified in response to ecological changes. In both adult males and females the bill-lengths of the Galloway sample are significantly greater than those of the Leven/Perth sample. We have already seen that the weights of the Galloway birds, caught in wing-moult, were rather surprisingly high. It would be most interesting to sample this semi-resident stock at other times, when the wing can be measured, to see if it is indeed becoming bigger bodied. So too, as we have already seen, would data be welcome for the non-migratory population of Greylag breeding in the Hebrides. Such as are available at present are too few for conclusions to be drawn. The geese there have shown themselves particularly adept at avoiding round-ups, being considerably favoured by the terrain.

Other geese in the samples

One of the surprises of this study was the small sample of Pink-footed Geese available for measurement at Loch Leven (85) and especially at the game-dealer's in Perth (38). This does not reflect the abundance of this species relative to the Greylag. Thus censuses carried out in November gave, for the adjacent counties of Perthshire, Fife and Kinross, totals in 1966 of 35,030 Greylags and 34,060 Pinkfeet, in 1967 of 30,150 Greylags and 26,820 Pinkfeet (Ogilvie 1968) It may well be that Pinkfeet are more difficult to shoot in large numbers and, certainly, experience at Loch Leven would bear this out. In view of our earlier discussion on the possibility that shooting methods might explain the preponderance of males in the adult sample at Perth, it is perhaps worth noting that the adult Pinkfeet there comprised 10 males and 11 females.

Also at the Perth dealer's was a small sample of Barnacle Geese *Branta leucopsis*, 70 birds in all. As this species is protected on the mainland of Scotland, these birds should not have come from the population wintering on the Solway, which ringing has shown to derive almost exclusively from Spitsbergen. The probable source was the Hebridean islands west of 5°W. on which there is a short open season. Their main stronghold is the island of Islay. Ringing has shown that this Hebridean population derives exclusively from breeding grounds in Greenland. Boyd (1963) has recorded the weights of 35 adults captured on the Solway, together with those of 13 rounded up flightless in Spitsbergen. Detailed analysis and publication of the present limited data was not considered to be justified and it remains on file at the Wildfowl Trust, together with unpublished weight data on 596 birds rounded up flightless in Greenland on three expeditions.

Acknowledgements

We are grateful to Sir David Montgomery, Bart., for permitting the examination of the shooting bags from Loch Leven; to Mr. T. Band, game-dealer of Perth, for similar facilities in their cold store; to Dr. J. V. Beer, H. Boyd and M. A. Ogilvie for the use of unpublished data; to Miss C. B. Gosling who assisted us with some tedious calculations.

The research was undertaken while we held posts at the Wildfowl Trust financed by grants from the Natural Environment Research Council.

Summary

1. Mensuration data for Western Greylag Geese *Anser anser anser* from various sources in Scotland are analysed.
2. The mean weights of males and females, and of first year and adult birds are significantly different but there is considerable overlap. There are variations in mean weight through the season, a peak being reached for all classes in December.
3. An imbalance in sexes on one of the samples is discussed and is thought likely to reflect different shooting techniques.
4. The weight of an 'average' Greylag is calculated to be 3,270 gm. (7 lb. 3 oz.).
5. Wing- and bill-lengths again are characters that separate but are not diagnostic of the sexes. Young birds have wings shorter than adults but their bills have reached full size in the first winter. In neither respect does much growth occur while on the wintering grounds.
6. On both weight and bill-length data the non-migratory feral Galloway population would appear slightly larger than the migratory Icelandic one.

7. Many fewer Pinkfeet occurred in the samples obtained by shooting than would be expected from their numbers relative to those of Greylag, suggesting a differing vulnerability.

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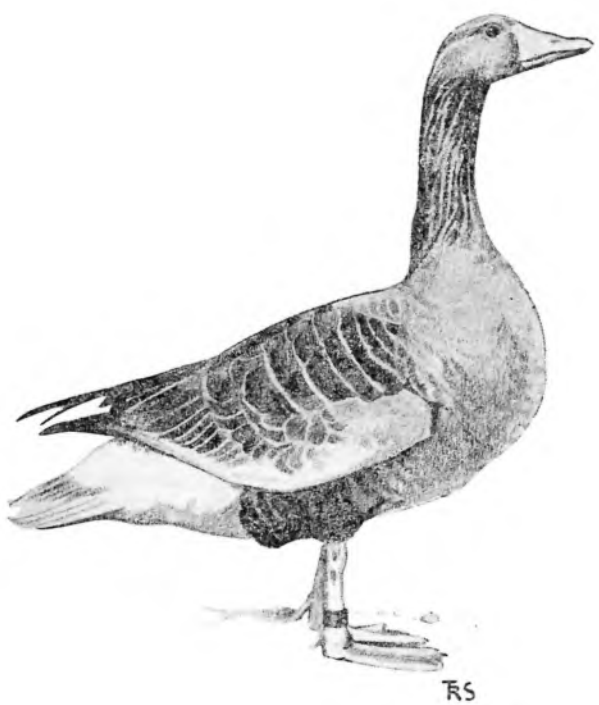


The International Wildfowl Research Bureau

The I.W.R.B. came into being in 1954, evolved from various bodies originally set up in the period between the Wars under the aegis of the International Council for Bird Preservation (I.C.B.P.). At first its Headquarters were in London, under the guidance of Dr. Edward Hindle, F.R.S. In 1962 they moved to the Station Biologique de la Tour du Valat, Camargue, France, under Dr. Luc Hoffmann. At the beginning of 1969 they moved again, to Slimbridge, with Dr. G. V. T. Matthews as Director.

The Bureau's primary functions are Stimulation and Co-ordination, on the international plane, of (and between) research and conservation involving wildfowl and wetlands. In wildfowl are included ducks, geese and swans, flamingos and waders; in wetlands, marshes and shallow waters, fresh and salt, static and flowing. The wetland habitats are amongst the most immediately threatened by development since modern techniques have made their destruction a relatively easy matter. Wetlands are also particularly vulnerable to pollution and degradation incidental to technological advances. Wildfowl, by their migratory nature, emphasise the need for international co-operation in the conservation of their habitats.

The work of the Bureau is carried out almost entirely on a voluntary basis, albeit under the leadership of professional scientists working in their own time or in such time as their national institutes can allow. The salaried staff at Headquarters consists only of an Administrator and secretary. The research activities are organised through specialist working-groups, the conservation activities through national representatives.

Research Groups on Populations

One of the bedrock principles of the Bureau is that its advice on conservation should be based on adequate and scientifically determined facts. The accumulation of these data is the responsibility of working-groups of scientists and amateur observers. In Europe, where experienced workers are relatively plentiful, specialist Research Groups have been set up. In each case an experienced Co-ordinator gathers a team of specialists, one in each country, who in turn organise their compatriots within their particular field. In this way an active international team results, enabling, in particular, younger workers to participate in the Bureau's activities.

The first group established was the Goose Research Group (Co-ordinator, Prof. M. F. Mörzer-Bruijns, the Netherlands). Geese congregate, to roost at least, in relatively few places and, for many races, mainly in the ornithologically active countries of north-west Europe. The Group has therefore been able to determine with some accuracy the population sizes of two species and of three races. Their fluctuations and variations in breeding success have been regularly followed. In other geese, which have wider ranges, this degree of knowledge has yet to be achieved. However, the Group has published maps of the wintering quarters of all the Eurasian geese and, again, the north-west segments of their populations are well studied.

The Duck Research Group (Mr. G. L. Atkinson-Willes, United Kingdom), recognising that the greater dispersion of duck populations makes complete species censuses virtually impossible, has concentrated on making representative sample counts so that population trends can be measured with confidence. Some of the ornithologically advanced countries had been making regular monthly sample counts of ducks since the late forties. The trends these revealed could well be obscured by geographical shifts of popula-

tions, so in recent years international mid-winter counts have been introduced, aiming at maximum coverage over at least the west of Eurasia. Countries with few ornithologists concentrate on making counts on just one date, special field trips are made to areas without local observers, and aerial surveys have been used to an increasing extent. Some six million wildfowl are registered in these counts and a sufficient run of data will soon be available to detect overall trends. Meanwhile detailed distribution maps have been drawn up for the wintering flocks of all the swans and the commoner ducks.

The Wader Research Group (Mr. F. Spitz, France) is more recently formed and has a particularly difficult task because of the high mobility, small size and dense-flocking behaviour of many species. Nevertheless, useful data on the distribution and numbers at the major resorts have been obtained by co-operative efforts.

Ringing wildfowl provides valuable data on their migratory movements and mortality. Apart from mist-netting waders and catching *Cygnus olor*, amateur participation is small compared with other bird-ringing. This is because the capture of ducks and geese requires massive trapping installations, expensive projectile nets or elaborate expeditions to high-arctic breeding sites. Most wildfowl ringing has therefore been associated with the efforts of national research institutes. Analysis of data has also tended to be on a national basis, though several co-ordinated studies have been made. With the agreement on a common recording method achieved through the international organisation, Euring, and the advent of automatic data processing, it is to be hoped that co-operative wildfowl ringing and analysis will possibly soon be organised by a Research Group of the Bureau.

Research Groups on Habitats and Hunting

Thus far we have considered Research Groups whose aim is to provide the basic data on wildfowl populations, their fluctuations, distribution and movements. Research is also needed to ascertain what must be done to offset declines in numbers where they do occur. Without doubt the loss of wetland habitat is the most important restrictive factor. In recognition of this the Bureau, in collaboration with the International Union for the Conservation of Nature (I.U.C.N.), and I.C.B.P., set up Project MAR, named for the first three letters of the word for marsh in many languages. An international conference of experts was held in the Camargue in 1962, and the published papers formed a massive basic documentation for planning wetland conservation. Next, an annotated list of more than 200 wetlands most important for wildfowl in Europe and North Africa was drawn up and published. The authoritative document, giving international status to certain wetlands has, in many cases, provided invaluable support to efforts aimed at averting drainage and reclamation schemes for these areas.

One of the most difficult messages to get across to the public, to Government agencies, to engineers, to agriculturists, is the idea that 'wetlands are not wastelands', that they are not merely places to dump waste, to build factories and airfields, to convert to marginal agricultural land. To explain why the conservation of wetlands is a moral, aesthetic, scientific and economic necessity, the Bureau sponsored, as part of Project MAR, an attractively illustrated booklet 'Liquid Assets'. This was distributed widely, particularly within those agencies likely to be the most destructive of wetlands. A French version 'Ressources Méconnues' has also been published and Italian and German versions are in preparation.

'Liquid Assets' also sets out the ways in which recreational uses of wetland, fishing, boating, water-ski-ing, shooting, and so on, can be organised so that they do not prevent wildfowl utilising the habitat. For it is not enough simply to save wetlands from destruction. Wildfowl reserves must be maintained free of disturbance (at least at critical times of the year) and managed to the best advantage. The Bureau has compiled and published (in 1966 and 1968) two large volumes of multiplicated sheets, setting out the details of existing wildfowl reserves in Europe, North Africa and Western Asia. They are vital planning documents and, together with the knowledge of distribution gathered by the other Research Groups, can serve to indicate where further reserves are needed.

To organise the research needed to determine which are the best ways to manage wetlands, the Bureau has set up a Habitat Management Research Group (Dr. J. Szijj, German Federal Republic). This seeks to encourage Universities into directing their ecological students on to studies of direct application to the management of wetlands. A Handbook on wetland management techniques is in preparation. The problems vary so widely

throughout the area in which the Group is interested that Branches studying related habitats have been formed. The first was concerned with Mediterranean estuaries (Dr. L. Hoffmann, France); recently formed was the Pannonicum Branch (Dr. A. Festetics, Austria) concerned with the area of the Danube basin and especially with its saline lakes.

An activity that impinges directly on wildfowl populations is hunting. While it is generally agreed that present-day stocks cannot stand the depletion of mass-destruction for market selling, there is much less certainty about the restrictions that should be imposed on shooting for sport. Again, the Bureau has sought to provide the necessary factual basis. It has first gathered together information on shooting seasons and other restrictions at present in force in the countries of Europe and North Africa. An analytical volume, in loose leaf format, has been published in 1966. Now there has been set up a Hunting Rationalisation Research Group (Dr. T. Lampio, Finland). This will aim to provide information that is still lacking on present regulations, but will be particularly concerned with formulating proposals for the international rationalisation of such regulations, on a biological basis. It will also stimulate the undertaking of research based on the activities of the hunters themselves, such as the analysis of age and sex ratios in their kill.

Wildfowl Surveys

In Africa and Asia there are vast wetland areas but very few amateur ornithologists, let alone professional ecologists. Yet, following the destruction of so much wetland habitat in the over-developed European countries, it is here that conservation is more urgently needed and efforts can be most effective. In these areas the Bureau has encouraged the formation of Wildfowl Surveys. These must necessarily work at a more superficial level than the Research Groups, but likewise aim to provide the basic information on the distribution of wildfowl and wetlands that is needed for conservation. They also seek to arouse interest in and action on the problems of research and conservation among the nationals of the countries within the region.

In Southern Africa a Wildfowl Survey (Prof. J. M. Winterbottom, S. Africa) has been in existence for as long as the Bureau itself. Besides general accounts of distribution, it has also produced monographic studies on a number of species of wildfowl. The West African Survey (Mr. R. Roux, France) is of more recent origin, but has already produced results of much interest. East African and North African Surveys are in process of formation. The South-west Asia Survey (Mr. C. D. W. Savage, Pakistan) has shown great activity and cohesion, even though its area stretches from Arabia to Assam. Basic documentation has been produced on many aspects of wildfowl conservation and plans are being made for the reintroduction of certain species. Surveys in Central Asia (Dr. V. E. Flint, U.S.S.R.) and North-east Asia (Dr. A. A. Kishchinsky, U.S.S.R.) have now been formed.

In North America, research and conservation on wildfowl populations, which are largely discrete from the Eurasian ones, have been under way since the early part of the century. A degree of sophistication has been reached which is not yet achieved in Europe. In this case the Bureau's aim is to ensure that the scientific results and conservation experiences in the New World are widely known in the Old. This it does by close contact with the agencies and institutions concerned. A similar relationship exists with Australasia.

National Representation

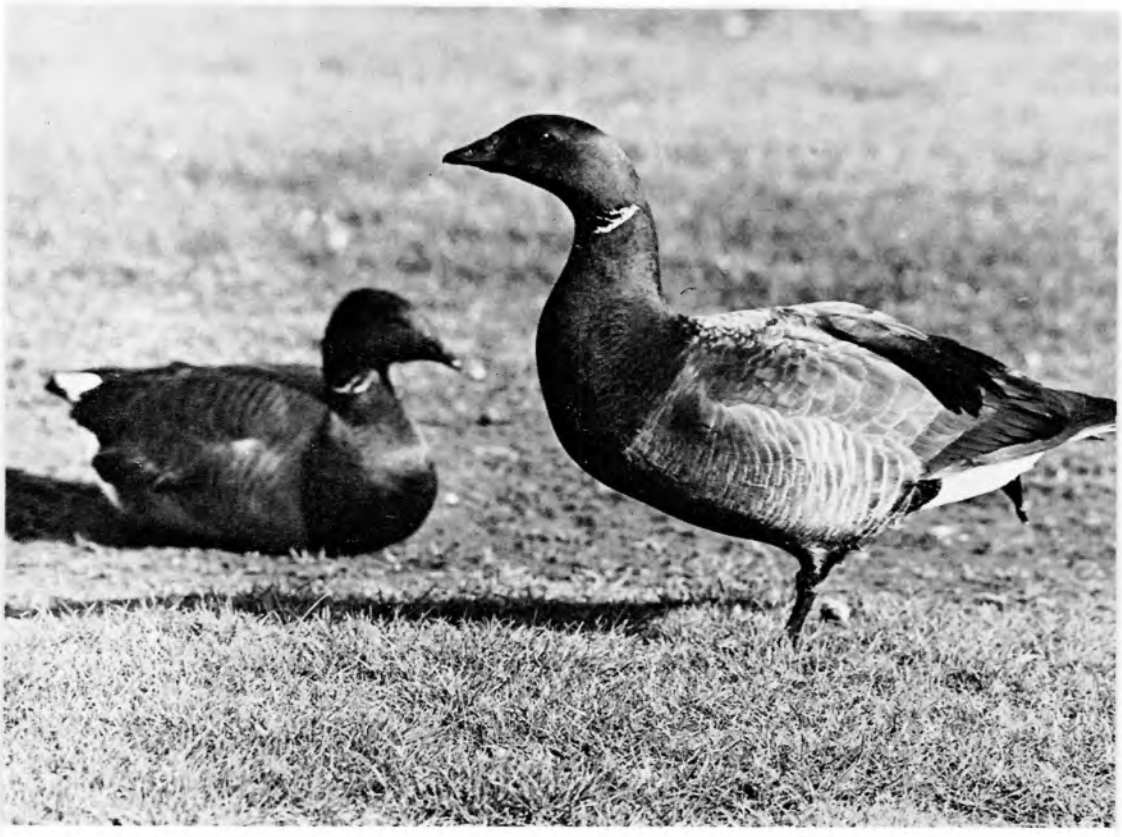
The Bureau is kept informed of developments, good or bad, in the various countries of Eurasia and Africa by their delegates to its Executive Board. It is with the guidance of these delegates that the Bureau offers advice to, and seeks to exert pressure on, the government agencies concerned with conservation. Fourteen countries each nominate two delegates, and eight other countries, not yet financially supporting the Bureau, two representatives. They are of senior standing, appointed by government agencies, national sections of I.C.B.P., or other representative national organisations. One or both should be closely connected with the governmental conservation agency, have a biological training and be acceptable to hunting organisations. Although keeping themselves informed on research activities and helping with the appointment of the national workers within Research Groups, they are not necessarily active in research themselves. In 26 further countries, not yet in a position to nominate official representatives, the Bureau itself nominates correspondents.

The Headquarters keep in touch with all these contacts and those within its Research Groups and Wildfowl Surveys, and with other agencies and organisations

J. A. Middleton

Plate VII. Two examples of nest defence by wildfowl. (a) A Muscovy *Cairina moschata* showing the open-bill threat above her nest in a hollowed-out tree stump. (b) A New Zealand Grey Duck *Anas s. superciliosa* lowers her head and fluffs up her feathers to drive off an intruder. Both birds were nesting in the Decoy Wood at Slimbridge.

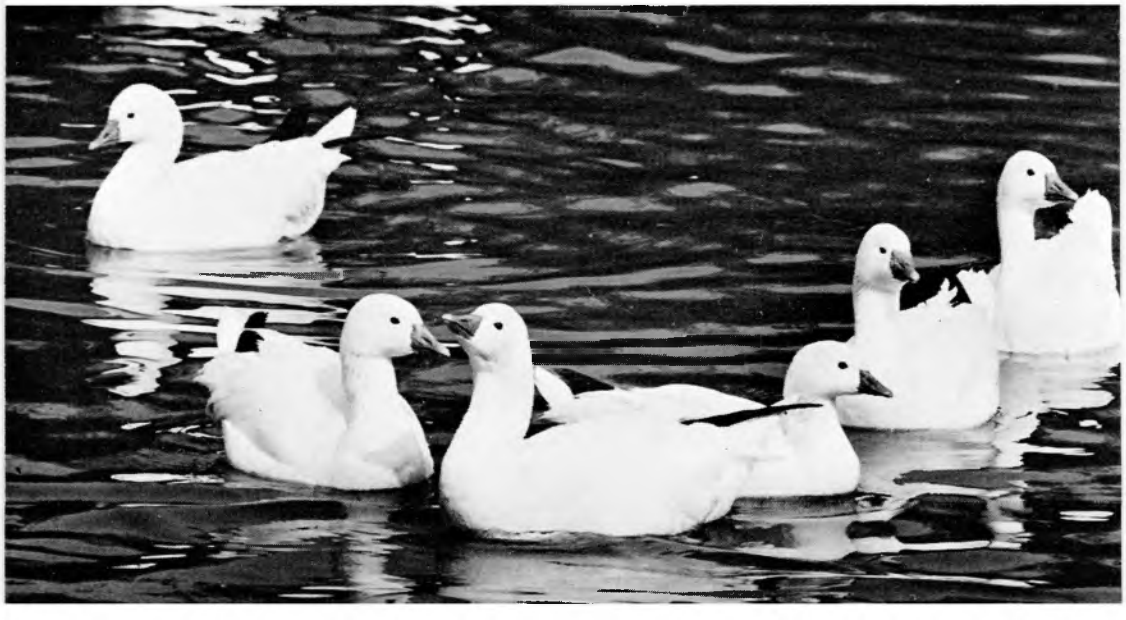
J. A. Middleton



Philippa Sco

Plate VIII. Two species of geese with limited world populations. (a) There are 25-30,000 Dark-bellied Brent Geese *Branta bernicla bernicla.* They breed in Siberia and winter in north-west Europe (see p. 119). (b) The 30-35,000 Ross's Geese *Anser rossii* breed in Canada and winter in the U.S.A.

Philippa Sco



through correspondence, liaison visits, publications and by periodically issuing an informative Newsletter.

International Meetings

The Executive Board of the I.W.R.B., comprising the Co-ordinators of Research Groups and Wildfowl Surveys, National Delegates, Honorary Counsellors and Representatives of associated International Organisations, meets once a year. National Representatives and members of Research Groups in the country where the meeting takes place (usually a different one each year) are also invited. Besides discussion of the Bureau's business, such meetings also help to stimulate conservation activities in the host country.

At longer intervals the Bureau is concerned with other organisations in the convening of wider ranging conferences at which all aspects of wildfowl conservation can be discussed, and at which official governmental representatives are present. One such European Meeting was held at St. Andrews, Scotland, in 1963; another in Noordwijk, the Netherlands, in 1966. Technical Meetings were held in Jablonna, Poland, in 1965 and in Ankara, Turkey, in 1967. An International Regional Meeting took place in Leningrad, U.S.S.R., in 1968. The next large International Conference is to be held in Babolsar, Iran, early in 1971. Besides the possibilities these conferences provide for influencing governmental opinion, their published Proceedings bring to the attention of a wide audience the current position, and problems, in wildfowl research and conservation in Europe, Asia and Africa. One very important activity now nearing reality, is the drawing up and signing of an international Wetlands Convention. Countries adhering to this would undertake to limit the destruction of wetlands, to inform an international secretariat of any impending changes in their wetlands situation and to consult with its co-signees before permitting any changes.

Administration and Finance

While the Bureau seeks to achieve its aims by encouraging workers in many countries to direct their researches and activities to those problems it feels important, an administrative headquarters staff is essential to ensure co-ordination and continuity. That at present employed is tiny, but the salaries must be found. There is also a heavy expenditure on communications and printing. The Wildfowl Trust most generously provides accommodation and various associated services. The rest of the Bureau's expenditure must be met from national subventions, by grants from the World Wildlife Fund, and by private donations. The Bureau could achieve much more if it had a more substantial income. It is for this reason that its bank account is named and prices are given for its publications.

Publications

Past issues of the I.W.R.B. Newsletters and of research papers prepared under its aegis are available from Headquarters at the flat rate of 5/- per publication. Future issues of Newsletters will be sent to organisations or individuals subscribing a minimum of £1 per annum to Bureau funds. (I.W.R.B. a/c, Lloyds Bank, Dursley, Gloucestershire, England.) The following publications are also available.

Project MAR. The Conservation and management of temperate marshes, bogs and other wetlands. Ed. L. Hoffmann. I.U.C.N. Pub. N.S. 2, pp. 475 (42/-).

Project MAR. List of European and North African wetlands of International Importance. Ed. P. J. Olney. I.U.C.N. Pub. N.S. 5, pp. 102 (22/-).

Liquid Assets. Ed. G. L. Atkinson-Willes. Many illustrations. pp. 15 (5/-).

Proceedings of the First European Meeting on Wildfowl Conservation, St. Andrews, Scotland. pp. 289 (28/-).

Proceedings of the Second European Meeting on Wildfowl Conservation, Noordwijk, The Netherlands. pp. 225 (46/-).

Proceedings of the Meeting on International Co-operation in Wildfowl Research, Jablonna, Warsaw. pp. 356 (20/-).

Proceedings of a Technical Meeting on Wetland Conservation, Ankara. I.U.C.N. Pub. N.S.12. pp. 273 (22/-).

Legislative and Administrative Measures for Wildfowl Conservation in Europe and North Africa. Looseleaf format (roneo-ed) (42/-).

Wildfowl Refuges in Europe, North Africa and the Middle East. Volume I. Volume II. Looseleaf format (roneo-ed) (42/-).

G.V.T.M.

The mid-winter distribution of wildfowl in Europe, northern Africa and south-west Asia, 1967 and 1968

G. L. ATKINSON-WILLES

Regular counts of wildfowl are now being undertaken in many parts of Europe and south-west Asia, and in a few districts of northern and central Africa. In some countries, including Britain, the counts have been made at monthly intervals throughout the winter for periods of up to 20 years; in most others, the studies began quite recently and are often more limited in scope.

The counts are organised by the Duck Research Group, which was set up by the International Wildfowl Research Bureau in 1966, to co-ordinate—and extend—the studies already being undertaken in some countries. Prior to that each country had conducted its own investigations, without any real attempt being made to examine the problems on an international scale. This insularity was basically unsound: in dealing with a migratory group of birds, such as wildfowl, it is essential to consider the populations as a whole.

The new international programme of research is designed specifically to enable countries which have not previously undertaken work of this nature to provide useful information at the earliest possible stage. The primary project is the organization of synchronized counts throughout the winter range. Ideally these should be made at monthly intervals between September and March, but in many countries this intensive programme is impracticable. A special effort is therefore made to obtain as many records as possible on one particular occasion each winter, the period selected being the Sunday nearest to 15th January, and the seven days before and after. The first of these annual censuses took place in January 1967.

The investigation covers all the species of ducks and swans which breed in the western half of the Palaearctic region, and winter in Europe, Africa and south-west Asia, eastwards to about 90° East. Coots are also included. The geese and waders are dealt with by separate research groups.

The primary aim of the censuses is to detect and measure changes in the levels of wildfowl population, and to determine the amount of protection which ought to be afforded to each species. This is essentially a long term study which cannot begin until comparable data are available over a series of several years. Thanks to the generous help of the Nature Conservancy, the records obtained since 1967 are now being transferred on to punch tape for subsequent analysis by computer. The first of these analyses is planned for 1970, when four seasons of data will be available.

Meanwhile the results of the initial censuses are being used to define the main centres of wildfowl population, and to assess the importance of the individual sites. In particular, they have been used to compile a set of distribution maps, showing the number of birds recorded in each area. These maps will help to demonstrate to Governments the extent of their responsibilities in the field of wildfowl conservation, and are perhaps a first step towards the establishment of an effective international system of reserves.

The scope of the census

In 1967 records were received from 4,500 sites in 31 countries, and produced a total of 6,581,000 ducks and 108,800 swans. In 1968, 33 countries took part and counts were made at 5,440 sites, producing a total of 9,468,000 ducks, 114,500 swans and 3,971,000 coots. Table I shows the number of places at which counts were made in each country, and gives a summary of the results. The data are grouped in accordance with the main geographical populations of wildfowl, defined by Isakov (1965).

The totals in Table I are compiled solely from data obtained during the prescribed periods, 7th-22nd January 1967 and 6th-21st January 1968. This limitation is imposed in order to reduce the likelihood of the same birds being recorded on two or more occasions in different areas. It would, of course, be preferable if the census could be confined to a single day, but this would greatly reduce the number of counts, and result in a much less satisfactory sample.

The results of the counts made outside the census period, from mid-December until mid-February, are contained in Table II. None of the sites concerned was also covered during the period of the census, and in most cases the records can probably be regarded as additional to those in Table I.

In northern Europe records have been received from most of the more important centres of wildfowl population, and from many hundreds of lesser sites. Compre-

hensive counts are also being made in several regions of central and southern Europe, and throughout the southern parts of the U.S.S.R., eastwards to 85° East. In most other districts of south-west Asia, and also in Africa, the counts are still at the exploratory stage, and many important areas have not yet been surveyed. The problems here are much greater than in Europe, due partly to the shortage of observers, and partly to the changing pattern of distribution under

Table I. The number of sites visited, and the total numbers of wildfowl (in thousands) recorded in each country during the census periods 7th-22nd January 1967 and 6th-21st January 1968. Unidentified ducks and swans are included. Additional counts were made in countries marked * (see Table II).

+ = less than 100. — = nil.

	No. of sites		*Ducks*		*Swans*		*Coots*
A: *Europe/Black Sea/Mediterranean*	*1967*	*1968*	*1967*	*1968*	*1967*	*1968*	*1968*
U.S.S.R. North-west:							
White Sea/Barents Sea	24	22	105.1	66.2	—	—	—
Baltic region	437	509	28.7	31.1	0.1	0.1	+
North and central European Russia	6	26	2.0	0.1	—	—	—
Finland	—	64		14.3		+	—
Sweden	353	394	107.7	98.2	6.9	5.2	3.1
Norway	26	49	11.8	26.3	0.3	0.2	—
Denmark	162	465	198.5	518.8	13.3	52.2	124.4
Poland	78	246	21.6	49.8	0.2	0.4	5.5
East Germany (D.D.R.)	144	243	346.1	122.2	20.5	10.3	61.3
West Germany (F.D.R.)	126	338	240.3	263.1	3.0	5.6	120.8
Netherlands	275	358	452.3	476.7	4.4	4.9	103.2
Belgium	103	63	38.1	31.4	0.3	0.1	3.3
Luxembourg	5	—	0.1		+		
Great Britain	1347	1047	483.0	442.7	10.8	9.0	42.5
Ireland*	132	7	92.0	13.6	5.0	0.4	0.1
France*	205	261	231.1	262.1	0.1	0.1	57.6
Spain*	—	42		90.8		—	17.8
U.S.S.R. South-west:							
Byelorussia and Ukraine (inland)	84	144	13.0	31.5	+	+	+
Ukraine (Black Sea)	83	101	698.7	124.8	15.0	13.5	3.6
Sea of Azov	111	45	210.4	570.0	0.7	1.1	173.4
Caucasia	53	68	223.2	42.7	0.1	0.3	11.0
Turkey (west of 35° E.)	19	17	46.5	81.3	—	+	54.3
Cyprus	3	—	3.1		—		
Roumania	7	—	2.2		+		
Hungary	40	31	4.0	5.5	—	—	0.1
Greece*	1	20	16.1	172.9	—	+	73.5
Yugoslavia*	—	11		19.4		—	2.5
Austria	20	37	17.3	22.3	0.5	0.6	9.6
Switzerland	327	334	84.5	108.7	2.8	3.0	79.6
Italy	6	21	78.8	18.0	—	—	29.5
Tunisia	9	27	27.1	49.7	—	—	48.8
Libya	—	4		+		—	—
Nigeria	32	12	9.3	3.6	—	—	—
Total	4222	5006	3792.6	3757.8	84.0	107.0	1025.5
B. *West Siberia/Caspian/Nile*							
U.S.S.R.							
North Caspian	11	40	32.1	50.3	3.9	1.5	3.1
Daghestan	37	24	241.6	133.9	1.6	0.7	11.7
Azerbaijan	23	21	1257.6	1480.5	4.3	2.0	469.2
Armenia	20	2	12.8	12.0	+	—	—
East Caspian	15	21	441.4	709.5	4.1	1.8	319.1
Turkey* (east of 35° E.)	10	10	129.4	2380.5	—	—	1830.2
Israel*	—	7		20.5		—	28.6
Jordan (Azraq)	—	1		18.5		+	1.5
Iraq*	4	29	84.3	77.9	—	—	20.8
Iran*	10	19	18.5	345.7	—	0.1	4.1
Trucial Oman	—	2		—		—	—
Ethiopia	1	—	0.3		—		
Total	131	176	2218.0	5229.3	13.9	6.1	2688.3

Table I (cont.).

	No. of sites		*Ducks*		*Swans*		*Coots*
	1967	*1968*	*1967*	*1968*	*1967*	*1968*	*1968*
C. *Siberia/Kazakhstan/Pakistan/India*							
U.S.S.R.							
S. Turkmenia	16	40	176.2	221.4	+	+	175.9
mid- and lower Amu-darya	18	57	11.8	26.6	—	0.2	1.7
Zeravshan	10	10	44.6	18.6	+	0.1	15.3
Surkhan dar'ya	5	14	4.3	23.4	+	—	28.8
Sur-dar'ya: mid	7	19	5.9	69.9	+	—	21.1
upper	15	41	14.8	20.5	—	+	1.4
Issyk-kul	2	15	18.6	42.4	0.9	1.1	2.9
Alakol	1	4	0.2	2.0	—	—	—
West Pakistan*	28	13	64.7	20.0	—	—	8.3
India*	37	20	208.1	13.3	—	—	1.9
Ceylon*	3	20	2.3	10.3	—	—	—
East Pakistan/Assam	8	9	18.9	12.7	—	—	—
Total	150	262	570.4	481.2	0.9	1.4	257.3

Table II. Additional counts made outside the census period, from mid-December to mid-February. The sites are different to those in Table I.
+ = less than 100. — = nil.

	No. of sites		*Ducks*		*Swans*		*Coots*
	1967	*1968*	*1967*	*1968*	*1967*	*1968*	*1968*
A: *Europe/Black Sea/Mediterranean*							
Ireland	28	—	22.8		2.8		
France	20	2	7.2	0.1	—	—	—
Spain	1	19	16.8	113.3	—	—	21.2
Turkey (west of 35° E.)	14	4	406.4	55.8	—	—	16.2
Bulgaria	4	—	2.8		—		
Greece	—	7		50.5		0.4	10.5
Yugoslavia	—	2		+		—	—
B: *West Siberia/Caspian/Nile*							
Turkey (east of 35° E.)	7	1	246.6	0.9	—	—	—
Iran	3	24	10.7	287.0	—	—	2.5
Iraq	1	—	1.7		—		
Israel	64	—	18.5		—		
C: *Siberia/Kazakhstan/Pakistan/India*							
West Pakistan	4	8	2.6	18.6	—	—	5.3
India	5	3	5.0	0.7	—	—	+
Ceylon	1	4	1.0	13.2	—	—	—

varying conditions of drought and flood. Nevertheless, the recent work has shown that these problems can be overcome, and that even a small cadre of enthusiasts can contribute a very great deal of information.

In a number of instances, in both Europe and Asia, small teams of visiting ornithologists were able to assist the national organizers by surveying areas which could not otherwise have been covered. Expeditions of this nature cannot be repeated annually, but have proved extremely valuable in helping to establish the numerical distribution of the species, and in stimulating the interest of local observers.

Aerial surveys were conducted with outstanding success in the coastal districts of Denmark and France, and along the rivers of central Ireland. This is undoubtedly one of the quickest and most effective method of exploring for ducks, and is probably the only practicable means of counting the large gatherings of sea ducks which cannot normally be viewed from the shore. Aerial counts of the large concentrations of wildfowl in the Niriz basin in southern Iran, and at Azraq oasis in Jordan were equally successful. There are many advantages in using light aircraft to survey remote and extensive areas of marshland such as these, and the method has an obvious application in many parts of Asia and Africa. In particular, it enables a single trained observer to cover large areas of difficult terrain, and to achieve results

comparable to those obtained by the regiments of observers which in some countries are deployed on the ground.

The distribution maps (pp. 104-112)

Some examples of the distribution maps, based on the counts for 1967 and 1968, are contained in Figures 2-8. In this case all the data have been used, including those obtained outside the census period from mid-December until mid-February. Records for the same period in other winters since 1963 have also been incorporated in areas for which no recent data are available.

The method of presentation is similar to that adopted by the Committee for Mapping the Flora of Europe, to whom grateful acknowledgement is made for a supply of special outline maps. The mapping is based on a system of 50 km. grid squares, the records for each square being consolidated to provide a total for each species. The size of the total is indicated by a symbol placed in the centre of the square concerned. If counts were made in both 1967 and 1968, the higher of the two totals has been used. The location of the squares in which counts were made is shown in Figure 1. This should be read in conjunction with the species maps in order to avoid misleading impressions; in many areas, particularly in southern Europe, the paucity of symbols on the species maps is due to lack of records and not necessarily to an absence of birds.

The data from the U.S.S.R. were received in the form of regional summaries, and cannot be presented in quite the same detail. The regions concerned are shown on the maps by shading, with figures to indicate the numbers of birds recorded (Isakov 1968).

Despite the lack of data in some areas, the maps indicate quite clearly the distribution of the main wintering grounds, and the districts of high density, towards which the main effort of conservation ought to be directed. In some cases the population within these districts is evenly distributed over a large number of sites, which in itself provides some measure of protection; in others, the birds are concentrated into relatively small areas, many of which are highly vulnerable to drainage, disturbance or pollution. These focal points deserve special consideration as potential sites for reserves.

The weather during the first half of January, in both 1967 and 1968, was reported to be colder than usual in many parts of central and south-eastern Europe. The maps may therefore be biased by these conditions. This is perhaps an advantage, because it is in cold winters that the birds stand most in need of care and protection. Sites which are capable of supporting large populations at such times are especially important, in that they provide a means of survival for migrants which might otherwise be faced with starvation.

Most of the largest concentrations were reported from the tropical and subtropical regions of Asia, Africa and southern Europe. The areas in which these gatherings occur are often isolated by broad stretches of inhospitable terrain, and thus provide the only habitats available. In addition to their use by wintering wildfowl, many of them afford temporary resting places for very large numbers of passage migrants. The loss of any one of them might therefore prove disastrous. In the more northerly regions there are numerous small areas of habitat and the population tends to disperse over a large number of relatively unimportant sites. Under these conditions the loss of an individual site may pass almost unnoticed, but in the aggregate the annual wastage of habitat is no less serious.

From the conservation viewpoint, any site or complex of sites which is capable of supporting 25,000 ducks, even for a short period, ought to be regarded as a wetland area of outstanding importance. In the European context this figure should certainly be reduced, perhaps to 10,000 or even lower.

The numbers and distribution of the individual species

Table III shows the total numbers of each species recorded in the 1967 and 1968 censuses. Because of the substantial differences in the number of places counted, the figures for the two years cannot at present be compared, nor can they be used to assess the relative abundance of the various species. Nevertheless the totals are of considerable interest: in particular they indicate the size of the samples which are available for future analyses.

The species best portrayed, in both the Table and the maps, are those which winter predominantly in the northern parts of Europe (where counters are plentiful), and which concentrate on to localized types of habitat, such as estuaries or flood meadows (which are readily accessible to observers on the ground). Very few species are in fact confined solely to northern Europe, but in several

cases the northern population appears to be discrete, and can thus be considered as a separate entity. The best examples are Common Shelduck, Bewick's Swan and Whooper Swan (Figures 7 and 8), followed by Goldeneye (Figure 7), Mute Swan and Scaup.

On the basis of the 1967 count the north European population of the Common Shelduck is estimated at about 100,000, a figure which agrees well with the summer numbers recorded on the moulting grounds around the Heligoland Bight. By mid-winter at least 40% of this population is concentrated in the British Isles.

The maps for Whooper Swan and Bewick's Swan provide an interesting example of two closely related species with quite distinct patterns of distribution.

The maps for several of the dabbling and diving ducks give a reasonable indication of the general distribution, but the detail is still far from complete. The species concerned are often widely dispersed over many different types of coastal and inland habitat, and comprehensive cover is consequently more difficult to attain. In some cases the northern populations are rather less important than those further south, and there is usually no clear dividing line between the two. In the absence of records from many southern districts, the maps may sometimes fail to present a properly balanced picture. This applies particularly to the species which are seen to occur in large numbers around the Mediterranean. The most reliable of the maps in this category are those for Wigeon, Tufted Duck (Figure 6) and Mallard (Figure 3). Those for Teal (Figure 4) and Pochard (Figure 5) are less representative because of the more southerly distribution.

The ability of the Mallard to adapt to a wider range of conditions is well illustrated by the quite large populations which remain to winter in north-east Europe, despite the prolonged periods of low temperature. The large native populations which occur in many other parts of Europe also appear to be mainly sedentary. Thus to some extent their conservation is a national, as much as an international, responsibility.

Table III. The total numbers of wildfowl (in thousands) recorded during the census periods 7th-22nd January 1967 and 6th-21st January 1968.

\+ = less than 100.

Species	*1967*	*1968*	*Species*	*1967*	*1968*
Mute Swan			Steller's Eider		
Cygnus olor	50.4	73.3	*Polysticta stelleri*	+	+
Bewick's Swan			Red-crested Pochard		
Cygnus columbianus bewickii	5.8	4.9	*Netta rufina*	347.9	400.2
Whooper Swan			Pochard		
Cygnus cygnus	36.9	36.2	*Aythya ferina*	507.3	568.8
Ruddy Shelduck			Ferruginous Duck		
Tadorna ferruginea	9.7	14.4	*Aythya nyroca*	43.5	29.3
Common Shelduck			Tufted Duck		
Tadorna tadorna	113.5	92.9	*Aythya fuligula*	492.0	969.1
Marbled Teal			Scaup		
Marmaronetta angustirostris	+	2.4	*Aythya marila*	123.7	136.2
Pintail			Common Scoter		
Anas acuta	316.5	308.3	*Melanitta nigra*	30.4	53.7
Teal			Velvet Scoter		
Anas crecca	682.6	933.8	*Melanitta fusca*	1.1	26.5
Mallard			Long-tailed Duck		
Anas platyrhynchos	2111.9	1763.0	*Clangula hyemalis*	20.4	22.7
Gadwall			Goldeneye		
Anas strepera	123.1	84.9	*Bucephala clangula*	98.0	148.3
Wigeon			Smew		
Anas penelope	774.9	825.2	*Mergus albellus*	37.8	57.6
Garganey			Red-breasted Merganser		
Anas querquedula	127.5	6.4	*Mergus serrator*	49.6	15.4
Shoveler			Goosander		
Anas clypeata	130.9	335.8	*Mergus merganser*	38.0	55.0
Eider			White-headed Duck		
Somateria mollissima	74.4	300.6	*Oxyura leucocephala*	2.3	2.2
King Eider			Unidentified ducks	218.7	2249.4
Somateria spectabilis	*105.1	*64.5	Unidentified swans	5.7	—

* These counts from the White Sea and Barents Sea were made from the air and include substantial numbers of *S. mollissima.*

The numbers of Teal recorded in northern Europe (72,600) are surprisingly small compared with those of Mallard (891,000) and Wigeon (300,000). By mid-winter a sizeable proportion of the birds in this region appear to be concentrated in the British Isles where a recent decrease has been noticed, following a period of great abundance during the early 1960s. This is attributed partly to the cold winter of 1963, and partly to a redistribution of the European population, resulting from drainage operations in the Netherlands. In southern France a recent increase is reported from the Rhône delta. Clearly, this is a species which needs thorough investigation.

The least reliable results are those for the southern species, which winter mainly around the Mediterranean, and in tropical Africa and south-west Asia. The species concerned are Garganey, Gadwall, Pintail, Shoveler, Red-crested Pochard, Ferruginous Duck, Smew and Ruddy Shelduck.

The sea ducks present special problems, and the counts for some species appear to be quite unrepresentative—except in Denmark, the Netherlands and France, where special surveys were undertaken from the air or by boat. One obvious omission was the failure to locate the main wintering flocks of the Long-tailed Duck, which during autumn passage is recorded in very large numbers from various points along the Baltic coast. The Velvet Scoter is also presumed to occur in much larger numbers than those recorded. The counts of Common Scoter and Eider seem more complete, but here again there must be many omissions, especially along the western seaboard of Scotland and Norway.

Despite these obvious short-comings, the results of the first and second censuses represent a remarkable achievement. Several thousand people have helped to provide the information on which this report is based, and to them I extend my very warmest thanks. The success of the project is due to their efforts alone. I hope that these preliminary findings will show that their work is being put to good use, and will encourage others to join us in future years. There is still much to be learnt.

Summary

International censuses of western Palaearctic wildfowl were held in mid-January 1967 and 1968. In 1967 over 6,600,000 birds were counted on 4,500 sites in 31 countries. In 1968 the total was over 9,500,000. In addition nearly four million coots were counted. Distribution maps are given for *Anas platyrhynchos*, *A. crecca*, *Aythya ferina*, *A. fuligula*, *Tadorna tadorna*, *Bucephala clangula*, *Cygnus bewickii* and *C. cygnus*.

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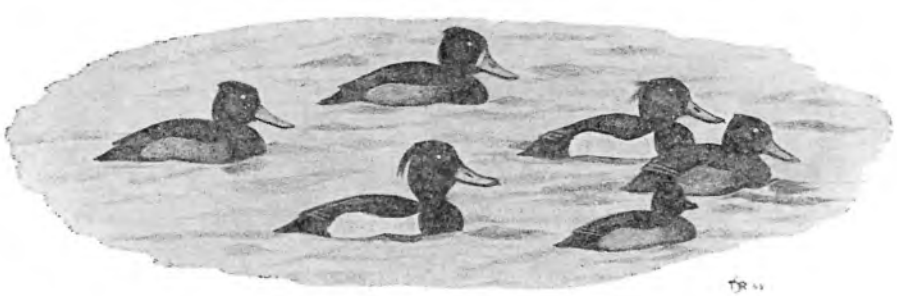
G. L. Atkinson-Willes, Co-ordinator, Duck Research Group, International Wildfowl Research Bureau, The Wildfowl Trust, Slimbridge, Gloucester.



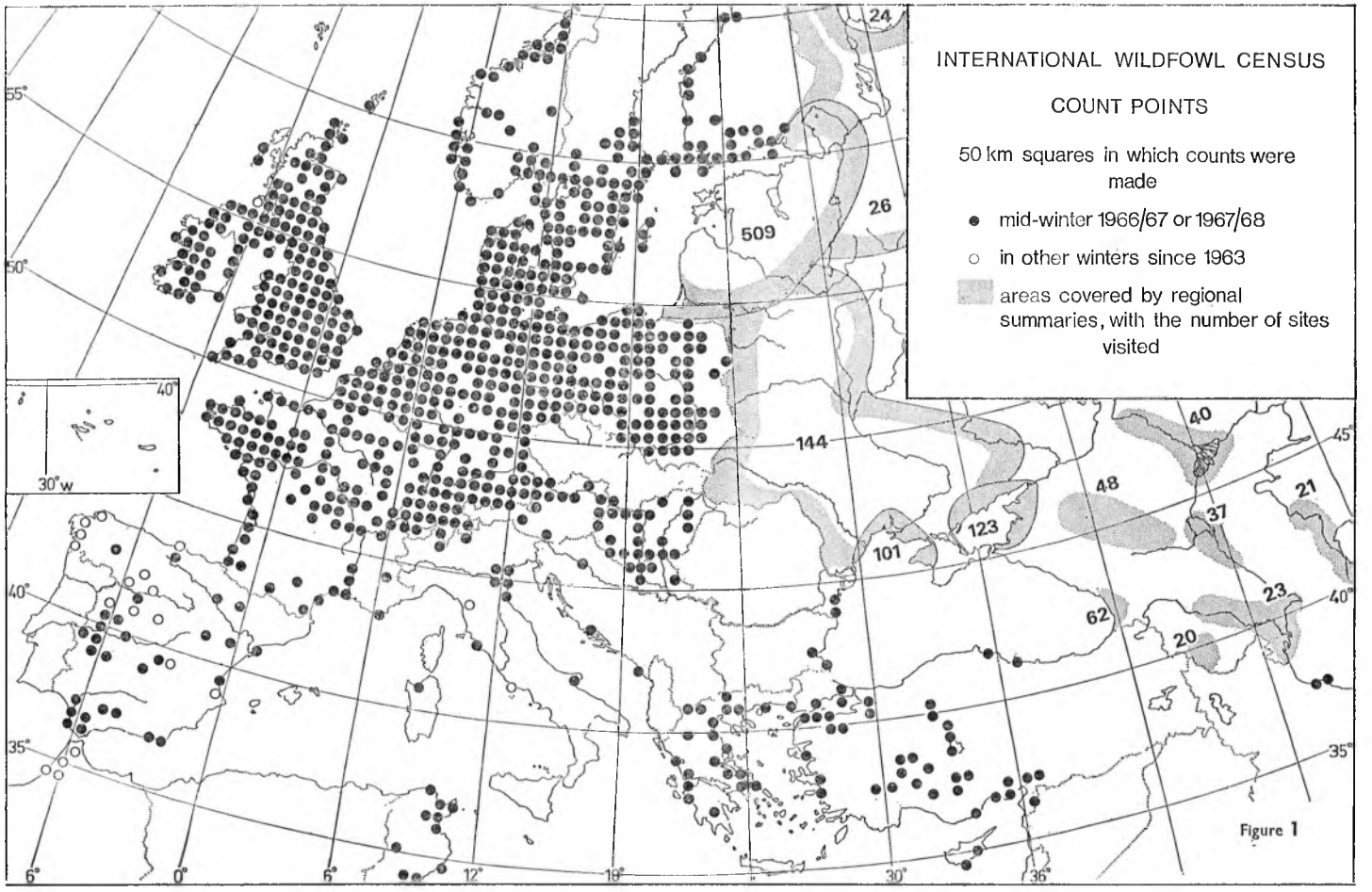

INTERNATIONAL WILDFOWL CENSUS
COUNT POINTS
50 km squares in which counts were made
mid-winter 1966/67 or 1967/68
in other winters since 1963
areas covered by regional summaries, with the number of sites visited
24
26
509
144
101
123
48
40
37
21
62
23
20
55°
50°
40°
35°
45°
40°
35°
30°w
40°
6°
0°
6°
12°
18°
30°
36°

Figure 1

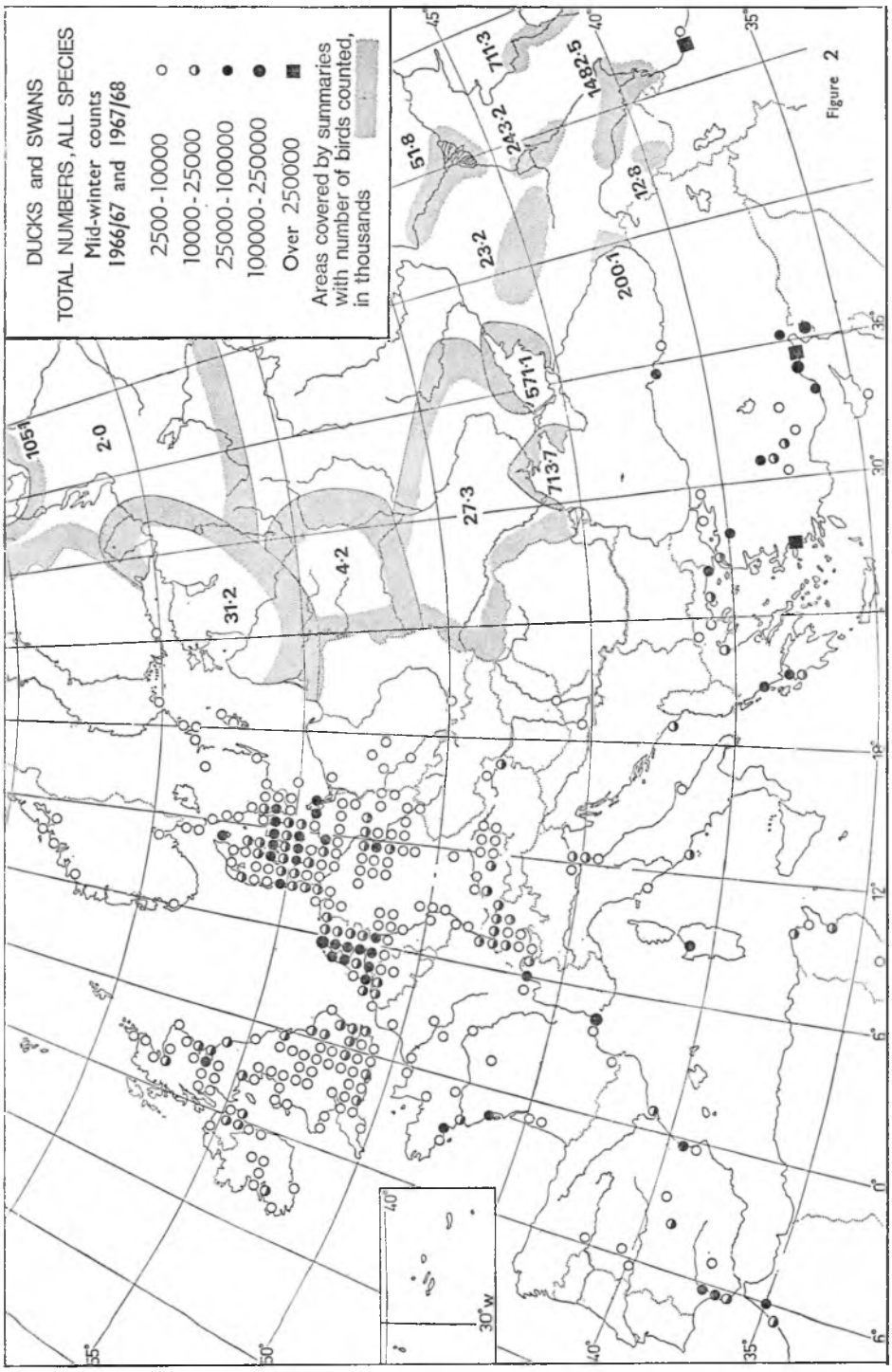

DUCKS and SWANS
TOTAL NUMBERS, ALL SPECIES
Mid-winter counts
1966/67 and 1967/68
2500-10000
10000-25000
25000-100000
100000-250000
Over 250000
Areas covered by summaries with number of birds counted, in thousands
105·4
2·0
31·2
4·2
27·3
571·1
713·7
23·2
200·1
51·8
24·3·2
711·3
1482·5
12·8
30° W

Figure 2

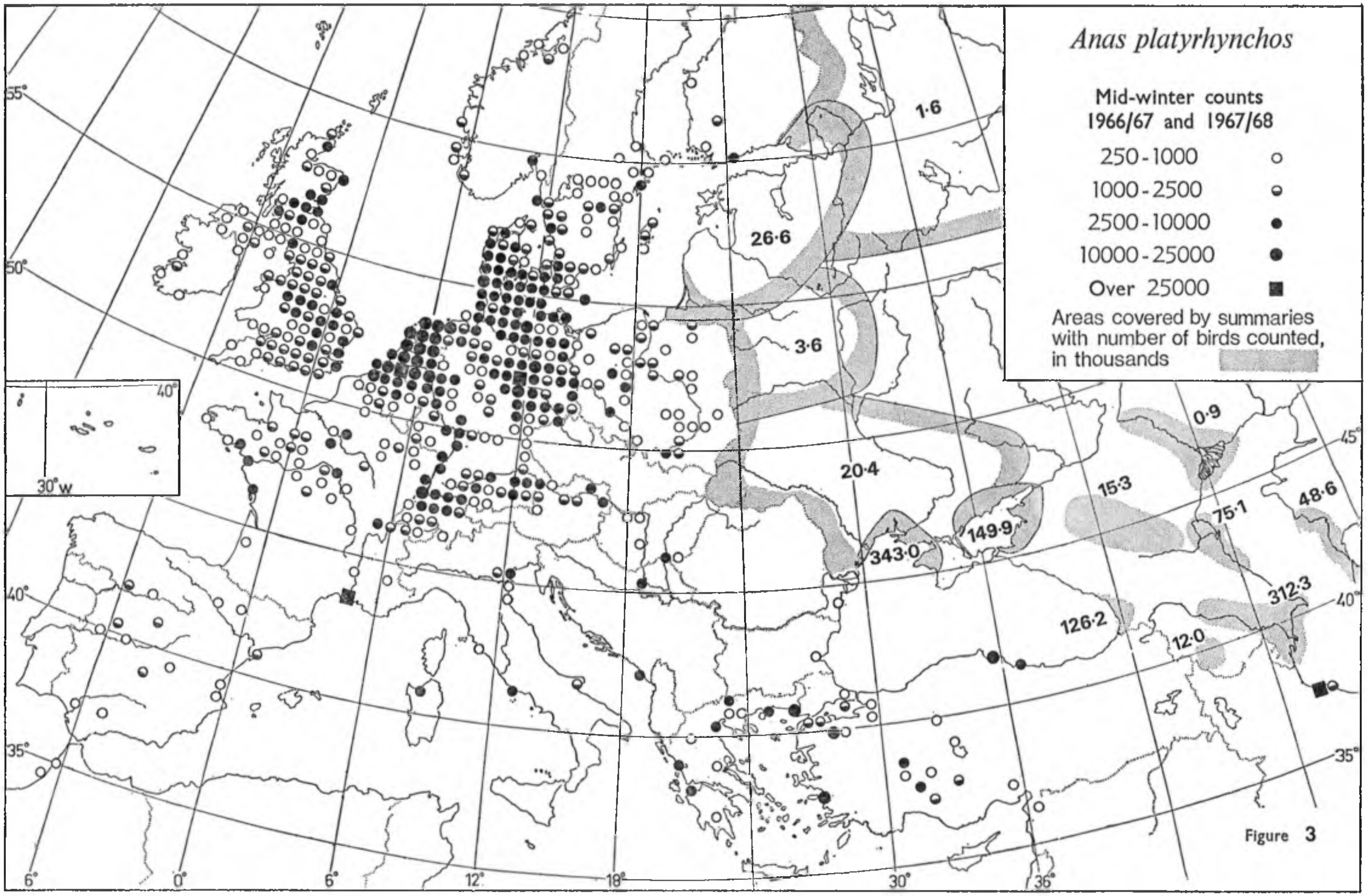

Anas platyrhynchos
Mid-winter counts 1966/67 and 1967/68
250-1000
1000-2500
2500-10000
10000-25000
Over 25000
Areas covered by summaries with number of birds counted, in thousands
1·6
26·6
3·6
20·4
0·9
15·3
48·6
75·1
149·9
343·0
312·3
126·2
12·0
55°
50°
45°
40°
35°
30°W
6°
0°
6°
12°
18°
30°
36°

Figure 3

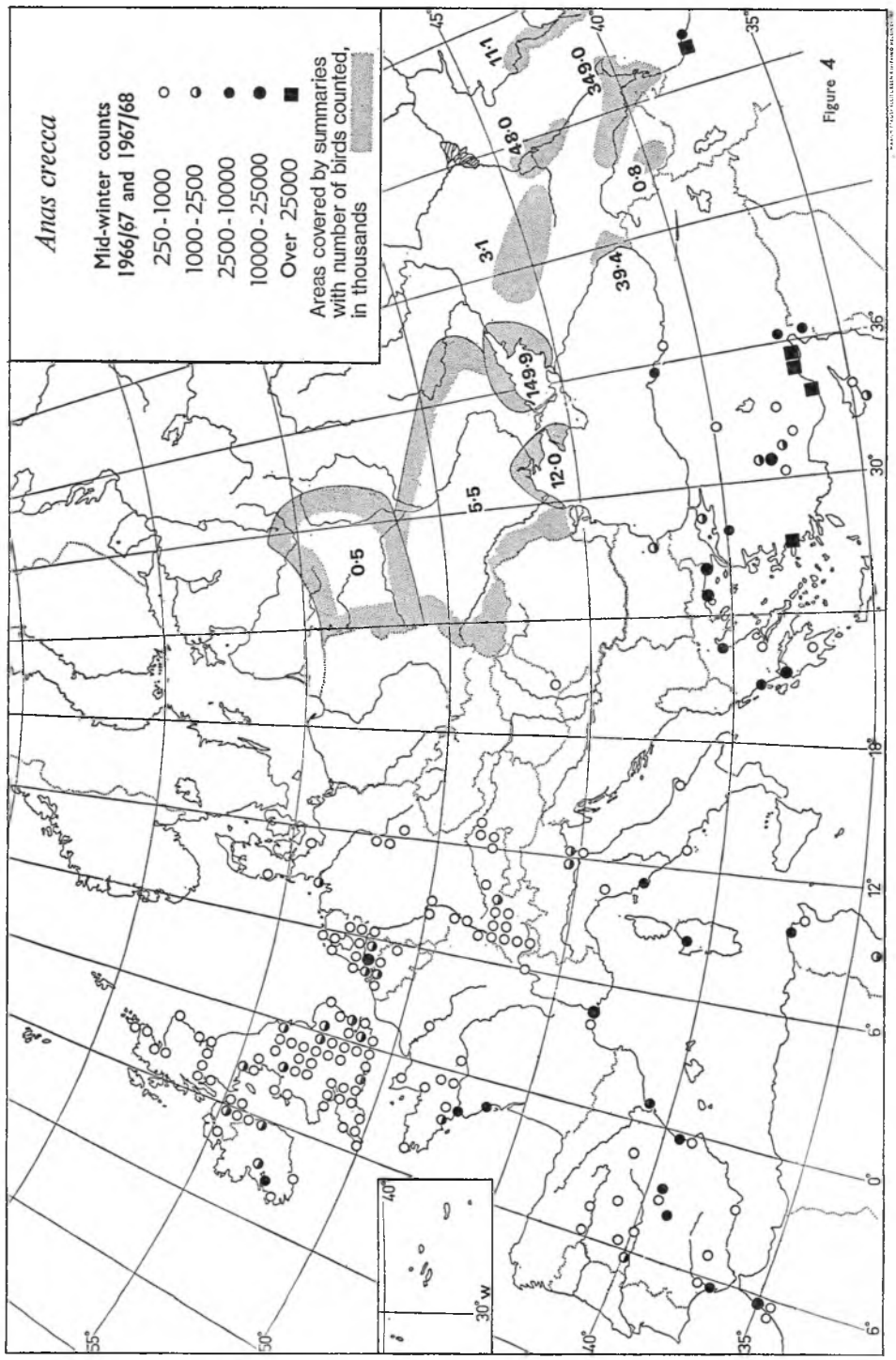

Anas crecca
Mid-winter counts
1966/67 and 1967/68
250-1000
1000-2500
2500-10000
10000-25000
Over 25000
Areas covered by summaries with number of birds counted, in thousands
0·5
5·5
12·0
149·9
3·1
39·4
48·0
11·1
349·0
0·8
30° W
40°
55°
50°
45°
40°
35°
36°
30°
18°
12°
6°
0°
6°

Figure 4

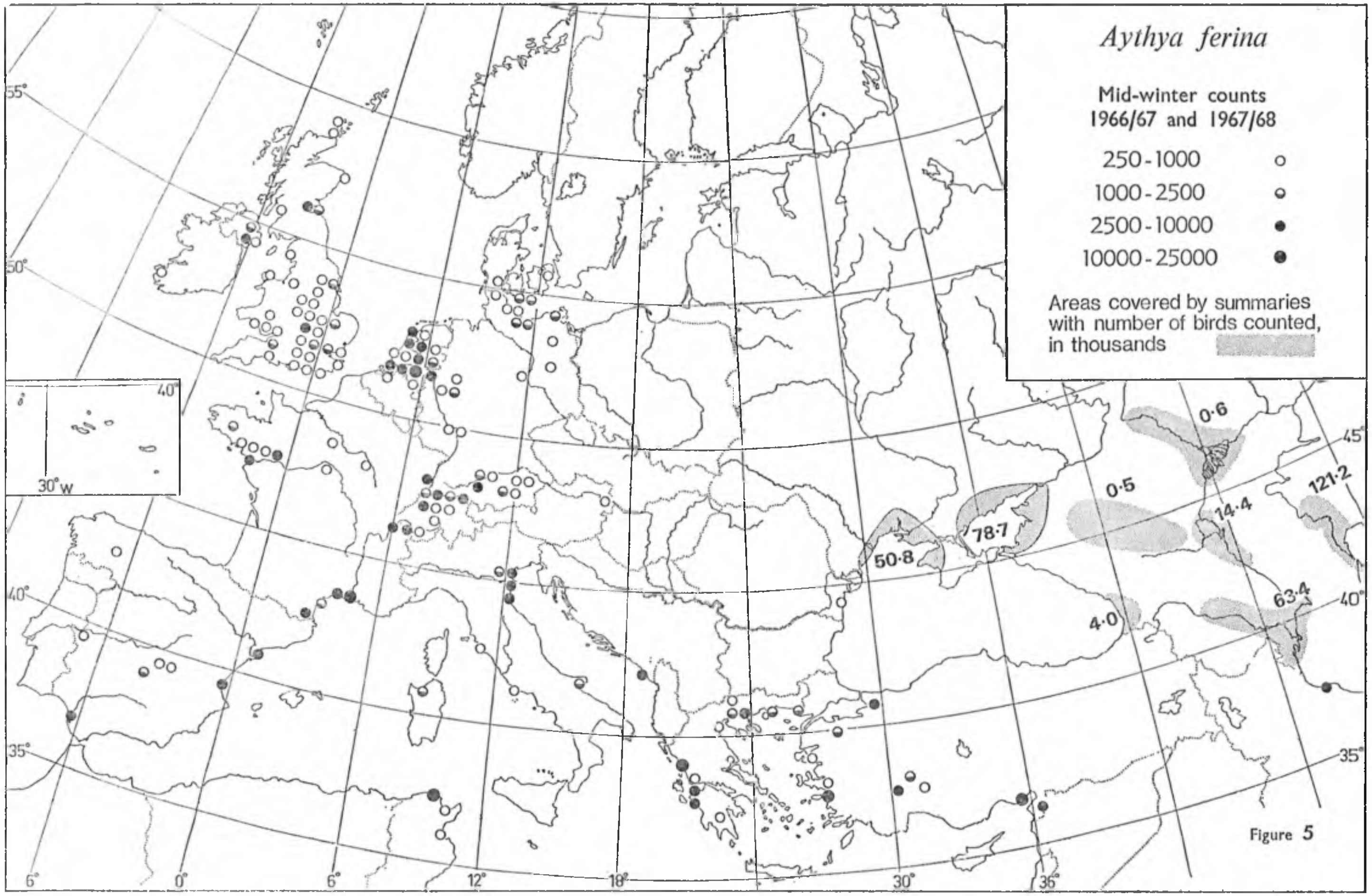

Aythya ferina
Mid-winter counts
1966/67 and 1967/68
250-1000
1000-2500
2500-10000
10000-25000
Areas covered by summaries with number of birds counted, in thousands
0·6
0·5
121·2
14·4
78·7
50·8
63·4
4·0
55°
50°
45°
40°
35°
30°W
6°
0°
6°
12°
18°
30°
36°

Figure 5

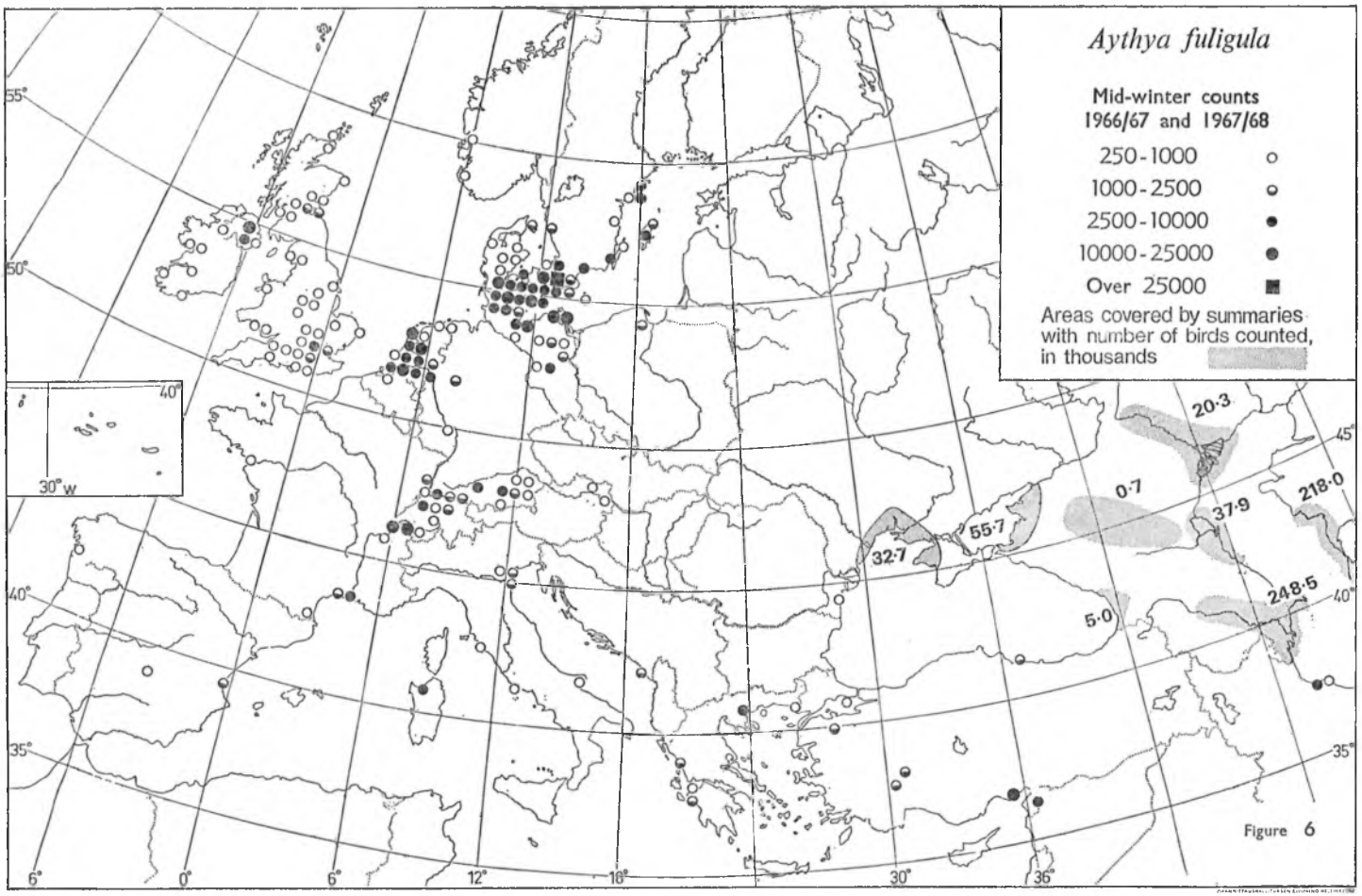

Aythya fuligula
Mid-winter counts
1966/67 and 1967/68
250-1000
1000-2500
2500-10000
10000-25000
Over 25000
Areas covered by summaries with number of birds counted, in thousands
20·3
0·7
37·9
218·0
55·7
32·7
248·5
5·0
55°
50°
45°
40°
35°
6°
0°
6°
12°
18°
30°
36°
40°
30° W

Figure 6

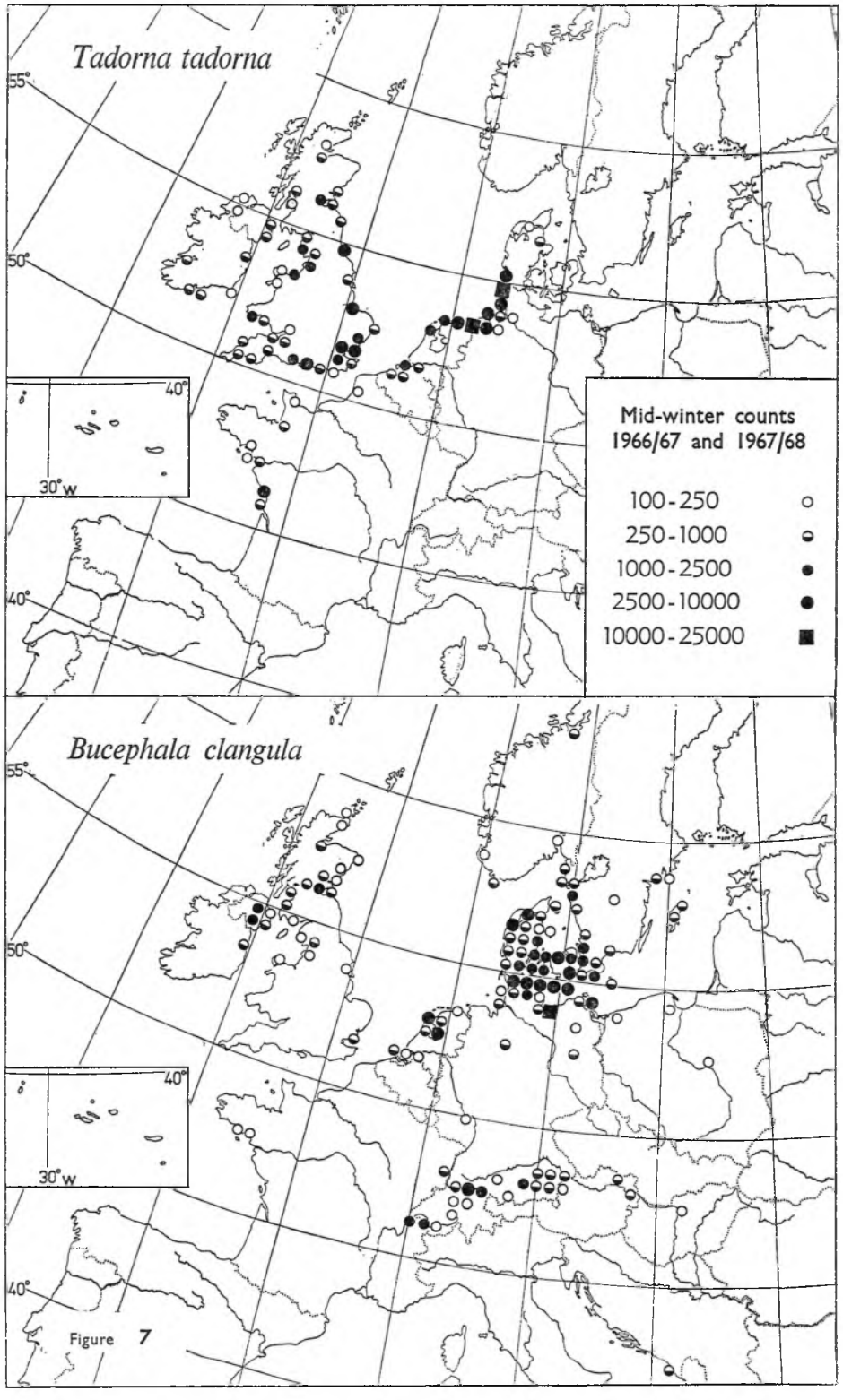

Tadorna tadorna
55°
50°
40°
30°W
40°
Mid-winter counts
1966/67 and 1967/68
100-250
250-1000
1000-2500
2500-10000
10000-25000
Bucephala clangula
55°
50°
40°
30°W
40°

Figure 7

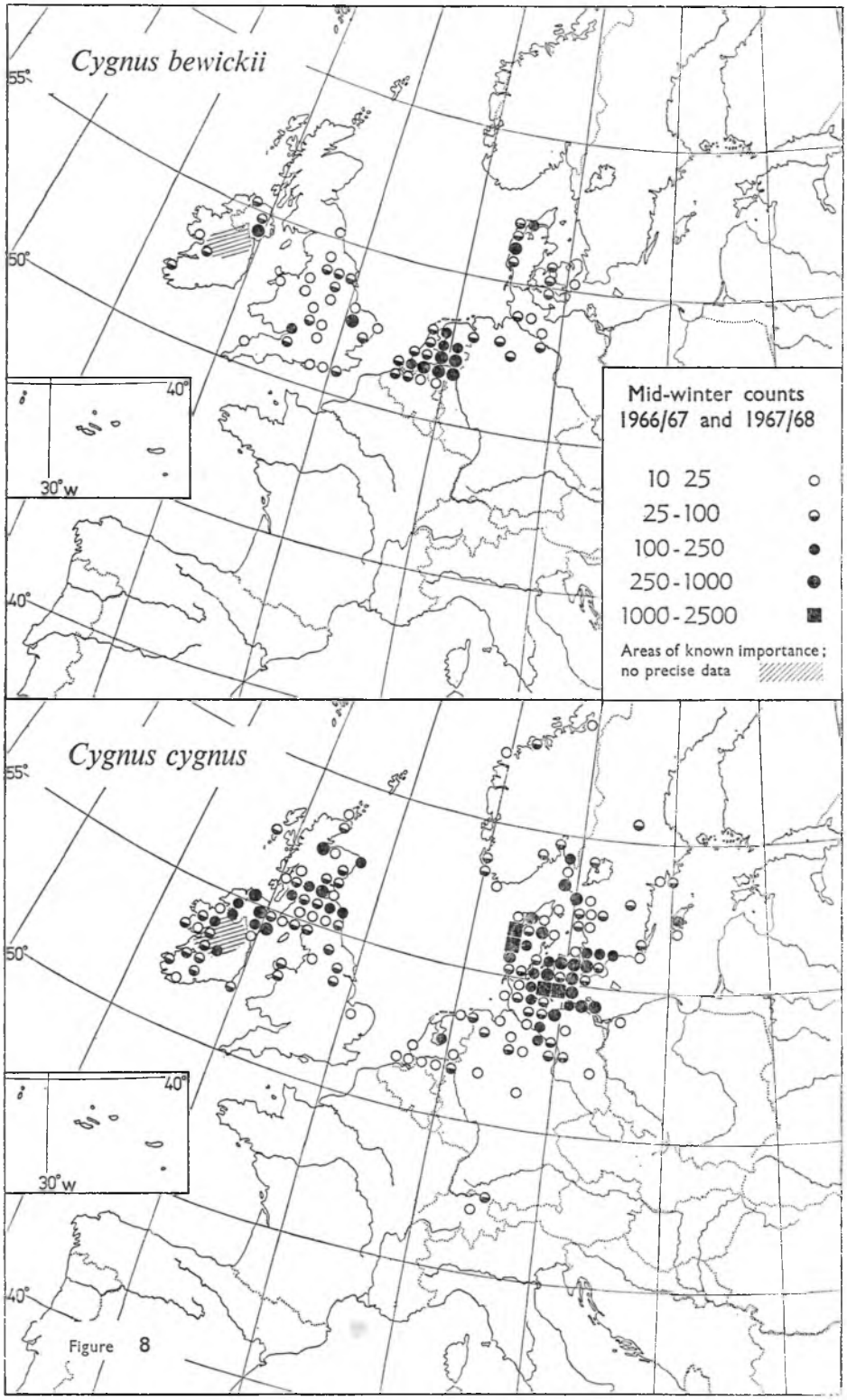

Cygnus bewickii
55°
50°
40°
40°
30°W
Mid-winter counts
1966/67 and 1967/68
10 25
25-100
100-250
250-1000
1000-2500
Areas of known importance;
no precise data
Cygnus cygnus
55°
50°
40°
40°
30°W

Figure 8

The migration of the Goldeneye in north-west Europe

LEIF NILSSON

Introduction

For many years, wildfowl counts have been performed in some European countries in order to increase our understanding of the movements and fluctuations of wildfowl populations (for example Atkinson-Willes 1963, Burckhardt 1958, Leuzinger 1964, Nilsson 1967a, 1967b, 1968, Requate 1954). In the ringing schemes of various countries large numbers of ducks have been ringed or marked with wing-tags and a few reports on the movements of European sea ducks have been published (Boyd 1959, Paludan 1962). However, no attempts at a combined analysis have been made.

The present paper seeks to outline the general pattern of the European Goldeneye *Bucephala clangula* migration in north-western Europe on the basis of the Swedish and Finnish ringing programmes, and of the wildfowl counts in Sweden, Britain and the Netherlands in 1961-62 to 1964-65. Sex ratio data were also collected.

General winter distribution in Europe

In winter, in Sweden, Goldeneye are mainly distributed around the coasts of the southern parts of the country, the January population probably not exceeding 20,000 (Nilsson 1967b, and unpublished). The species is widespread in Denmark, where 64,000 were actually counted in a survey covering the whole country in January 1968 (Joensen 1968). In Norway the species is widely distributed along the southern coasts but details are lacking (H. Holgersen *in litt.*).

The number wintering in the Netherlands is estimated to be about 50,000 but details are lacking (J. A. Eygenraam *in litt.*). The species is also common in Belgium during the winter (Lippens 1954), whereas the winter population of France is estimated at only 3,000 (F. Roux *in litt.*).

Atkinson-Willes (1963) summarises wildfowl counts from Britain and considers the winter population to be about 10,000. The species is common during the winter in Ireland with up to 5,000 on Lough Neagh alone.

In Germany up to 22,000 were counted along the coast of the Baltic in January 1967 (H. W. Nehls and G. A. J. Schmidt *in litt.*) and the species is also fairly common in inland Germany (Bezzel 1959, Requate 1954). Up to 1,000 are regularly counted on the Lake of Constance (Szijj 1963). The Goldeneye is also a common winter visitor to Switzerland (Burckhardt 1958, Geroudet 1963, Leuzinger 1964), where up to 5,500 were counted in January 1967 (I.W.R.B. unpublished report).

Information is scarce from other parts of Europe but small numbers occur in winter in Austria, Czechoslovakia, Yugoslavia and the Balkan countries (Donner 1959; I. Tutman, B. Urbanek *in litt.*).

Analysis of ringing recoveries

Many Goldeneye have been marked with rings or wing-tags in Sweden and Finland, whereas in Norway and Denmark only a few have been ringed, yielding no recoveries showing any movement (H. Holgersen, N. O. Preuss *in litt.*).

Erz (1965) mentions two recoveries of Goldeneye marked in northern Germany and later found near Genoa, Italy, and in Bavaria. The ringing activities in Britain (Spencer 1966) have yielded four foreign recoveries, all of birds marked at Newburgh, Aberdeenshire, Scotland. Two were recovered in the following spring at the breeding places near Luleå in northern Sweden and one on the west coast the following autumn. One British-ringed Goldeneye was shot in SW. Finland in the autumn four years later.

All published and unpublished recoveries (except controls) from the ringing offices in Sweden and Finland up to August 1967 are tabulated according to country and month of recovery in Tables I and II (see also Figures 1 and 2). Goldeneye marked as young birds and as adult females in the breeding boxes are treated together as no differences were found between the two groups.

Goldeneye from the woodland area of northern Sweden (Figure 1) scatter over the countries bordering the North Sea to winter in Denmark and in the British Isles. Autumn recoveries were obtained from the west coast of Norway.

A large number of Goldeneye have been marked in a rather restricted area in central Sweden (Jämtland, southern part of area I) with recoveries mainly from Norway, Denmark and the British Isles. These Goldeneye thus either migrate over Norway, following the coast, to cross to Scotland, or pass inland through Norway and/or Sweden, crossing the Skagerack to Denmark, and, in smaller numbers, to Holland and France.

Table I. Recoveries of Swedish Goldeneye. Controls and recoveries on the breeding-places during the summer months of juveniles marked in the same year not included.

Country	*Sept./Oct.*	*Nov./Dec.*	*Jan./Feb.*	*March-May*	*Total*
Sweden	35	4	2	21	62
Finland	1	—	—	—	1
Norway	4	6	4	—	14
Denmark	7	22	9	2	40
Germany	—	3	2	1	6
The Netherlands	—	2	—	—	2
British Isles	1	8	9	2	20
France	—	1	3	—	4
Total	48	46	29	26	149

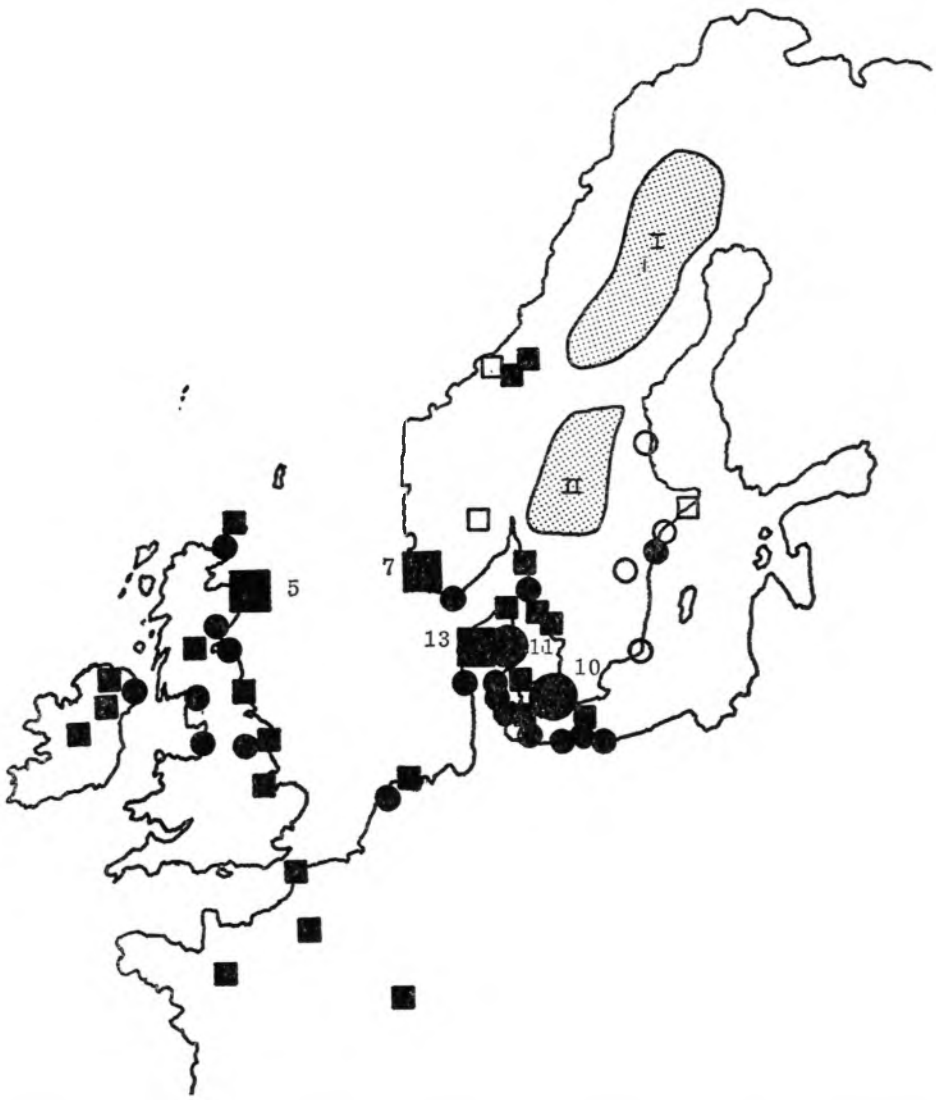


Figure 1. Recoveries of Goldeneye marked in north Sweden (I) (solid squares) and central Sweden (II) (solid circles). Open symbols denote recoveries from Norway and Sweden in September/October and March/April (recoveries from the winter areas in these months not separated on the map). Recoveries within 100 km. from the place of marking excluded.

Table II. Recoveries of Finnish Goldeneye. Control and recoveries on the breeding-places during the summer months of juveniles marked in the same year not included.

Country	*Sept./Oct.*	*Nov./Dec.*	*Jan./Feb.*	*March-May*	*Total*
Finland	6	—	—	—	6
Sweden	—	4	1	4	9
Norway	1	—	—	—	1
Denmark	—	8	13	2	23
Germany	—	3	3	—	6
The Netherlands	—	1	—	—	1
British Isles	—	—	1	—	1
Others	—	—	6	—	6
Total	7	16	24	6	53

Figure 2. Recoveries of Goldeneye marked in Finland. Open circles denote recoveries in September/October and March/April. Recoveries within 100 km. from the place of marking excluded.

The Goldeneye from more southerly parts of Sweden (Figure 1, area II) winter mainly in Denmark although seven recoveries were made in the British Isles and one in Holland. There are clear indications that they do not move as far to the south-west as do birds from area I. Three autumn recoveries show that some individuals follow the Baltic coast during the migration.

The great importance of Danish waters for Swedish Goldeneye is apparent from the map. Two areas are especially frequented: Goldeneye from northern Sweden stay mainly in the Limfjord area of Jutland, whereas Goldeneye from the southern parts of the country are common around the Danish islands. Swedish Goldeneye overwintering in the British Isles are mainly from the western and northern parts of Sweden. The British winter population is probably mainly of Scandinavian origin as there is only one Finnish recovery there. It is rather unlikely that Goldeneye from further east would be commoner than Finnish birds.

The scarcity of Scandinavian recoveries from the Netherlands is striking when the large winter population of the country is considered. The majority of the Goldeneye in this country may come from areas further to the east than Sweden (and Finland). When discussing the geographical distribution of recoveries it must be remembered that such data are undoubtedly biased due to different shooting seasons and different intensities of shooting.

The Goldeneye from Finland (Figure 2) mainly take a south-westerly course and arrive in Denmark after having traversed southern Sweden. The majority stay for the winter in this country, equally divided between the Limfjord area and the Danish islands (including neighbouring areas of the south-western Baltic). Several, however, have been recovered in central Europe and down to the Mediterranean and Black Seas.

Seasonal fluctuations as revealed by wildfowl counts

The organisation of wildfowl counts is described in the papers cited in the introduction. Of the countries in which large numbers of Goldeneye winter, Britain, the Netherlands and Sweden have sufficient monthly counts to examine changes within the season. The Swedish data are restricted to the four seasons 1961-62 to 1964-65, so the comparative discussion is likewise limited. The British data are treated in three regions, England and Wales, East Scotland and West Scotland.

The number of places on which Goldeneye were counted and the peak numbers recorded (Table III) varied widely between regions. To render the data more comparable, the following procedure was adopted. For each region and for each season the number present in the peak month was taken as 100. The numbers present in the other months were then expressed as percentages of this peak. A mean index for each month over the four seasons can then be calculated, the maximum value being restored to 100 and the other means adjusted accordingly. Although not very respectable, statistically speaking, this method produces a fairly good picture of the fluctuations and obviates the need to present massive tabular information. The original data

Table III. Number of count points and the peak numbers of Goldeneye counted thereat in four seasons.

	1961-62	*1962-63*	*1963-64*	*1964-65*
Inland Sweden				
Counts	61	68	54	42
Peak	904	1697	722	743
Coast Sweden				
Counts	17	22	17	16
Peak	653	2201	1552	2103
The Netherlands				
Counts	61	86	121	117
Peak	7422	2939	789	2051
East Scotland				
Counts	39	40	49	46
Peak	855	2180	1456	2834
West Scotland				
Counts	24	25	27	27
Peak	647	502	390	501
England & Wales				
Counts	138	141	152	135
Peak	1195	1145	1236	983

are deposited at the Wildfowl Trust, Slimbridge.

Of the four seasons studied, 1962-63 was characterised by a very severe winter with almost no open water in Sweden in January whereas the other winters were more normal.

The wildfowl counts in Sweden give the following picture of the seasonal changes (Figure 3, see also Nilsson 1967b). In September there are only few birds on the waters in southern Sweden. In October autumnal maxima are noted at most inland resting places other than the extreme south (Scania) and some Goldeneye arrive at the coasts. By mid-November Goldeneye are still common in inland Sweden but the birds have moved in large numbers to the coasts. By December Goldeneye are generally scarce in inland Sweden and numbers north of Scania are at the winter level. The coastal localities have a peak in this month. During January and February numbers are low inland whereas numbers at the coasts vary mainly with the ice conditions; in the extremely hard winter of 1963 only a few were left in January. During March a heavy build up occurred at the coasts in all years followed by inland migration during April. Regional differences in southern Sweden north of Scania are negligible.

Data from the Netherlands (Figure 3) shows that Goldeneye arrive here in small numbers during October with greater numbers arriving in November followed by a peak in December and a decrease to a minimum in January. Numbers then increase again to a peak in February or early March depending on weather conditions. In the hard winter of 1962-63 January numbers were rather low, still lower numbers in February, but a marked spring peak occurred in March.

In Britain the general picture varied little in the four years. In all regions a marked increase occurred between the counts in October and December (Figure 4). In eastern Scotland the seasonal maximum was reached in the latter month, followed by a decrease during January and February and a new influx of migrants in March. In western Scotland the increase after the autumn migration continued slowly so that maximum numbers did not occur until later in the winter. In England and Wales the increase during autumn was about the same as in eastern Scotland but the peak was

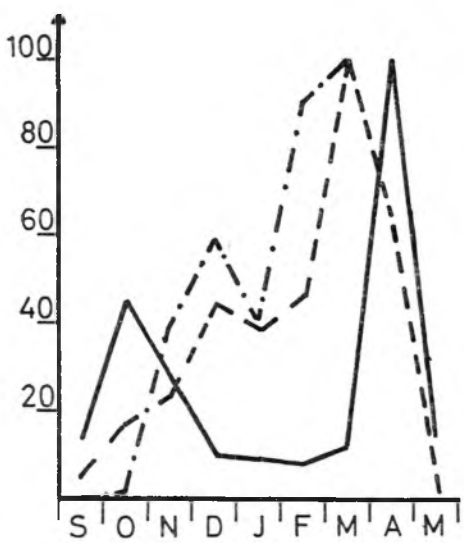


Figure 3. Mean seasonal indices for Goldeneye from wildfowl counts in inland Sweden (——), coastal Sweden (- - - -) and the Netherlands (- · - · -) in 1961-62 to 1964-65. The means were recalculated to obtain a peak index of 100 for each area.

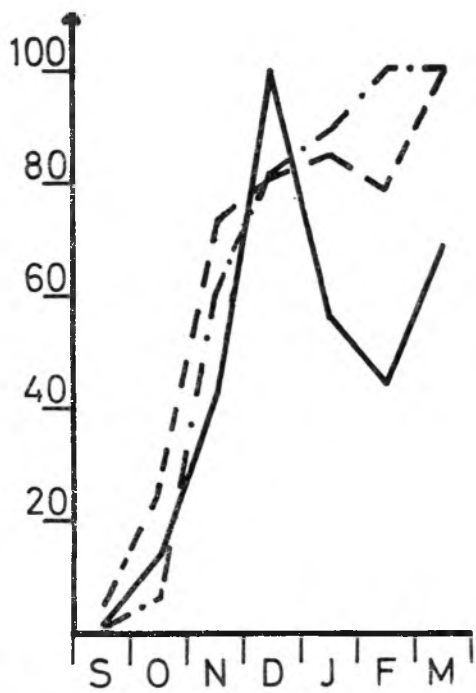


Figure 4. Mean seasonal indices for Goldeneye from the wildfowl counts in east Scotland (——), west Scotland (- - - -) and England and Wales (- · - · -) in 1961-62 to 1964-65. The means were recalculated to obtain a peak index of 100 for each area.

not reached until February or March, just before spring migration started.

In the hard winter of 1962-63 a decrease was noted in western Scotland during January whereas the numbers normally increase in this month. In eastern Scotland that winter, the decrease from December to January was more marked than in the other years. The counts in England and Wales, however, showed the normal seasonal pattern, with no complementary increase. The Goldeneye which left western Scotland in greater numbers than normal therefore probably continued to Ireland.

A comparison between the wildfowl counts from the three countries show that the main influx begins in November in all areas except inland Sweden, where it starts in October. In normal years the majority of the Goldeneye arrive almost simultaneously in the British Isles and on the coast of south Sweden. This and the regional differences in the timing of peaks in Britain is consistent with migration of the British winter birds through Norway, where there are few suitable resting places. During the winter the most marked variation occurred in southern Sweden that is the most northerly of the winter areas examined. In the hard winter of 1962-63 all areas except England and Wales experienced some emigration of Goldeneye during the coldest period. In spring peak numbers occur in both Scotland and southern Sweden in March, whereas the peak was generally earlier in England and Wales and in the Netherlands.

The proportion of adult males among wintering Goldeneye

The sex ratio counts of Goldeneye in Sweden (Nilsson 1967b) show marked seasonal variation in the percentage of adult males indicating differential migration between the adult males and the first winter males plus females. The pattern is, however, complicated by local variations and differences in flocking tendencies between the sexes (Nilsson in prep.). Differences in other regions might also be suspected. For this reason data on the proportion of adult males have been collected from other parts of Europe (Table IV).

The counts for this purpose are restricted to the months December-March. The Swedish data are grouped according to whether they are from inland, or from coastal waters of the southern tip (Scania). The latter are further divided into those from the Öresund (on the west coast between Sweden and Denmark) and those from the south coast. The data are mean values from counts of all Goldeneye resting in the respective areas, to even out local variations. The proportion of adult males in the whole population is given, as some first winter males are similar to the females and have not generally been separated.

From the table a clear trend can be seen in the percentage of adult males in the Goldeneye when proceeding from the breeding grounds towards the winter areas, i.e. in a south-westerly direction. Adult males dominate the populations only in Sweden north of Scania and the lowest values in western Europe are found in

Table IV. Percentage of adult males among Goldeneye in different regions.

		December		*January*		*February*		*March*		
Region	*Years*	*Sample*	*%*	*Sample*	*%*	*Sample*	*%*	*Sample*	*%*	*Source*
Sweden (inland)	1959-67	1795	45	2851	59	2363	55	9630	61	(a)
Scania (Öresund)	1962-67	5472	28	10362	39	9972	44	27488	43	(b)
Scania (S. coast)	1964-67	5715	49	12584	51	12027	47	8308	38	(b)
S-Holstein (coast)	1963-67	—	—	5855	40	—	—	3100	51	(c)
N. Germany (inland)	1955-61	546	47	554	48	754	35	985	45	(d)(e)
S. Bavaria	1955-58	1219	38	1714	36	833	42	947	46	(f)
Scotland	1950-63	454	35	1374	33	—	—	1013	33	(a)
England	1950-63	611	22	725	19	775	20	663	30	(a)
N. Switzerland	1958-61	1599	23	2392	27	3151	30	934	24	(g)
L. Constance	1959-61	612	11	407	21	—	—	620	16	(h)

Sources. (a) National Wildfowl Counts; (b) Nilsson in prep.; (c) G. A. J. Schmidt; (d) Erlich (1963); (e) S. Dittmann, H. Hasse, A. Hinsche, K. Puchstein, K. Tuscherer; (f) Bezzel (1959); (g) H. Leuzinger; (h) R. Kuhk.

England, Switzerland and Lake Constance. It may be noticed that the Goldeneye in the two latter areas come mainly from more easterly breeding populations than the Swedish.

While the regional differences in the percentage of adult males among wintering Goldeneye to be expected from the seasonal changes in sex ratio in Sweden is apparent in the data presented here, sex ratio counts from southern Norway, Denmark, the Netherlands, and Ireland are badly needed.

Acknowledgements

First I wish to thank all those who have answered my requests for information on the species. Special thanks are due to the following persons who helped me in obtaining count data or unpublished ringing recoveries: Mr. G. Atkinson-Willes and Mr. C. J. Beale for help with British Wildfowl Count data during a stay at Slimbridge; Mr. J. A. Eygenraam and Mr. H. Leuzinger for supplying wildfowl count data from the Netherlands and from Switzerland; and the staffs of the bird ringing offices in Sweden and Finland for help with ringing recoveries. Finally I wish to thank Mr. M. Moon for correcting my English manuscript. Financial support for the study was obtained from the Swedish Ornithological Society (Elis Wides Foundation) and the Ornithological Society of Scania.

Summary

An analysis of the recoveries of Goldeneye *Bucephala clangula* up to August 1967 show that Goldeneye from Sweden winter in the countries bordering the North Sea, with the majority of recoveries in Danish waters. Finnish Goldeneye were mainly recovered in Denmark but some were found scattered over the continent.

According to wildfowl count data from Sweden, the Netherlands and Britain in 1961-62 to 1964-65, the first main arrivals occurred in November simultaneously at the coasts of southern Sweden, in Britain and the Netherlands. In spring, peak numbers at the coasts of southern Sweden and Scotland occurred in March but it was generally earlier in England and the Netherlands.

Adult males dominated among the Goldeneye in Sweden north of Scania, whereas females and immatures predominated in all other areas from which data were obtained.

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Brent Geese, mudflats and Man

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Introduction

In past times adaptive radiation leading to increased specialization was a fairly safe option in evolution. Animals which became adapted to unpleasant environments and unusual foods were freed from competition with more powerful or prolific rivals. Modifications in the environment were slow, so the specialized species could have a reasonably long evolutionary life-span. Technological Man is now plundering, corrupting and polluting his environment so rapidly and efficiently that an entirely new time-scale is being imposed on the pattern of evolution to extinction. Specialist animals are disappearing with sickening alacrity. One well down the slippery slope would seem to be the Dark-bellied Brent Goose *Branta bernicla bernicla.*

The specialization of the Dark-bellied Brent Goose

The bird breeds only on the harsh coastal areas of northern Siberia (Uspenski 1955), along an arc of some 500 miles up to 95°E and around 75°N (Figure 1A). Although there are 24 hours of daylight in the summer, only for a few weeks is snow cover absent and the soil warm enough for plant growth. This is barely long enough to allow the completion of the normal cycle of egg-laying, incubation and rearing the young to flying. Any setback, a late thaw, or a cold, rainy spell in mid-summer, will result in an almost complete breeding failure.

The Brent then undertake a long migration, of over 3,000 miles, to an equally circumscribed wintering area in NW. Europe (Figure 1B), to the coastal and

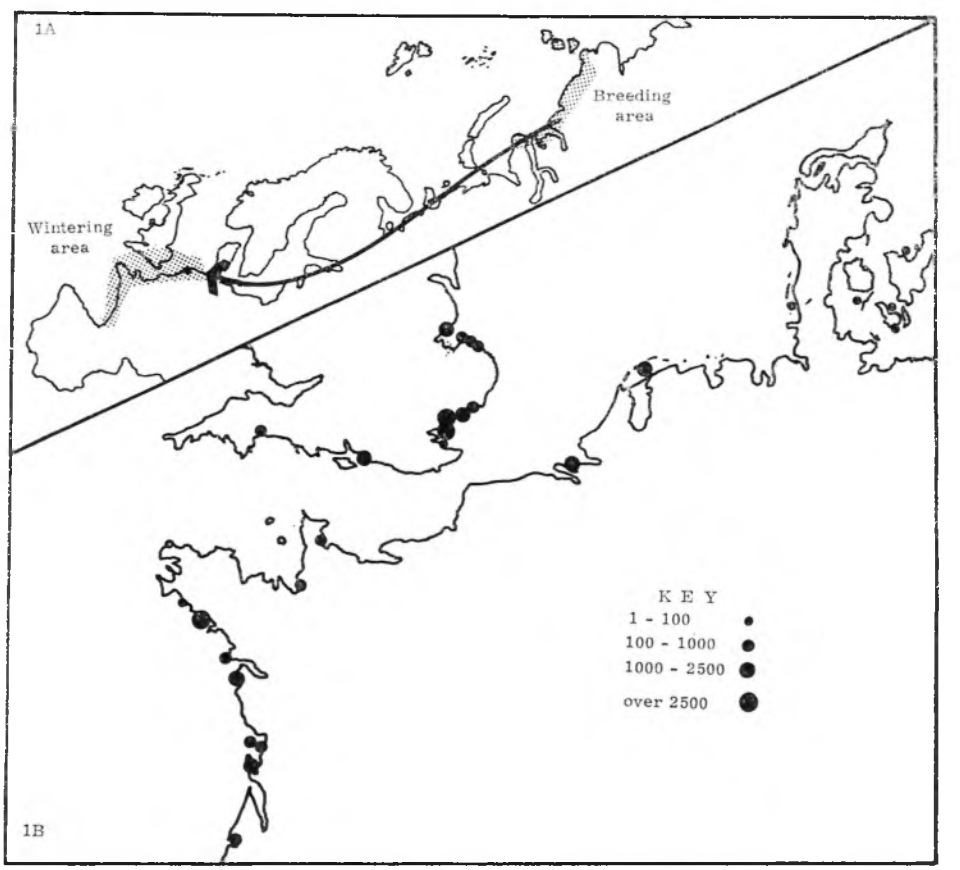

Figure 1A. The circumscribed breeding and wintering zones of the Dark-bellied Brent Goose.
1B. The wintering resorts with indications of maximum numbers present.

estuarine mudflats. During the winter they are almost exclusively maritime, seldom going above high-water mark. Their food is then virtually restricted to two plants, the alga *Enteromorpha* and eel-grass *Zostera*, one of the few flowering plants growing in the intertidal zone. The latter was the preferred plant when, in the 1930s, it was attacked by a mysterious disease associated with, if not caused by, the mycetazoan *Labyrinthula*. Over the whole of its Atlantic and Pacific range the beds of *Zostera* were wiped out. Among the many animals directly or indirectly dependent on them the Brent were as hard hit as any. Because there were no precise records of numbers before the catastrophe, its extent is arguable. Salomonsen (1958) suggested that the population in the early 1950s was barely 10% of that present in the second half of the nineteenth century. Morzer Bruijns and Timmerman (1968), confining themselves to Dutch data rather than the whole population, are in agreement with this figure. Atkinson-Willes and Matthews (1960) argued that Salomonsen's interpretation of early records was exaggerated and suggested that the diminution was of the order of 75%, but this was still a disastrous decline.

Control of hunting

After the last war, although detailed analyses were then lacking, the position was obviously alarming. Efforts were made to take the immediate positive action of imposing a ban on the killing of Brent in all countries in which they bred, passed through and wintered. Against varying opposition this has nearly been achieved and the birds are now protected in the U.S.S.R., Finland, Sweden, the Netherlands, Belgium, France, Great Britain and Ireland. The ban in the U.S.S.R. was particularly important in that hitherto the geese had been subject to massacres by the Samoyeds who rounded them up during the wing moult. The only country which at times holds important numbers of Brent and which has not imposed such a ban is Denmark. This is despite persistent efforts on the part of Danish conservationists, and international pressure. Fog (1967) gave figures that indicated the annual kill in Denmark was only about 1,300 birds. But even this, as will be apparent, is greater than the year's production for the whole population in bad breeding seasons.

It is now becoming accepted among thinking sportsmen that the only birds which are suitable game species are those which regularly produce a large proportion of young birds each year. As these are surplus to the requirement for maintaining a steady population, a harvest can be taken instead of allowing birds to die off through natural adversities. What exactly constitutes a surplus is, of course, arguable, and if there are large numbers of sportsmen in proportion to the species population, then the kill must be rationed out in some way, by limiting the length of shooting season or the size of the bag.

There is now very little doubt that the Dark-bellied Brent Goose is not suitable as a game bird, for its production of young is negligible in as many years as it is substantial. The success of each breeding season can be determined by examination of the wintering flocks. Young birds of the year at first lack the white throat bar and, throughout the winter, have fairly conspicuous white edgings on their wing-coverts. Since 1954 detailed age ratio counts have been made among the massive Essex flocks by Burton (for example 1965) and others. Further counts have been made in other parts of England, the Netherlands and France. There is remarkably good agreement between such counts in any one season, indicating that the factors, adverse or beneficial, have been similar over the whole of the limited breeding range. The data for the past 15 years are shown in Table I. In only 8 years has there been a substantial production.

Table I. Proportion of young birds in wintering flocks of Dark-bellied Brent Geese, 1954-1969.

Winter	*% young*	*Winter*	*% young*
1954-55	40	1962-63	<1
1955-56	26	1963-64	35
1956-57	7	1964-65	7
1957-58	53	1965-66	35
1958-59	<1	1966-67	40
1959-60	23	1967-68	6
1960-61	45	1968-69	<1
1961-62	3		

Habitat conservation

While the prevention of active destruction may assist, it does not of itself ensure the continued existence of an animal population. A suitable environment and, especially, an adequate food supply, must be maintained.

The crash in the Brent population coincident with the wiping out of *Zostera* by disease was strong evidence that in the wild these birds do not modify their winter feeding habits, even though some can

in captivity, being maintained in a healthy condition on grass supplemented with grain. In the spring the Brent begin to feed on plants growing above the high tide mark (Ranwell and Downing 1959) particularly as they move through the Netherlands and Denmark on their migration to the breeding grounds. But there remains this fatal rigidity of feeding behaviour in mid-winter, and if this connot be accommodated the Brent do not thrive.

After the *Zostera* disease subsided, the plant began to regenerate, but slowly and incompletely. The Atlas of the British Flora (Perring and Walters 1962) shows *Zostera marina* as having been recorded in 180 of the 3,500 10 kilometre squares investigated. Of that 180, the occurrence in 102 was based on pre-1930 records only, and the plant has not been identified since. It is therefore a fair statement to say that *Zostera marina* has been eliminated from more than half its previous localities. If we confine our statement to southern Britain, covering the coasts where the Dark-bellied Brent previously occurred, the proportion of recovery is only one-third (53 pre-1930-only records out of 78). Sometimes the disappearance of *Zostera* with its binding root system has led to the sweeping away of the mudflats themselves (Voisin 1968). In some cases *Zostera marina* has been replaced by two other species of eel-grass, *Z. angustifolia* and *Z. noltii*. These have smaller leaves with, at maximum, areas 1/10th and 1/30th those of *Z. marina* and show comparably smaller yields (Burton 1961). There is also evidence that the alternative food plant, *Enteromorpha*, is less nutritious than *Zostera*, containing only a third of the protein and a good deal less carbohydrate (Ranwell and Downing 1959).

It is certain, therefore, that the winter food supplies are not, on the British evidence, anything like as good as they were in the era before the *Zostera* disease. The situation elsewhere in north-west Europe appears to be similar. We do not however have sufficient information to make a general quantitative statement on the total amount of food available and hence the size of the wintering population it would support. Burton (1961) attempted such an assessment for the coasts of the county of Essex, the major wintering ground, and concluded that there would be, theoretically, sufficient food for about 12,000 Brent throughout the winter. Allowing for the feeding of other birds and the fact that Brent will only tolerate a certain degree of crowding, he suggested that a comfortable winter-through average would be 6,000. This has been well exceeded in the last four seasons, as will be seen from the data in Table II (rounded to the nearest hundred). The similarity of the mean figure over the four years would indeed suggest that a limit of holding capacity has been reached, the numbers late in the season being smaller if the early numbers were large, and vice versa. There are further indications of some interrelation between the peak counts in southern England and those in western France (Table III).

Table II. Monthly totals of Brent Geese in Essex, 1965-1969.

Season	*November*	*December*	*January*	*February*	*Mean*
1965-66	8700	9000	12500	7700	9500
1966-67	7100	11000	8700	6700	8400
1967-68	8700	10300	11400	9100	9900
1968-69	10600	9200	10000	8900	9700

Table III. Peak winter counts of Brent Geese in England and France, 1964-1969.

Season	*England*	*France*
1964-65	10000	13500
1965-66	14000	11000
1966-67	15600	11500
1967-68	16000	8600
1968-69	13700	8900

When the former increase the latter decrease, and vice versa, although the relationship is not an absolute one. It does suggest, however, that when the standing crop of food plants in one country has been reduced some of the geese have to move elsewhere. More frequent counts in the French resorts are needed to test this hypothesis thoroughly. Other factors than goose grazing, such as weather conditions, may be affecting the production of the food plants, thus complicating the issue. F. Roux (pers. com.) is certainly of the opinion that maximum goose numbers in terms of food supply may have been reached in France in the last few years. Wolff *et al* (1967) showed in the Delta area of the south of the Netherlands a very close correlation between the distribution of the food plants and that of the geese.

We are faced with the prospect, therefore, that even if there were a run of good breeding years, considerations of winter food supply might already be a limiting factor. The obvious question is whether something could be done about this by increasing production of the food plants where they exist or propagating them where they do not. The matter has, in fact, been very thoroughly investigated, for the well-being of *Zostera* is a matter of concern to many fishery interests and to local industries using the dried material, as well as to wildfowl biologists. Phillips (1964) and McRoy and Phillips (1968) have published bibliographies on *Zostera marina* which cover 575 books and research papers. In none of them are there successful recipes for propagating eel grass on a large scale. Indeed the situation has not improved since Cottam and Munro (1954) reported that 'extensive attempts at planting by personnel of several States, the Fish and Wildlife Service, and a few private individuals and agencies, have not been successful.'

The total (world) population

Salomonsen (1958) from his enquiries came to the conclusion that the population level in the 1955 to 1957 era was between 15,000 and 16,500. Monitoring the fortunes of the Brent population was one of the first and continuing enterprises of the International Wildfowl Research Bureau's Goose Research Group set up in 1958 with Professor M. F. Mörzer Bruijns as Co-ordinator. The organisation of the Brent counts devolved on Mr. P. J. K. Burton who had pioneered counts and age ratio examinations of the Essex flocks. In 1964 the task was passed to one of us (M.A.O.).

Brent are not the easiest of geese to count in view of the fact that they both roost and feed offshore. Nevertheless at certain stages of tide, depending on local conditions, the flocks are concentrated and accessible enough for detailed and accurate counts to be made. The very limited number of places in which the birds occur is a great help, since sufficient local ornithologists of merit and application can usually be found to cover them. A major difficulty, when dealing with such a mobile population, is the synchronisation of counts, particularly between the different countries. The advent of the I.W.R.B.'s international mid-winter count around January 15th has been of great assistance in this respect. January counts are also best in that the main migratory movements have ceased, with at least half the birds in England where counters are particularly numerous and active.

Reasonably satisfactory total censuses made in February 1961 and January 1963 were reviewed by Burton and Boyd (1964), and others have been made for each subsequent winter. The results are given in Table IV and shown graphically in Figure 2.

Table IV. Estimated total population of Dark-bellied Brent Geese, 1955-1969.

Winter	*No.*	*Winter*	*No.*
1955-1957	16500	1965-66	25000
1960-61	22000	1966-67	30500
1962-63	23000	1967-68	29000
1963-64	23500	1968-69	26000
1964-65	25000		

In view of the infrequency of successful breeding and the current limitation of habitat and food supplies, it is perhaps not surprising that the Brent have made only a slow recovery from the trough of the early 1950s and that already there are indications that the population has begun to stabilise and fluctuate in the 25-30,000 range — a tiny population for a migratory bird.

The dubious future

To face reality, it is not a question as to whether we can improve this situation, but whether it can be prevented from worsening. For too long the technocrats have regarded coastal sand and mudflats as waste lands whose only purpose is to absorb industrial waste, to serve as sites for dirty, smelly or dangerous factories or, more positively, to be reclaimed for agricultural or other purposes. Previously the rate of corruption and destruction was slow, but modern techniques have accelerated the process until the estuarine habitat is rapidly becoming the most restricted in Europe. It is of great scientific interest because of the complexity and richness of its flora and invertebrate fauna, and the wide range of fish and bird life which derive their nutrition therefrom (see Verwey *et al* 1967, for example). Many interests besides those of the Dark-bellied Brent Goose will suffer as more and more inroads are made.

At the present time the vast Delta works in the south of the Netherlands will eliminate many of the favoured Brent feeding grounds in that country by the late 1970s. If attention is then switched to cutting off the Wadden See in the north, by linking the Frisian Islands with dams, the Brent will have no place in the

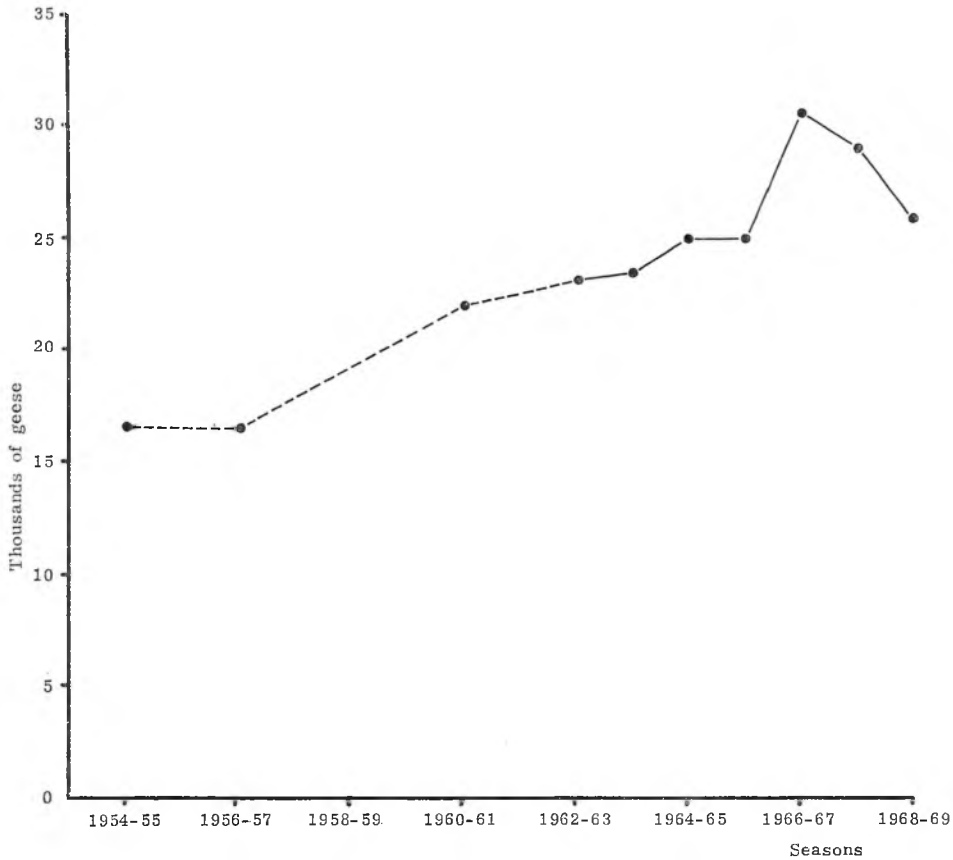

Figure 2. Changes in the total mid-winter population of the Dark-bellied Brent Goose, 1955-69.

Netherlands at all. The scheme is being vigorously resisted by Dutch conservationists but once vast amounts of equipment and armies of trained men are available for 'coastal engineering' it is exceedingly difficult to divert them on to other types of activity. The Danish Wadden See is similarly threatened and if both schemes came about there would be an arc of concrete from Jutland to Belgium. The main French Brent resort in the Gulf of Morbihan in Brittany is facing piece-meal reclamation and the spreading requirements of the oyster-culture industry.

In Britain, estuaries and coastal waters are as much under threat as anywhere. The increasing need for fresh water has aroused interest in coastal empoundments and one such scheme is being studied for Morecambe Bay, another is adumbrated for the Solway Firth. On the east coast the already polluted Teesmouth faces further reclamation to support chemical factories. Of more immediate importance to the Brent are proposals to close off the Wash in a barrage scheme, various development threats to Langstone Harbour in Hampshire and last, and worst of all, the proposal to site the Third London Airport on land reclaimed from the Foulness Sands, Essex.

The Third London Airport site controversy

This is a classical case of the wetlands-are-wastelands approach. A requirement is made out for an airport covering a huge area at which a steady procession of thundering vehicles will take off and land. The planners look around for a site that will meet the technical requirements and cause the minimal clash with vested interests or amenity requirements. Those responsible for the Foulness suggestion probably thought it an ideal solution, apart from the extra cost of grappling the land from the sea. Fortunately the Government has set up a Commission to investigate and weigh the merits of the

Foulness site and of three other, inland, sites. The national and local societies concerned with bird conservation showed an unparalleled degree of unanimity of opinion and co-ordination of action. The Army Bird Watching Society, the British Trust for Ornithology, the Essex Bird Watching and Preservation Society, the Essex Joint Council of Wildfowling Clubs, the Essex Naturalists' Trust, the Foulness Wildfowl Counting and Bird-watching Group, the Royal Society for the Protection of Birds, the Seabird Group, the South Essex Natural History Society, the Wildfowlers' Association of Great Britain and Ireland, and the Wildfowl Trust joined together to present a reasoned objection at the Public Enquiry held by the Commission. They were supported by the International Council for Bird Preservation, and the International Wildfowl Research Bureau. Letters were also written to the Commission by foreign experts in Denmark, the Netherlands and France. The representatives of 15 nations meeting at the I.W.R.B. conference in Vienna in May cabled the Commission with the request that it should most carefully consider the scientific evidence submitted to it.

This evidence, as presented by the objecting naturalists' organisations, together with a neutral factual document from the government body, the Nature Conservancy, laid primary emphasis on the threat that the siting of the Airport at Foulness would represent to the population of the Dark-bellied Brent Goose. It was pointed out that England now provides the winter quarters of half the world population. The figures for 1968-69 were England 13,700, France 8,900, the Netherlands 3,300. In the past four winter seasons the numbers present on the Foulness sands alone have reached 7,000 and, over the months November to January, averaged 6,200. Thus the conversion of the Foulness sands would remove the feeding grounds of more than a fifth of the world population of this goose. We have already seen that the existing resorts are at near-capacity and that there is nowhere left in their winter range in which such a number of Brent could be accommodated. It is not even necessary to consider whether the birds could tolerate the disturbance and feed on what vegetation was left. The planners have clearly stated that the geese would have to be driven away because of the danger these relatively large and heavy birds would represent to aircraft landing and taking off. This problem of bird-strikes on aircraft (see Murton and Wright 1968) is a very real one, particularly at coastal airports. The ornithological bodies have properly emphasised this risk to the Enquiry. Besides the Brents, some 5,000 Wigeon, 200 Mute Swans, tens of thousands of waders and up to 180,000 gulls frequent the area at certain times.

To be cynical it is 'practical' considerations such as the dangers of bird-strikes, the cost of construction of the site, its isolation from the main industrial centres and its being out on a communications limb that will sway the ultimate decision, hopefully against the choice of Foulness. How much more edifying it would be if an advanced country such as Britain could set a civilised example by making the decision on the grounds of international responsibility for maintaining a fast-vanishing type of natural habitat and for ensuring the continuation of a race of geese.

The racial question

There are those who ask why there is such a fuss about a mere race of birds. There are several answers. This is not some fiddling race dreamed up by a museum systematist laying out dreary rows of skins. It is one clearly distinguishable in the field, breeding as a population entity with very little, if any, overlap with other races. It is the Brent Goose of Europe and if it went we would be left with only some slivers of the Light-bellied race *B. bernicla hrota* coming from Spitsbergen to Denmark (about 2-3,000, of which a few hundred may spend a time on the Northumberland coast) and from Greenland to Ireland (some 8,000 at the most recent counts). It would be a sad thing if we had to travel to North America to see Brent. There, after a similar decline with the *Zostera* disease, numbers have built back to over the 100,000 mark. Similarly the Pacific race *B. bernicla nigricans* has recovered something like its former status. In both cases it has been possible to re-open a limited shooting season. The failure of European stocks to recover despite near total protection certainly suggests that habitat limitations are a prime cause.

But surely the necessity to secure the future of the Dark-bellied Brent Goose needs no stressing, for in this day and age we should not tolerate the elimination of any species or race, even by default.

Acknowledgements

We are grateful for the dedicated work of those ornithologists in several countries

who counted and investigated the Brent Geese and made their results freely available through the Goose Research Group of the I.W.R.B. Mr. P. J. K. Burton's efforts must be singled out for special praise.

The paper was written while we were holding posts at the Wildfowl Trust financed through the grant of the Natural Environment Research Council.

Summary

The specialised behaviour and ecology of the Dark-bellied Brent Geese, and the vulnerability these impose, are discussed. The intermittent reproductive success makes it unsuitable to be a game bird. The habitat and food supplies available would now appear to be a limiting factor. After recovering from a low of about 16,500 the total (world) population appears to be fluctuating in the 25,000 to 30,000 range. Further destruction of habitat and in particular the proposal to site the Third London Airport off Foulness make the future of these geese dubious.

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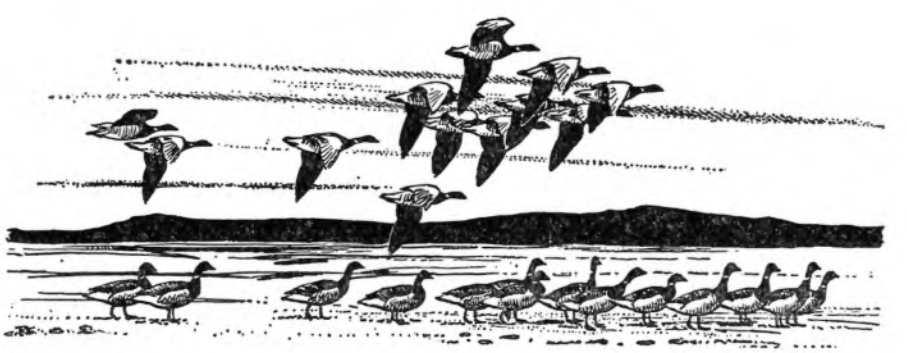

Comments on Waterfowl Habitat and Management Problems in Argentina

MILTON W. WELLER[1]

Interest in foreign waterfowl is at an all-time high because of (1) our concern for rare species, (2) our desire to learn of the biology of species in other lands which may aid in our understanding our own species and conservation problems, and (3) the desire to share management and conservation skills with other nations.

During my studies of the Black-headed Duck *Heteronetta atricapilla* in Argentina in 1964-65 (Weller 1968b), I had an opportunity to visit a number of waterfowl habitats in that country in search of Black-headed Ducks and other species. The work was funded by N.S.F. Grant GB-107. The behavioural and ecological observations have been summarized elsewhere (Weller 1967a, 1967b, 1968a) but there are certain general observations of a non-quantitative nature that may aid other biologists in assessing and improving our knowledge of the ecological, biological and sociological problems of waterfowl conservation in Argentina.

Wetland types and waterfowl

The unique and diverse waterfowl species complex of Argentina cannot be understood without reference to the habitat which has produced and supports this group. Approximately one-third the size of the United States, Argentina has at least 35 species of breeding waterfowl. Many are unique taxonomically and undoubtedly are the product of centuries of isolation from northern forms. Others are taxonomic and ecological equivalents of northern hemisphere species. Only a few species are identical.

Habitat diversity is great and ranges from the sub-antarctic marine and desert conditions of southern Patagonia to extentive subtropical forest or desert in north-central Argentina, and even to true tropics in the Province of Missiones in north-eastern Argentina. From east to west, the level pampas change to desert in the rain shadow of the Andes, the latter rising abruptly to a maximum of 23,000 feet altitude—the highest peaks in the western hemisphere. In its northern portion, this mountain range has an extensive plateau, the 'puna' zone, which has a unique avifauna of its own.

Based on my own observations, a classification of Argentine avifauna by Dabbene (1910), plus waterfowl distributional data by Casares (1933, 1934, 1945), I have tentatively classified Argentine wetlands according to their gross topographic and vegetative features as well as their waterfowl use (Figure 1). I profited greatly from discussions and field trips with duck hunters and naturalists, outstanding among whom are Peter Miles, Maurice Rumboll, Phillip Runnacles, and professional ornithologists Dr. C. Olrog and the late William Partridge.

The major populations of nesting waterfowl probably occur in the belt of fresh tule *Scirpus californicus* marshes (Figure 1, Zone A). Because this area also has the highest human population and is the major agricultural zone, it is a zone of actual and potential competition between livestock or farming activities and wildlife resources. Plant communities and avian associates in these lakes and marshes are similar to those in our western desert marshes but also share some similarities with southern marshes. Coots, gulls, egrets and ibises are common in addition to the complex of anatids: Black-necked Swans *Cygnus melanocoryphus*, Coscoroba Swans *C. coscoroba*, Rosybills *Netta peposaca*, Fulvous Whistling Ducks *Dendrocygna autumnalis*, Argentine Red Shovelers *Anas platalea*, Yellow-billed or Speckled Teal *A. flavirostris*, Cinnamon Teal *A. cyanoptera* and Versicolor or Silver Teal *A. versicolor*. The south-westward extension of Zone A represents slightly rolling country with the large, highly saline Guamini Lakes, which possibly should be regarded as a separate zone. This area is utilized some by the huge flocks of wintering sheldgeese of three species: Upland Goose *Chloephaga picta*, Ashy-headed Goose *C. poliocephala* and Ruddy-headed Goose *C. rubidiceps* (Plotnik 1961). Yellow-billed Pintails or South Georgian Teal *Anas georgica*, Cinnamon Teal, Argentine Red Shovelers, Chiloe Wigeon *Anas sibilatrix*, and Yellow-billed Teal also use this area in winter but little is known about the summer nesting period.

The open-country, warm desert marshes (Zone B) have some of the vegetation of temperate marshes (Zone A) and some of more sub-tropical areas. Some

[1] Journal Paper No. J-6248 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1504.

tropical ducks like Ringed Teal *Anas leucophrys* and Comb Duck *Sarkidiornis melanotos* frequent the area but there are also large populations of what appear to be wintering Rosybills and Yellow-billed Pintails and other species of the southern temperate marshes.

The river marshes along the Parana (the north-south portion of Zone C in Figure 1) and the Chaco swamps and marshes (east-west portion of Zone C) are considered as one zone. They seem to have much of the same waterfowl complex but differ in the more tropical wooded vegetation in the Chaco. Both areas have Ringed Teal, Brazilian Ducks *Amazonetta brasiliensis* and Masked Ducks *Oxyura dominica* but Comb Ducks, Muscovys *Cairina moschata* and White-faced Whistling Ducks *Dendrocygna viduata* apparently nest only in the northern subtropical areas of the wooded Chaco.

I have had limited personal experience with the remaining zones. The small but unique tropical forest area in the Province of Missiones (Zone D) is part of the

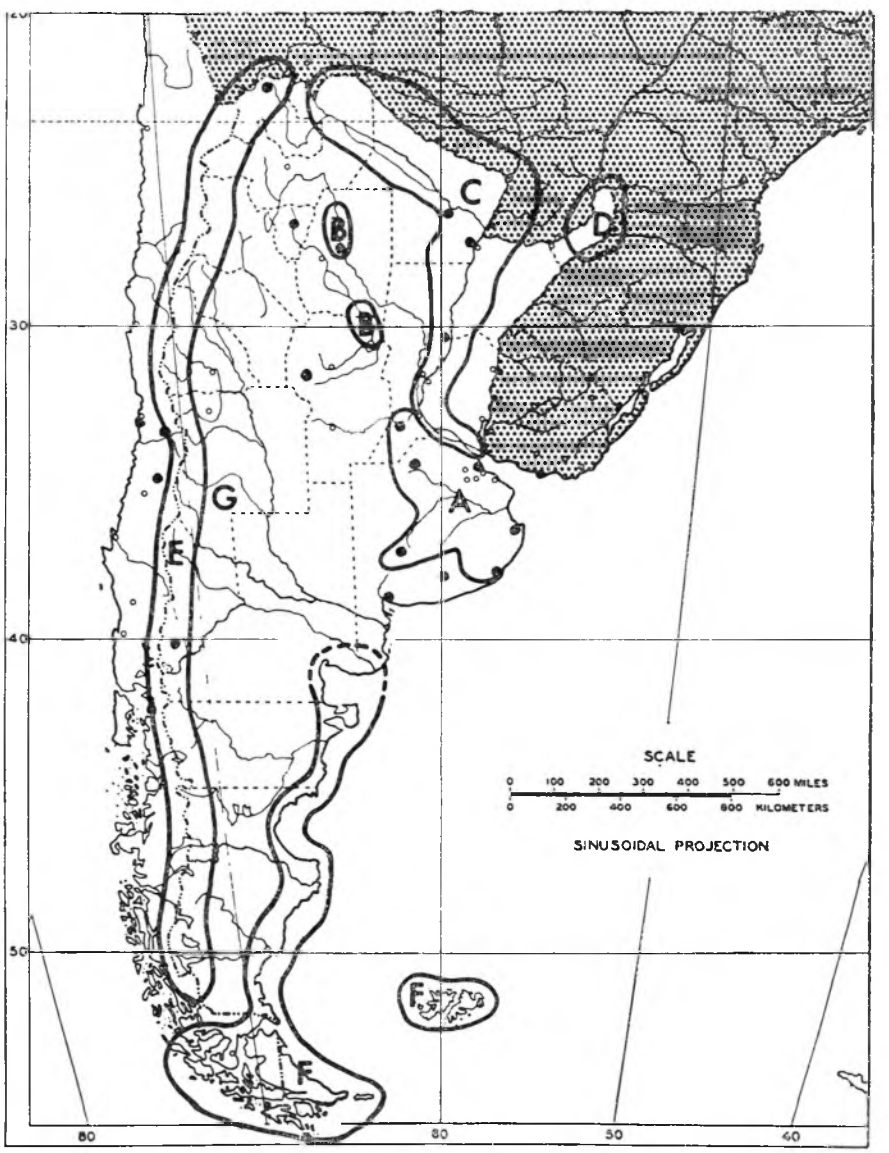

Figure 1. Classification of some Argentine wetlands in reference to waterfowl use and plant life-form. Dots show areas where I did some field work during 1964-65.

Brazilian plateau and has some slow to moderately swift streams which are separated by waterfalls from the lower slow-moving streams which harbour the predacious fish, the dorado *Salminus maxillosus*. It is in these dorado-free streams that the rare Brazilian Merganser *Mergus octosetaceus* breeds (Partridge 1956). It is one of only two mergansers recorded from the southern hemisphere, the other being extinct.

The Andes (Zone E) probably should be subdivided into streams and lakes, and differences probably exist in northern versus southern areas. This area contains the torrential streams which are the home of the unique and little-studied Torrent Duck *Merganetta armata*. The more southerly, larger and slower moving streams are used by the beautiful Bronze-winged Duck *Anas specularis*, both sexes of which have a bold white crescent in front of the eye. The alpine sedge marshes of the northern part of this zone harbour Andean Geese *Chloephaga melanoptera* as well as Andean Crested Ducks *Lophonetta specularioides*, Puna Teal *Anas puna* (possibly a sub-species of the Silver Teal), Cinnamon Teal, and the ubiquitous Yellow-billed Pintail. In the deeper southern lakes, Flying Steamer Ducks *Tachyeres patachonicus* also occur.

The marine zone (Zone F in Figure 1) of lower Patagonia, Tierra del Fuego and the Falkland Islands has a harsh climate in which several unusual species have evolved. These forms are unique among the waterfowl of the world in their restriction to the marine environment and include the Kelp Goose *Chloephaga hybrida*, and the huge, boat-like Flightless Steamer Ducks *Tachyeres pteneres*. Other nesting ducks include migratory species like Chiloe Wigeon, Silver Teal and Yellow-billed Pintails and other dabbling ducks.

There are additional lakes and reservoirs along the foothills of the Andes (Zone G) which with the slow moving streams are utilized by sheldgeese, Crested Ducks, Chiloe Wigeon, Yellow-billed Pintails and a larger, taxonomically confusing Ruddy Duck *Oxyura sp.*

Hunter harvest

By northern hemisphere standards, waterfowl hunting is not popular but is favoured mainly by the Anglo-Argentines and American businessmen. However, according to residents, interest is gaining as the standard of living increases, and there is evidence of increasing interest in all outdoor activities. Undoubtedly, waterfowl hunting will increase in popularity as has hunting of the quail-like tinamous.

Because of the lack of pressure for shooting sites, hunting methods are simple. Pass-shooting is common but marsh hunting without decoys produces excellent bags. Roadside shooting of sitting-ducks is still more common than it should be.

There are 22 provinces, and each apparently is able to set seasons on all game species without Federal influence. Some provinces consider ducks more of a nuisance than game but others have specific shooting seasons and bag limits. During 1964-65, the Province of Buenos Aires had a three month season from 1st May until 31st July with bag limits of 20 ducks per day. This limit probably is reasonable with present hunter activity but the timing of the season may need evaluation. Regulations on tinamous seem to have a strong influence on duck hunting: seasons in the Province of Buenos Aires were set concurrently when the timing of the reproductive periods differed.

Species composition of the kill was assessed by bag checks in northeastern Buenos Aires Province, southern Santa Fe Province and in the seasonally flooded marsh areas of north-central Province of Santiago del Estero (Table I). Rosybills and Yellow-billed Pintails were preferred species everywhere and Yellow-billed Pintails were the number one species observed and shot in all areas checked.

Table I. Anatids examined in hunters' bags, 4th March — 23rd July 1965 in eastern Buenos Aires and south-eastern Santa Fe Provinces (Zone A).

	No.	*%*
Yellow-billed (Brown) Pintail	122	*46*
Yellow-billed Teal	27	*10*
Red Shoveler	23	*8*
Rosybill	16	*6*
Black-headed Duck	16	*6*
Chiloe Wigeon	13	*5*
Versicolor Teal	12	*4*
Cinnamon Teal	12	*4*
Bahama Pintail	12	*4*
Coscoroba Swan	6	*2*
Fulvous Whistling Duck	2	*2*
Argentine Ruddy Duck	2	*2*
	263	

Some management problems

Depredations

Crop damage is characteristic of all areas of the world where ducks, water and crops come together. The rice-growing

areas of the Paraná River Basin are no exception and ducks are on the outlawed list. Wintering ducks from Zone A appear to be the chief nuisance but probably some ducks reared in the flooded rice fields also are involved. Yellow-billed Pintails, Rosybills and Fulvous Whistling Ducks were most mentioned. Hunters are hired to shoot ducks in the fields and one rice grower reported that aerial applications of pesticides have been used on blackbirds and ducks. This same grower suggested that poor farming practices were responsible for the puddles which attracted ducks. Apparently, no other diversionary tactics have been tried and ducks remain generally unpopular in rice areas.

Competition for grazing areas by cattle and sheldgeese is a major conflict in southern Buenos Aires Province. Cropland is not common in the area but some damage to forage crops is reported. Methods of control are mainly scaring with aircraft, a system in use for 20 years or more and considered satisfactory because of the great fear these birds have for aircraft. Apparently, sheldgeese can be driven many miles and some pilots even try to drive them out to sea in an effort to drown them. All sorts of control measures have been suggested, including shooting females on the breeding areas, but the farmers' co-operatives seem content to pay pilots to drive them to some less important field.

Habitat Loss

Although waterfowl presently are an abundant and little-used resource, habitat destruction of various types is moving at such a rate that the resource is being endangered before public sentiment reaches a level of concern and action. This already has happened with larger land mammals. Much loss of habitat already has occurred. Huge agricultural drainage ditches remove excessive rain water from the rich tule marshes of eastern Buenos Aires Province. This apparently has reduced both the size and permanence of some wetlands. Some of the canals have control structures which allow tidal action to influence marsh levels to a degree where flooding of nests is possible. Apparently these marshes remain essentially fresh water, however.

Grazing is sufficiently severe in many areas adjacent to marshes that production of dabblers must be seriously affected. Fencing of marsh areas is rare and some destruction of emergent vegetation occurs because of cattle trampling during dry periods. Some of these key production areas need to be set aside now for preservation of nesting-habitat. These can be fenced to allow cattle access to water without destroying all cover adjacent to the marsh, and hunting may not be detrimental if limited to the non-breeding season.

One of the most successful dabbling ducks in the tule marsh zone (A) is the Yellow-billed or 'tree' Teal, a close relative of the American Green-winged Teal *Anas crecca carolinensis*. Its success probably is due to the fact that it has adapted to using old nests of Monk Parakeets *Myopsitta monarcha* which are 30-60 feet up in *eucalyptus* trees planted near most estancias. These Teal are known to nest on the ground but it is rare in Zone A. Although tree nest sites would seem safe and permanent, there is presently a major campaign to eliminate the parakeets because of crop damage and because of their possible role as vectors of psittacosis. The loss of these nest sites would place these Teal back in competition with cattle—a condition which at present would provide few ground nesting-sites. However, I feel sure that artificial nesting boxes would be used if parrot nests are ever eliminated; we need to learn this now to plan for the future.

Lack of biological data

Comparatively speaking, little is known about the nesting habits, productivity or movements of even the most common ducks. The banding programme of Dr. C. Olrog (1962) of the Lillio Institute is a promising endeavour but this and similar efforts must be initiated with stronger financial backing.

There is considerable variability in timing of nesting periods because of the lack of importance of seasonal changes and the great importance of water availability (Weller 1968a). This produces serious problems in the timing of the harvest seasons. Although harvesting of a few breeding birds may not be serious at this time, there is a need for better data. Moreover, in the northern regions, water availability induces both breeding by ducks and hunting. Because of annual variation in any given area, some index to breeding of subtropical birds is badly needed so that seasons may be set quickly and effectively. Harvest seasons, where they occur, now are set by provinces but I do not know the basis for the timing. Whether Federal regulations would provide a more sound basis for setting sea-

sons according to biological zones needs to be considered.

A needed stimulous

There is serious need now for an active national—not necessarily governmental—research and management organization. Some of the better work being done is by the national agricultural organization, the National Institute of Agricultural Technology (I.N.T.A.) but this seems to vary with interested staff. Several amateur ornithologists have contributed greatly toward a knowledge of distribution, nest sites and general habits of waterfowl but much still is to be done. I learned of no provincial governments which are sponsoring management - orientated research projects on waterfowl.

Because of sensitivity by provincial governments about Federal control of activities, it is possible that a private organization financed by contributions from interested businesses and sportmen would be best. Financing by any national license seems unlikely, and provincial licenses have not been well enforced. An independent organization could encourage management-oriented research by local as well as foreign workers. In addition, this organization could stimulate and co-ordinate programmes of the provincial federal governments, and develop licensing and enforcement systems which eventually could finance a research, management and conservation scheme. Such a group might also co-ordinate the activities of ornithological workers as well, because there appears to be some unnecessary friction between the 'birdwatchers' and hunters.

One other problem this organization could tackle is the issue of international management agreements. At present, there is little interest in problems of wildlife movements across national borders in South America. Waterfowl movements do occur between Uruguay, Brazil and Argentina (Olrog 1962) and presumably between Chile and Argentina. Although it does not seem a major problem, the development of co-operative programmes of these nations will lead to further study and improved attitudes towards all migratory species.

Summary

Waterfowl habitat in Argentina is reviewed, and the main waterfowl species listed. Management problems such as hunters, habitat loss and the lack of good data are discussed. An independent organisation is needed to stimulate and coordinate research, management and conservation.

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Nacton Decoy and its catches

G. V. T. MATTHEWS

On 1st August 1968 the Wildfowl Trust acquired Nacton Decoy in Suffolk, on a 21-year lease from the Orwell Park Estate. Thanks to the interest and generosity of the Trustees of the Estate, and to the efforts of the late Major-General C. B. Wainwright, the last of the great commercial decoys in Britain is now engaged in ringing ducks instead of killing them for the market.

Payne-Gallwey (1886) described the decoy in the following terms. 'About fifty or sixty years ago a Decoy was constructed at Levington Heath, near Orwell Park, by Sir Robert Harland. It is four acres in extent, and when in full working order had five pipes. The present owner of the estate, Colonel George Tomline, worked it for many years, and then gave up doing so for a time. He states that the largest number of fowl he ever captured in one year was 3,000. In 1853 2,380 were taken; in 1854, 2,279; in 1855, 1,803; the total number of Ducks secured in eighteen years being 27,991, of which 5,711 were Wigeon. At the present time only one pipe is worked, in which during the season of 1884-85 more than 700 Ducks were taken by the end of November, but Colonel Tomline is now constructing a second pipe with the assistance of one of the Skeltons. There are some pinioned Wigeon here which breed freely, and the young birds are quite tame. A curious circumstance is, that although the Decoy is within 300 to 400 yards of the Felixstowe Railway, the wildfowl appear to take no notice of it. In sharp weather there are great numbers of fowl in this Decoy, and Colonel Tomline has seen thousands assembled on the ice, and informs me he has lately met with such success that he intends fitting up the disused pipes again.'

Payne-Gallwey used the name 'Orwell Park Decoy' and also described two 'Nacton Decoys' on Nacton Heath. However, they lay in the parish of Foxhall, not in that of Nacton, and were 'sometimes spoken of as the Bixley or Purdis Hall Decoys.' These were operational in 1885 but have been defunct now for many years and 'Nacton Decoy' has long been used as the name for the decoy in Orwell Park. Payne-Gallwey does not mention all the curious circumstances of the Decoy's situation and construction. Most decoys near the coast are on low-lying marshland. Nacton Decoy is on sandy land more than fifty feet above the River Orwell's estuary, which lies a mile to the south. It appears that the ponds were originally constructed not for a decoy but to store water from springs to provide power for a small water-mill. It was then observed how attractive the ponds were to duck, particularly when the marshes below were disturbed. Modifications were therefore made so that they would serve as a decoy. This is probably why Payne-Gallwey's dates for the construction of the Decoy are rather vague, 1825-1835 (rather earlier than the Trust's decoy at Slimbridge, completed in 1843). It is also the explanation of the unusual arrangement shown in Figure 1, whereby the Decoy pool (2.2 acres) has adjacent to it another pond of similar size. This pond is little used by the duck and would indeed be a handicap to catching if it were. It is therefore not kept undisturbed and the catches at SE. and SW. pipes are ringed and released on its margins.

The fifth pipe is situated not on the main ponds, but on a small pool to the north, of just over half an acre. This was designed to catch Teal but is now little used for the purpose. The wooded slopes climb quite sharply from the ponds (Plate IXa, facing p. 136) and use was made of this configuration to place little gazebos, charming hexagonal wooden structures, above the end of each pipe. These give the observer unrivalled views of the whole catching operation, looking down on the decoyman and his dog. Also included in the 28 acres leased to the Trust are two large rectangular tanks, at present used for rearing domestic ducks, and the storage hut where the catch was sorted and laid out (Plate IXb). There is also a delightful high-gabled cottage for the decoyman, something straight out of Hansel and Gretchel.

The Skelton mentioned in Payne-Gallwey's account was George Skelton, who operated the refurbished Decoy until he died in 1919. He was a great-grandson of the first George Skelton who left Friskney, Lincolnshire, to construct and demonstrate 'proper' decoys in East Anglia, beginning with Winterton Decoy, Norfolk, in 1807. Before that, odd decoy pipes had been built in the angles of large lakes there, but Skelton and his family of decoymen spread the more efficient Dutch technique of using a small, secluded pond with several pipes. George

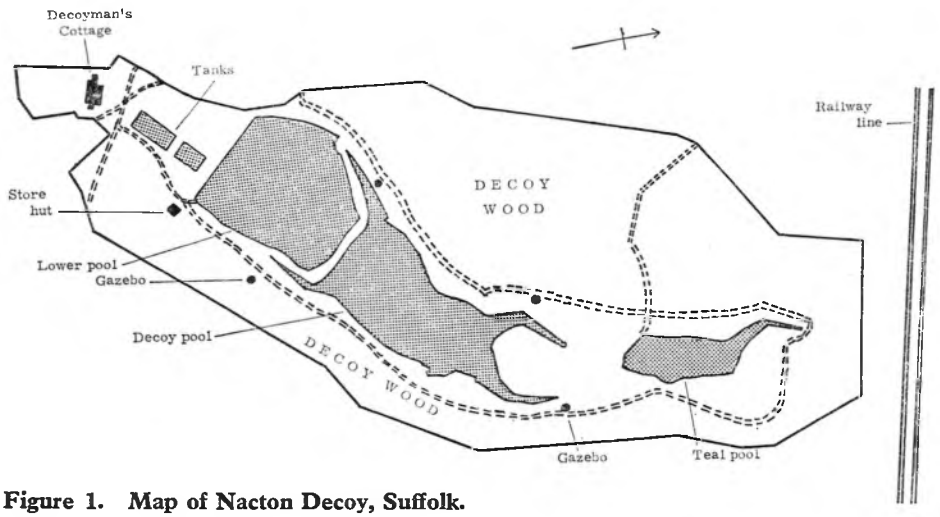


Figure 1. Map of Nacton Decoy, Suffolk.

Skelton the Second (1790-1857) was the most famous of the family and figures as the frontispiece of Payne-Gallwey's book. He ended by working Dersingham Decoy, Norfolk, now owned by Mr. J. E. A. Lambert, and also operated as a ringing station with support from the Trust (Lambert and Cook 1967).

On 23rd July 1919, Tom Baker took over as decoyman and has continued ever since, completing his half-century this year. Indeed his association with the Decoy goes back 12 years earlier, to the same date in 1907 when, as a boy, he started helping Skelton. Four years fighting in France, 1914-18, constituted his only prolonged absence from Nacton. Now an active 74, his wiry frame seemingly impervious to the elements, Tom differs from the popular concept of a decoyman — small, taciturn and secretive — in being a good six feet tall and a fascinating talker on any aspect of Suffolk folklore and the arts of decoying.

We are fortunate in having been allowed access to the detailed Estate records of the birds caught, day by day and species by species, from 1895 to the present day. Since the Decoy was being operated under the Estate Office, these figures were subjected to meticulous auditing at the end of each season and so must be one of the most reliable of such records in existence. The details of the catches provide wonderful data for detailed analysis of the effects of weather and so on, but this is outside the scope of the present paper. We will confine ourselves mainly to the seasonal totals as set out in Tables I and II.

While George Skelton operated the Decoy the kill averaged 2,200 (against the 1,555 indicated by Payne-Gallwey) and fluctuated between one and three thousand a season; this is the usual range for decoys both in this country and in the Netherlands. However, instead of declining with the decoyman's advancing years (as had been the case with the Trust's decoy near Peterborough, Borough Fen Decoy, when it was under Billy Williams)

Table I. Take of ducks at Nacton Decoy in 24 seasons with George Skelton as decoyman.

Season	*Mallard*	*Teal*	*Wigeon*	*Pintail*	*Others*	*Total*
1895-96	697	208	381	15	—	1301
1896-97	1379	110	497	16	—	2002
1897-98	715	294	306	20	—	1335
1898-99	482	502	176	31	—	1191
1899-00	2576	429	239	51	—	3295
1900-01	1267	120	223	29	2	1641
1901-02	1040	255	101	27	3	1426
1902-03	1711	166	168	40	—	2085
1903-04	1387	219	194	45	—	1845
1904-05	2070	558	168	54	—	2850
1905-06	1549	471	222	40	—	2282
1906-07	2299	462	161	57	—	2979
1907-08	2195	868	130	57	—	3250
1908-09	1715	426	229	46	—	2416
1909-10	1003	228	104	24	—	1359
1910-11	677	327	76	30	—	1110
1911-12	921	547	180	29	—	1677
1912-13	406	210	178	26	—	820
1913-14	1056	1202	432	29	—	2719
1914-15	790	1155	315	14	4	2278
1915-16	966	808	1176	42	3	2995
1916-17	1614	481	1151	39	—	3285
1917-18	1366	970	1537	16	5	3894
1918-19	909	577	1772	20	3	3281
Totals	30790	11593	10116	797	20	53316
Average	1283	483	422	33	1	2222

the kill climbed to new heights and nearly reached 4,000 during the war years. Possibly ducks became more abundant when sportsmen were busy shooting each other.

When Tom Baker took over after the First War the total kill jumped to a new level and did not once fall below 3,000 a season until the end of the 1930's. The all-time record was the fabulous total of 9,303 in 1925-26, followed by 8,356 in 1928-29. These are most remarkable figures to judge from those assembled by Payne-Gallwey. To find bigger kills it is necessary to go back to the 18th Century. Thus Lakenheath Decoy, Norfolk, was credited with as many as 15,000 in one season; Dowsby Decoy, Lincolnshire, with 13,180 in 1765-66; Great Oakley Decoy, Essex, with perhaps 12,000; Glebeland Decoy, Essex, with 10,000. But these were clearly exceptional and of doubtful accuracy in view of the lack of information on how many full ducks (Mallard) and half ducks (Wigeon, Teal, etc.) were included in the duck-dozens then recorded. The only total approaching Nacton's and recorded with apparent accuracy was 7,345 duck (comprising 6,286 Wigeon, 675 Mallard, 338 Teal and 46 Pintail) at Steeple Decoy, Essex, in 1714-15. Thereafter Payne-Gallwey could only uncover 6,357 in 1834-35 at Ashby Decoy, Lincolnshire, and 6,059 at the same place in 1852-53. It is clear that Nacton Decoy and Tom Baker were a combination of efficiency the like of which had seldom been seen in the history of English decoys.

Table II. Take of ducks at Nacton Decoy in 50 seasons with Tom Baker as decoyman.

Season	*Mallard*	*Teal*	*Wigeon*	*Pintail*	*Others*	*Total*
1919-20	1551	2049	2116	22	3	5741
1920-21	2540	3483	1727	33	—	7783
1921-22	2781	2127	1288	48	11	6255
1922-23	1195	975	2315	19	5	4509
1923-24	2875	1564	1218	37	9	5703
1924-25	1111	1060	1975	47	23	4216
1925-26	4799	3358	1020	97	29	9303
1926-27	1188	1441	2216	67	8	4920
1927-28	3163	1247	780	34	4	5228
1928-29	3203	2492	2600	46	10	8351
1929-30	1664	1374	3572	48	8	6666
1930-31	1380	1400	2854	68	3	5705
1931-32	1508	2185	3608	88	8	7397
1932-33	975	1854	999	27	10	3865
1933-34	2376	2843	805	92	3	6119
1934-35	1116	1821	660	23	—	3620
1935-36	826	1224	160	—	—	2210
1936-37	1082	1118	125	8	1	2334
1937-38	1784	1519	379	39	—	3721
1938-39	1787	1004	165	53	—	3009
1939-40	1296	1134	415	42	6	2893
1940-41	1902	1279	307	45	9	3542
1941-42	862	356	325	23	9	1575
1942-43	631	830	186	285	2	1934
1943-44	1132	336	49	113	4	1634
1944-45	923	291	15	56	1	1286
1945-46	1225	964	824	57	14	3084
1946-47	929	413	608	283	8	2241
1947-48	1380	460	795	319	21	2975
1948-49	636	166	539	138	1	1480
1949-50	637	299	1566	234	2	2738
1950-51	624	466	754	71	3	1918
1951-52	640	1578	2585	113	—	4916
1952-53	939	1939	1317	221	—	4416
1953-54	559	1975	1495	252	—	4281
1954-55	465	1248	2060	111	—	3884
1955-56	790	1473	2891	216	13	5383
1956-57	449	805	1651	162	5	3072
1957-58	1123	332	1425	83	—	2963
1958-59	786	598	113	67	—	1564
1959-60	1747	2580	1213	244	—	5784
1960-61	607	1396	158	202	—	2363
1961-62	1519	2209	714	575	—	5017
1962-63	868	811	328	275	—	2282
1963-64	860	455	820	682	—	2817
1964-65	1052	1454	1633	784	—	4923
1965-66	618	470	1161	532	5	2786
1966-67	862	98	32	272	—	1264
1967-68*	844	248	121	426	—	1639
1968-69*	876	449	207	358	—	1890
Total	66685	63250	56889	8137	238	195199
Average	1334	1265	1138	163	—	3903

* Birds ringed, not killed.

However, the surpassing of records is not now of importance where ringing is concerned. The general movements and mortality patterns of Mallard and Teal wintering in England are pretty well

In the 1940's the catch declined, thereby countering the suggestion made earlier that war years would be times of duck abundance. However, many seasons in the 1950's totalled more than 4,000 birds, a peak being reached in 1959-60 with 5,784. Even as late as 1964-65 the season's total was 4,933, only surpassed three times in the previous thirty years. So the drop in the recent seasons may be only temporary. The average for the fifty years was 3,903. Tom says that if he could get one more season like 1925-26 he would die content. It could be argued that when the ducks are not killed, but ringed and released, as they have been in the last two seasons, their wariness of the 'pipes' communicates itself to uncaught birds and so depresses the catching total. However, Slimbridge Decoy ringed 1,933 ducks in 1962-63, far more than the maximum killed in any one season in the old days, 1,410 in 1853-54. Similarly, the total duck ringed at Borough Fen Decoy in 1964-65, 2,773, had seldom been equalled in the kill of past seasons.

known thanks to massive ringing since the Second War. The future requirement for these species will be sufficient ringing to provide enough recoveries to indicate whether there are changes in migration and mortality. On an annual basis this would require about 2,000 birds to be ringed in each known sub-population, for example, 2,000 Mallard for Nacton *and* Abberton Reservoir combined. For the other species we are still in the position of needing to ring as many as possible. It was Nacton's reputation for catching Wigeon and Pintail that made its conversion to ringing particularly attractive.

Before leaving the heady realm of records, we can take a look at some of those achieved in periods shorter than a year in the times when the weight of duck killed was the measure of success for a decoy and Mallard were twice as valuable as Teal. The greatest catch made on one day was on 3rd December 1925 when 331 duck, all Mallard except six Teal and four Wigeon, were secured. This was also the biggest day's catch of Mallard. Such a day was almost matched as recently as 12th October 1965 when 330 duck were secured. In this case there were only 14 Mallard amongst 255 Wigeon and 61 Pintail. This was also the best day for Pintail, but 307 Wigeon were killed on 12th October 1954 along with 5 Mallard, 2 Teal, and 6 Pintail making a day's total of 320. Teal were never caught in such masses, but 181 were secured on 18th October 1920. There were remarkable runs of catches and some of them not so long ago. Thus it took ten days of December 1899 to net 1,325 duck (1,191 of them Mallard), but only five days of October 1954 to kill 1,083 (925 Wigeon). Perhaps the most destructive period was the first fortnight of December 1925. Only on one day did the catch fall below a hundred and at the end of that period 2,114 Mallard, 410 Teal, 81 Wigeon and 3 Pintail, 2,608 duck in all, had been secured.

As far as seasons were concerned, the best for Mallard was 1925-26 with 4,799; for Teal 1920-21 with 3,483; for Wigeon 1931-32 with 3,608; for Pintail 1964-65 with 784. Clearly different species trap better in different years, in part due to fortunate combinations of catching conditions. Thus Tom Baker reckons that for large numbers of Wigeon to be caught the need is for cold northerly winds in October; these, he maintans, bring the birds quickly from their arctic breeding areas while the young are still without experience of the wiles of Man.

Bumper years aside, there are clear indications of longer term changes in the composition of the catch. Figure 1 shows

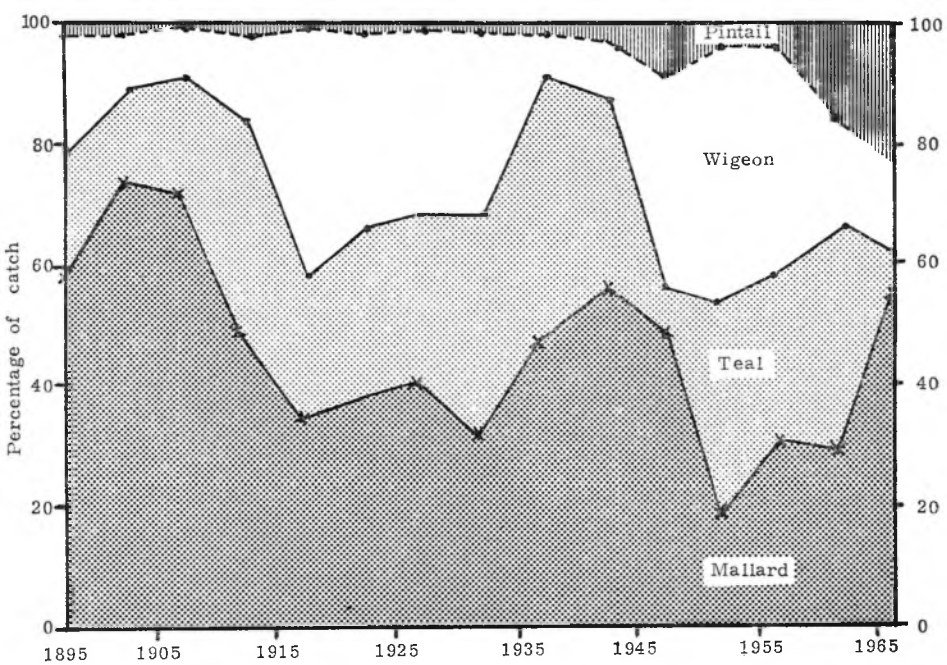


Figure 2. Relative proportions of four main species of duck in the catch at Nacton Decoy. (Points are five-year averages.)

the relative proportions of the four main species. In the early years, Mallard made up three-quarters or more of the take. They fell to a half just before the First War and only in nine years have exceeded this proportion since. For much of the time, indeed, they have constituted less than a quarter of the total. From the point of view of international conservation this made Nacton even more destructive, for it was mainly killing birds reared where conservation measures could not be taken to improve their breeding to match the toll taken. Teal began to make up an important part of the catch at about the time of the Mallard's decline. They sometimes have exceeded half the take, but usually constitute a third or less. Wigeon are the most erratic and there are relatively few periods when they consistently made up over a quarter of the catch; 1915-16 to 1919-20, 1928-29 to 1932-33, 1945-46 to 1957-58 (the longest such run) and 1963-64 to 1965-66. Pintail have had a curious history. For the first forty-eight seasons they never exceeded 3% and often much less. This was so despite their earlier totals being slightly inflated by a probable failure of the records to split off 'other' species. Then in 1942-43 they jumped to 15% and although the proportion fell back it remained consistently above the previous maximum of 3%. In recent years it has gone up again and in several seasons has made up around a quarter of the catch.

If variations in catching conditions cannot explain these periodic fluctuations, how far to they reflect the numbers of the different species available to be caught? Wainwright (1967) showed that there was a general correlation between the number of Teal caught at Abberton Reservoir and the numbers counted there. Since the trends in the latter show quite a close fit with those for Britain as a whole, the catches at Abberton could have given some indication of the size of the past British wintering Teal population. A major complication there is that catches are influenced by water levels; when they are low very productive traps can be placed on an island which then emerges. There is no such complication at Nacton Decoy and, with the magnificent series of catch data available, it was worth testing whether a correlation existed between catch and counts and, if this were so, to use the catches to extrapolate our knowledge of duck populations back to the beginning of the century.

No counts had been made of the Decoy pool itself, so comparison was made with the wildfowl priority counts. The procedure by which winter population indices for several species of duck are obtained from the widespread counts by amateur observers in Britain has been described by Atkinson-Willes and Frith (1965). Briefly, the numbers present on around 200 of the most important waters in 1959-60 are indexed as 100 and compared month by month to the numbers present on the same waters in other years. A weighted compilation of the monthly indices (September to March) gives an annual index. The data from the whole country have been treated in this way from 1950-51 to the present day, for Mallard, Teal and Wigeon, but not for Pintail. They were compared with the Nacton catches for the same seasons, expressed as percentages of the 1959-60 catch.

The two sets of indices, national count and Nacton catch, failed to show any correlation in the Mallard and Wigeon. There was a degree of correlation in the Teal figures in that for both counts and catches 1959-60 and 1961-62 were the highest and second highest in the 19 years. For the other years the catch indices fell to a lower relative level than did those of the counts, and fluctuated more or less independently of the latter. Thus it would appear that when there were *unusually* large numbers of Teal in the country, catches were high; but in other circumstances other factors were more important in determining catch size.

Since there might be a better correlation if the counts referred to a smaller area, advantage was taken of the fact that since 1959-60 count indices have been calculated separately for Scotland, west England and Wales and for east England. The indices for the latter area (which comprises Yorkshire, Nottingham, Leicester, Northampton, Oxford, Berkshire, Hampshire and counties to their east) were compared with the Nacton catches (Table III). Again, however, Mallard and Wigeon show no correlation between the indices. Ringing has already shown that the Mallard winters in fairly circumscribed sub-populations, that around Abberton, for instance, hardly overlapping with that around Borough Fen Decoy near Peterborough (Boyd and Ogilvie 1961). Indeed the catches of Mallard at the latter decoy from 1890 to 1959, which were set out by Cook (1960), show little correlation with the Nacton catches of this species. It is probable that further ringing of Wigeon will show that this species too winters in largely discrete sub-

Table III. Comparison of the south and east England duck count indices with those of the catch at Nacton Decoy.

Season	*Mallard*		*Teal*		*Wigeon*	
	Count	*Catch*	*Count*	*Catch*	*Count*	*Catch*
1959-60	100	100	100	100	100	100
1960-61	91	35	52	54	96	13
1961-62	103	87	81	86	107	59
1962-63	94	50	48	31	100	27
1963-64	107	49	28	18	98	68
1964-65	109	60	34	56	62	135
1965-66	118	35	33	18	96	96
1966-67	124	49	38	4	127	3
1967-68	109	48	28	10	107	10
1968-69	107	49	38	17	124	17

populations and that decoy catches will only relate to abundance within a rather small surrounding area. An historical extrapolation would be possible with that restriction, but would be of equally limited interest.

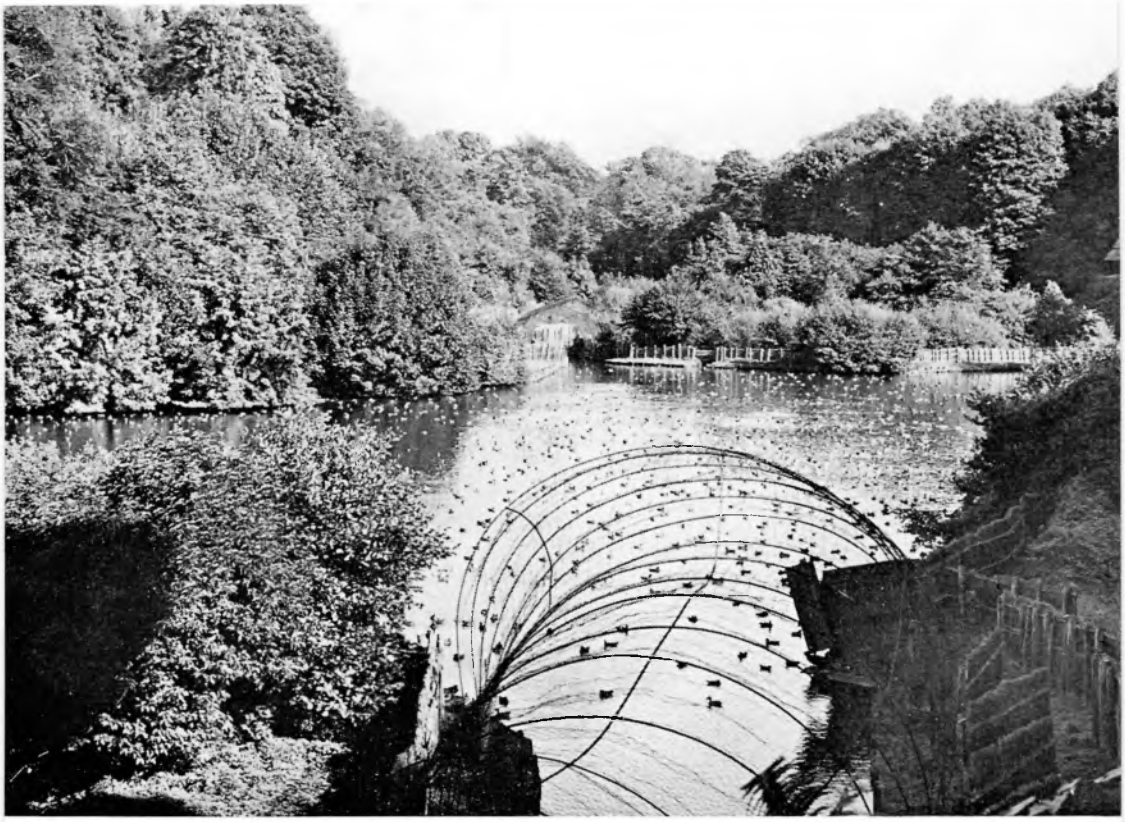
Ringing has indicated that Teal are rather less prone to form small sub-populations. It was to be expected that their indices for Nacton catches and counts in east England would show the same sort of relation as they did when the counts used covered the whole country. So even for a limited area the catches do not give us any precise knowledge of past population levels. However, they would presumably have been influenced by seasons of exceptional abundance in the past, just as they have been recently. There were no such peaks in the 24 years up to 1918-19, and the catch index averaged 19. Then there was a period of 15 years in which the 1961-62 level was approached or exceeded seven times, falling between whiles to an average of 53. The bumper years were 1919-20 — 79; 1920-21 — 135; 1921-22 — 82; 1925-26 — 130; 1928-29 — 97; 1931-32 — 85; 1933-34 — 110. Then followed 25 years with an average of 37, before the recent series set out in Table III, with two peaks and eight other years averaging 23.

These figures are open to several interpretations, and too much stress should not be laid on any one of these. On the one hand it could be said that the present level of non-peak indices has returned to that prevalent at the beginning of the century. On the other hand, the non-peak years since 1919-20 have shown a successive decline, from 53 through 37 to 23. In the case of the peak years we can say that although higher peaks were recorded in the 1920's, they were not so vastly greater than the recent ones. Probably the fairest conclusion is that the Teal population wintering in Britain (or at least eastern England) has declined somewhat, but not catastrophically, since the First War.

The earlier bumper years, apart from the first two, were isolated peaks, with much lower catch indices between, just as were the two recent peak years. The latter occurred after the final drying out of the Southern Flevoland Polder in the Dutch scheme reclaiming the former Zuiderzee. This large polder was pumped out between 1950 and 1957. For a time it was a paradise of unshot marshland and enormous numbers of Teal, over 300,000, were estimated to winter on its 119,000 acres. It is thought that these were then forced to come to England where they no longer had sanctuary, and were quickly reduced to former levels. It has been forecast that a similar influx can be expected in the next year or so as the next massive polder, Eastern Flevoland, dries out.

It is tempting to seek a similar explanation for the earlier bumper years; temporary very favourable conditions in the Netherlands, followed by a massive population shift. This cannot be so in the case of our first three peaks, because the first major polder, the Weiringer Meer, was not reclaimed until 1927-30. But its evolution might have had something to do with the last three. Unfortunately there was no Teal peak at Nacton corresponding with the reclamation of the North-eastern Polder between 1937 and 1942. So we do not reach a simple conclusion of cause and effect. It is seldom that one does in ecology.

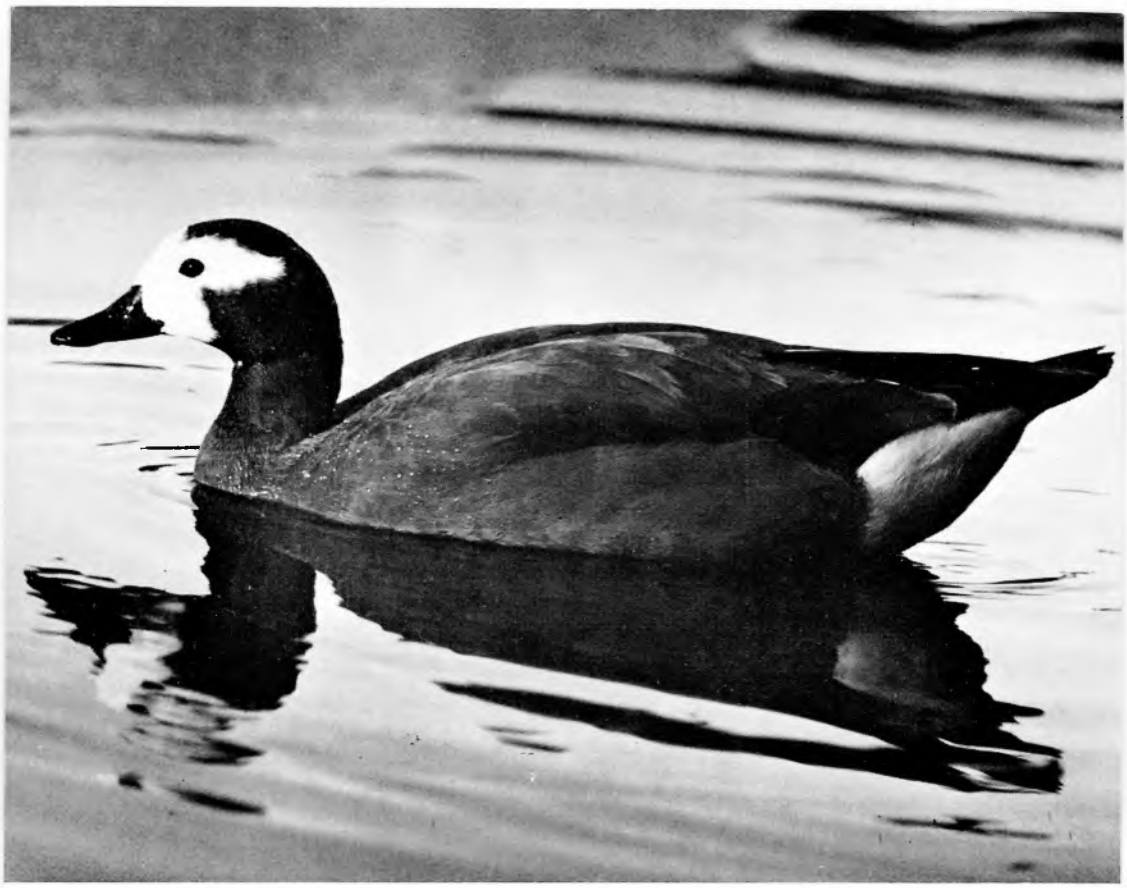
Meanwhile Nacton Decoy's future has been secured and an important contribution made to the international conservation of wildfowl. Tom Baker has converted readily and very ably into a ringer, thanks to a trial season under the meticulous tuition of the late Major-General Wainwright before the Trust's lease began. Indeed Tom is far less worried by this radical change in the processing of



C. P. Rose

Plate IX. The Wildfowl Trust has leased Nacton Decoy, Suffolk (see p. 131). (a) A view of the pond showing the beautiful wood and, on the right, one of the four gazebos. The photograph was taken from another. (b) The decoyman, Tom Baker, in the storehouse with part of a good day's kill in the past. All the ducks are now ringed and released alive.

Winifred Baker



J. A. Middleton

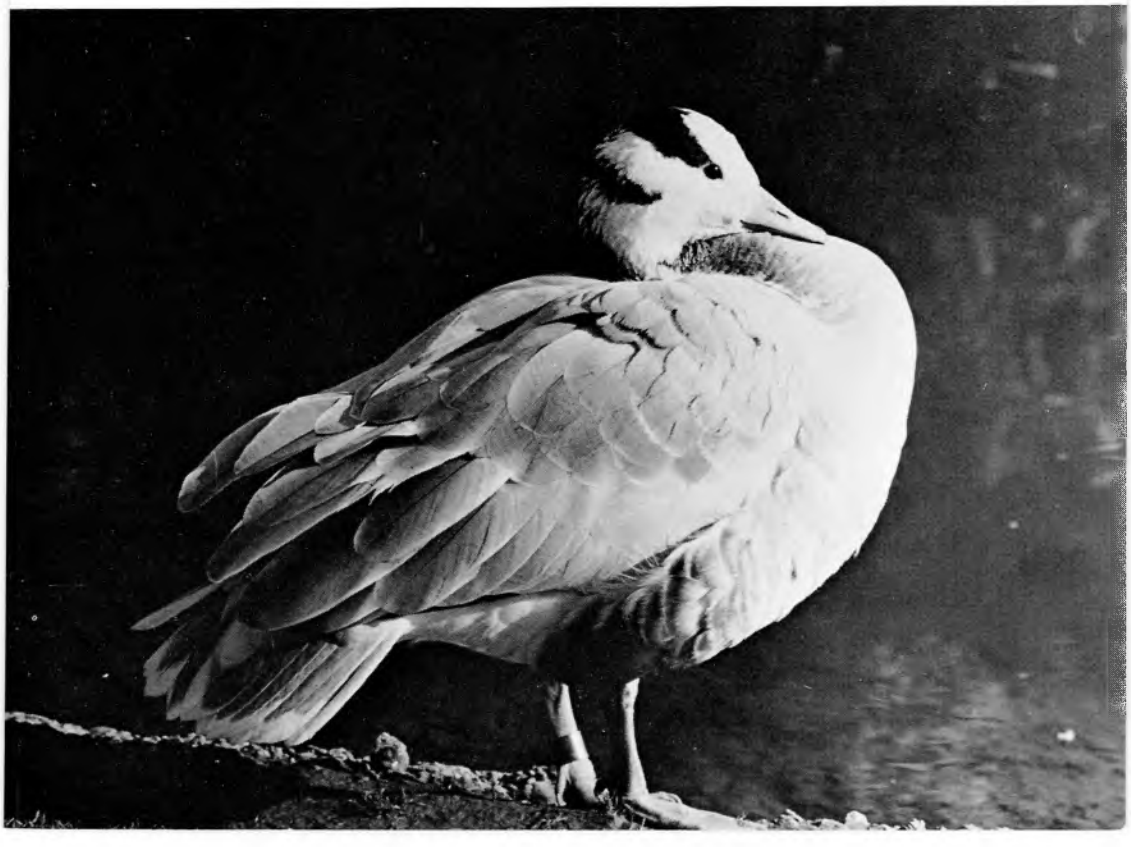
Plate X. Two studies in smoothness. (a) A female Cape Shelduck *Tadorna cana.*
(b) A New Zealand Scaup *Aythya novaeseelandiae.*

Philippa Scott

J. A. Middleton

Plate XI. Two studies in texture. (a) A male Pintail *Anas acuta.* (b) A Bar-headed Goose *Anser indicus.*

Philippa Scott



Pamela Harrison

Plate XII. (a) Major General C. B. Wainwright, C.B., who died in 1968. (b) One of the movable Abberton Duck Traps, being visited by his assistant, Roy King. (See p. 138)

the end-product of his decoying than is his old 'piper' dog. The latter is clearly bewildered at the sight of live birds being thrown into the air, but has given up trying to retrieve them.

Already the ringing at Nacton is bearing fruit in the shape of new information, particularly on the Pintail. In two seasons 784 have been ringed, compared with 910 in the whole of Britain for the past sixty years. Already the Nacton Pintail have produced 45 recoveries; back in the Russian breeding grounds as far as 67°N, 71°E on the River Ob; in Roumania; and on down through France and Italy to Morocco. But the most spectacular journey thus far was that of the juvenile female killed in January 1969 near St. Louis, Sénégal (16°01'N, 16°30'W). This was the first British-ringed duck of any species to be recovered south of the Sahara.

Acknowledgements

We are grateful to the Trustees of the Orwell Park Estate for entering into a leasehold agreement with the Wildfowl Trust and for allowing us access to past records of the Decoy and giving us permission to publish them. The late Major-General C. B. Wainwright greatly facilitated negotiations and the change-over to a ringing station. Tom Baker has metamorphosed cheerfully and effectively and has proved a mine of information. C. J. Beale calculated the count indices.

Note.—In the interests of the efficiency of the Decoy, and by the terms of the Trust's lease, it is necessary to restrict access to those with written permission from headquarters at Slimbridge. This cannot be given except in very special circumstances in connection with the Trust's research programme.

Summary

Nacton Decoy, Suffolk, the last commercial duck decoy in Britain, has been converted to ringing. Full details of its catches in the last 74 years are set out; the best year was 9,303 in 1925-26, but as recently as 1959-60 it caught 5,784. Mallard, Teal, Wigeon and Pintail have been caught in varying proportions, the latter two being the most important to ringing.

Attempts are made to correlate catches with wildfowl counts, without success for Mallard and Wigeon. Teal catches and counts show some correlation of peak years and give some idea of likely population levels back to 1895.

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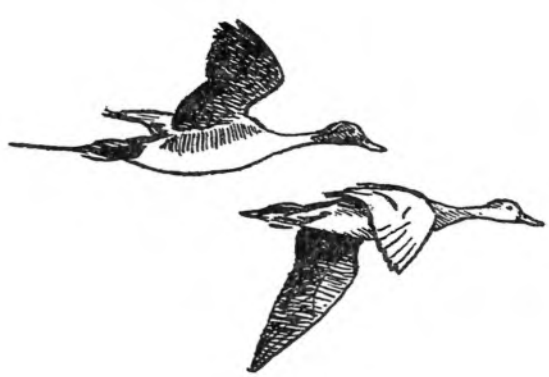


Major-General C. B. Wainwright, C.B.

(See Plate XII, facing p. 137)

On 23rd October 1968 the General died, suddenly and unexpectedly, in his home overlooking Abberton Reservoir.

From Oxford he had gone straight into the Army in 1914, later gaining his wings with the Royal Flying Corps. His subsequent career in the Royal Artillery was distinguished, with unorthodox diversions, such as teaching the Scots to play polo. He retired in 1948.

At that time many were talking about the uncertain future of wildfowl. The General believed in action and, recognizing that conservation should be based on hard, scientific facts, created what is now the internationally known ringing station at Abberton. His own account of the years from 1949 to 1966, published in the Wildfowl Trust's 18th Annual Report, naturally laid small emphasis on the early hardships that he and Lady Craven shared. They then lived some forty miles from Abberton, and with current theory mistakenly requiring ducks to be removed from cage traps only after dark, the inconvenience is easy to visualize, let alone the dangers—he once sank to his neck in a bomb hole, but his ever-glowing pipe served as a rescue beacon. A caravan by the reservoir temporarily solved the travel problem, and in its efficient tidyness has continued to serve as a model ringing centre. Indeed, everything about Abberton was meticulous: rings always precisely butted, records superbly kept in enormous detail.

He rather delighted in maintaining the external image of a fierce Major-General. A pennant fluttered from the bonnet of his car (but the emblem was a wagtail). Fools were by no means borne gladly. Undisciplined bird watchers he considered as big a menace as undisciplined shooters. Woe betide any who intruded on 'his' reservoir, especially on a wildfowl count day. Once three figures were discerned squatting on the opposite shore a full half-mile away. Leaping from his car he enjoined them in thunderous, and highly descriptive, terms to remove themselves. They did too, at the double. But he was chuckling as he got back into his car and demonstrated his high spirits by plunging off the perimeter track to do a 'wall-of-death' round the steep embankment. This alarming manoeuvre he usually employed to scare the daylights out of any he judged self-important or stuffy. For he disliked humbug in any form (scientific or otherwise). He respected simple virtues such as loyalty and good manners. But straight-laced he was not, especially when entertaining guests in the lovely old farm-house, surrounded by creature comforts and many creatures. He was a loveable person who bridged the generation gap with startling simplicity.

His bird-ringing achievements were quite remarkable. It was with a touch of proper pride that he announced the ringing of his hundred thousandth bird, supported by the fantastic list overleaf. He proposed to retire from his second career when his wildfowl total at Abberton had reached 50,000. Sadly he did not quite achieve this, falling short by only 7,195. The accumulated recoveries of wildfowl had then reached 9,041, together with 2,341 recaptures in subsequent years. It was finding these 'old friends' year after year that gave him his keenest pleasure. He knew exactly from which trap and in whose company they had previously been taken.

He played an effective part in the politics of conservation. Being a keen shooter he was well placed to reconcile wildfowlers and ornithologists, especially when their heads needed knocking together. Although he served on committees, he was in no sense a committee man, tiring quickly of vacuities. He could then be heard (especially as deafness advanced) regaling his neighbours with ringing stories or offering them noisily-wrapped sweets. Once he produced a simple device for sexing ducks, exploding with laughter when the suspended cork neither circled nor pendulated over an adjacent knee, but described a figure of eight.

His major recent conservation achievements were his part in the conversion of Nacton Decoy from killing to ringing ducks, and the safeguarding of Abberton Reservoir as a Bird Sanctuary under a Home Office Order. The owning company, convinced by him of the recreational importance of bird-watching, are constructing a fine public access area equipped with a beautiful observation hide. This must now serve as a last reminder of this gentle soldier-ornithologist.

G.V.T.M.

The 100,000 birds ringed by Major-General C. B. Wainwright up to 18th April 1968.

Shelduck	290	House Martin	42
Pintail	117	Sand Martin	533
Teal	28312	Rook	57
Mallard	9649	Jackdaw	292
Gadwall	80	Magpie	8
Wigeon	1499	Great Tit	395
Garganey	274	Blue Tit	618
Shoveler	315	Long-tailed Tit	70
Pochard	170	Bearded Tit	7
Tufted Duck	622	Tree Creeper	15
Scaup	16	Wren	218
Hybrid ducks	8	Mistle Thrush	51
Exotic and unidentified ducks	18	Fieldfare	67
Mute Swan	416	Song Thrush	901
Great Crested Grebe	9	Redwing	32
Little Grebe	147	Blackbird	1664
Cormorant	8	Wheatear	190
Sparrow Hawk	8	Stonechat	11
Kestrel	15	Whinchat	81
Water Rail	140	Redstart	10
Moorhen	759	Nightingale	20
Coot	1728	Robin	583
Lapwing	708	Reed Warbler	579
Ringed Plover	108	Sedge Warbler	3686
Little Ringed Plover	14	Blackcap	41
Turnstone	22	Garden Warbler	7
Snipe	1434	Whitethroat	1671
Jack Snipe	84	Lesser Whitethroat	929
Green Sandpiper	100	Willow Warbler	448
Wood Sandpiper	48	Chiffchaff	54
Common Sandpiper	2118	Wood Warbler	12
Redshank	486	Spotted Flycatcher	32
Spotted Redshank	22	Dunnock	1251
Greenshank	24	Meadow Pipit	1935
Little Stint	33	Tree Pipit	7
Dunlin	461	Rock Pipit	159
Curlew Sandpiper	17	Pied Wagtail	3862
Ruff	122	Grey Wagtail	39
Common Gull	13	Yellow Wagtail	7268
Black-headed Gull	1037	Starling	7191
Common Tern	63	Greenfinch	4665
Little Tern	8	Goldfinch	201
Stock Dove	37	Linnet	1977
Wood Pigeon	15	Bullfinch	296
Turtle Dove	592	Chaffinch	1381
Barn Owl	7	Brambling	40
Little Owl	10	Yellowhammer	527
Swift	61	Corn Bunting	153
Kingfisher	6	Reed Bunting	1624
Sky Lark	893	Snow Bunting	86
Swallow	512	House Sparrow	58
		Tree Sparrow	210

In addition he ringed the following species:—

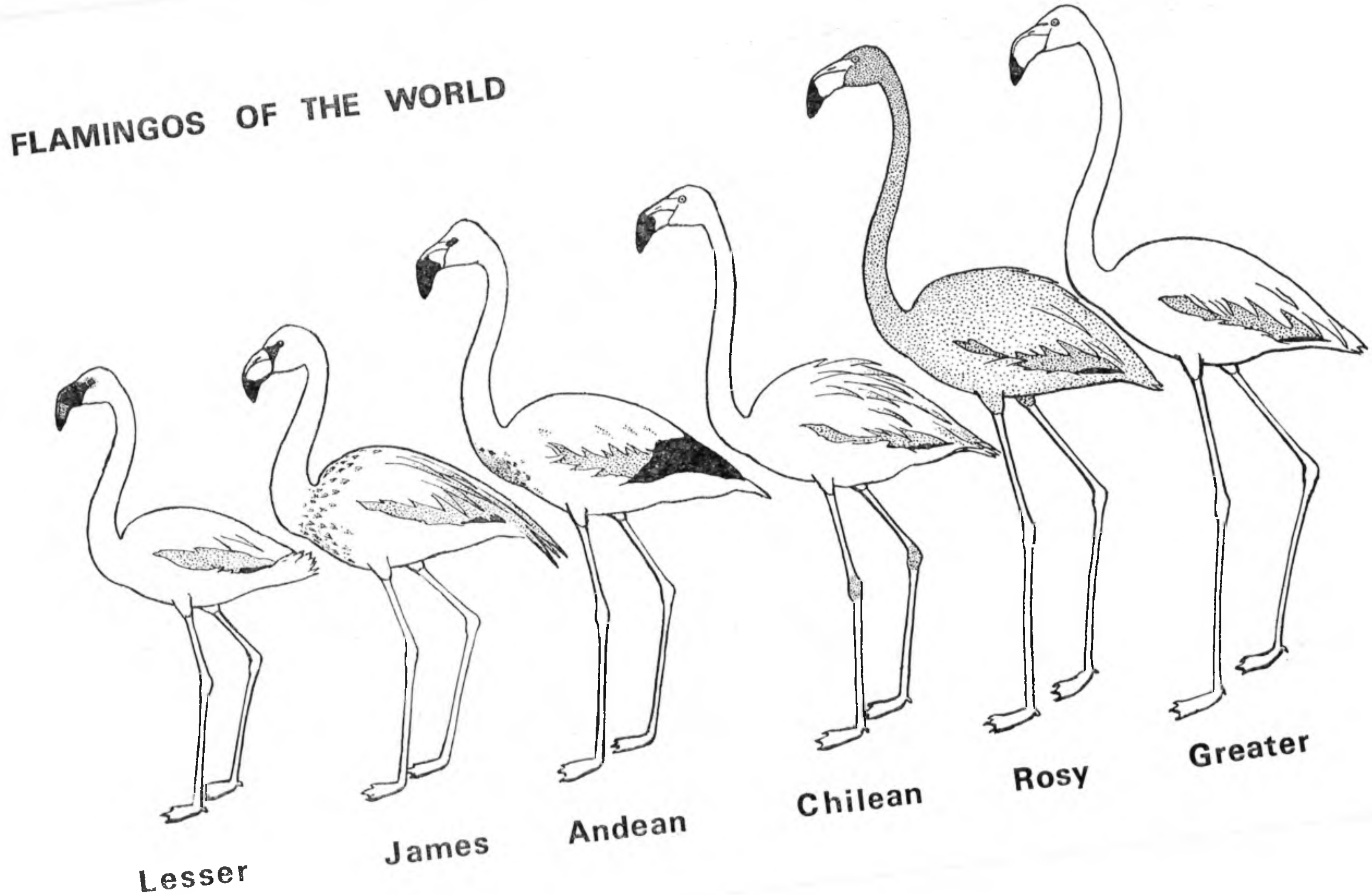
1 bird — Common Scoter, Canada Goose, Bewick's Swan, Great Northern Diver, Slavonian Grebe, Whimbrel, Black-tailed Godwit, Pectoral Sandpiper, Gull-billed Tern, Long-eared Owl, Great Spotted Woodpecker, Wood Lark, Greenish Warbler, Great Grey Shrike.

2 birds — Heron, Bittern, Temminck's Stint, Nightjar, Green Woodpecker, Coal Tit, Marsh Tit, Dipper, Goldcrest.

3 birds — Goosander, Smew, Oystercatcher, Knot, Cuckoo, Tawny Owl, Crow, Jay. Jay.

4 birds — Red-crested Pochard, Goldeneye, Spotted Crake, Golden Plover, Little Gull.

5 birds — Curlew, Nuthatch, Red-backed Shrike.


FLAMINGOS OF THE WORLD
Lesser
James
Andean
Chilean
Rosy
Greater

A brief guide to the Flamingos *Phoenicopteridae*

There are six forms in this ancient family which shares characteristics with both the wildfowl (Anseriformes) and storks (Ciconiiformes) as well as having features of its own. Typically associated with warm shallow brackish or saline lakes, they feed by filtering out small animals or plants by means of a highly specialized bill. Breeding, which is probably delayed until the fifth year, takes place in dense colonies, a single egg being laid on a mud nest. Both sexes incubate. Males tend to be larger than females, but the sexes are almost indistinguishable, even by cloacal examination. Wing lengths (mm.) are given. The plumage is white, suffused to varying degrees with the pink pigment canthaxanthin, derived from the food. The most striking differences between forms are in bill and leg colour.

Greater or African Flamingo *Phoenicopterus ruber roseus*

Bill, pink with black tip; eyes, straw-coloured; legs, grey-pink, joints and feet darker pink; wings, crimson and black, ♂ 360-445, ♀ 355-425. Found, south-western Europe, southern Asia east to India, much of Africa. Habitat, shallow lagoons, especially temporary salt or soda pans. Diet, chironomid and other insect larvae, shrimps, molluscs.

Rosy, Caribbean, Cuban or West Indian Flamingo *P. ruber ruber*

Bill, orange-pink, tipped black with white base; eyes, straw-coloured; legs and webs, grey-pink, joints and toes, darker pink; wings, crimson and black, ♂ 401-425, ♀ 370-408; body, bright pink. Found Bahamas, Cuba, Yacatan, Bonaire and, less commonly, on other Caribbean islands; isolated colony on Galapagos; introduced in Florida. Habitat, stable salt lakes on coast. Diet, larvae and pupae of brine fly *Ephydra*, shrimps, molluscs.

Chilean Flamingo *P. ruber chilensis*

Bill, very pale pink, tipped black; eyes, pale yellow or slightly pink; legs, upper yellowish-grey, lower grey, joints and webs bright pink, toes grey; wings, carmine, vermillion and black, ♂ 406-445, ♀ 385-410. Found southern Chile and Peru, Bolivia and northern Argentina, less common Brazil and Uruguay. Habitat, salt waters from sea level to 16,500 feet. Diet, molluscs, crustaceans, algae.

Andean Flamingo *Phoenicoparrus andinus*

Bill, black with basal half ivory-coloured, some birds have pinky-orange flush on ivory of upper mandible; eyes, dark red-brown with a spot of bare red skin in front; legs and feet, yellow, no hind toe; wings, bright pink with conspicuous black tips, ♂ 430-457, ♀ 413-422; breast purple. Found SW. Peru, plateau of W. Bolivia, rare in Chile and NW. Argentina. Habitat, salt lakes between 14,000 and 16,500 feet, breeding sites possibly associated with hot springs. Diet, diatoms and algae.

James' Flamingo *Phoenicoparrus jamesi*

Bill, yellow with black tip; eye, dark red-brown with extensive area bare red skin in front; legs and feet red, no hind toe; wings, red-pink tipped black, long red scapulars and wing-coverts, ♂ 416-425, ♀ 374-415; purple spots on breast and shoulders. Found mainly Laguna Colorada, Bolivia. Habitat, mountain salt lakes, associated with Andean Flamingo.

Lesser Flamingo *Phoenicopterus minor*

Bill, dark purplish-grey with dark red band above black tip; eyes, orange red; legs, grey-pink, joints and feet slightly darker; wings, pink blotched with crimson and crimson-lake, and black-tipped, ♂ 321-354, ♀ 310-325. Found eastern and, less commonly, southern Africa, Cameroons, Madagascar and north-west India and Pakistan. Habitat, usually permanent salt lakes, often in association with Greater Flamingo. Diet, mainly unicellular algae but also small invertebrates.

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JANET KEAR

Book Reviews

The Wildfowl Trust Annual Report series gave only infrequent reviews of books. WILDFOWL will endeavour to deal more regularly with those volumes on our subject which are brought to our attention and are thought worth reviewing.

Handbook of Waterfowl Behaviour by Paul A. Johnsgard. 1965. xvi + 378 pp. Photographs and line drawings. London: Constable. 75s.

Paul Johnsgard spent nearly two years at Slimbridge studying the behaviour of the ducks, geese and swans then in the collection. He shot off a mile and a half of 16 mm. film through his gun-stock mounted camera. And when his long figure was not to be seen loping through the grounds, his whereabouts could generally be ascertained from the rattle of his typewriter. More than a dozen specialized scientific papers poured off the machine. This book makes his activities and conclusions available to a wider audience.

The book is called a Handbook and a Handbook it is. One must not expect long discursive essays, but rather a compressed catalogue of the types of display known in each living species. A further caveat which must be entered is that the adjective 'Social' or perhaps even 'Sexual' could have been inserted before 'Behaviour' to emphasise the strong bias that the book has. The author's main interests in behaviour are concerned with systematics, and behaviour associated with mate-selection and copulation in birds does throw light on their evolution, development and relationships. It is also the most visually stimulating, and often bizarre. The latter aspect is reflected in the descriptive vocabulary, full of grunt-whistles, oblique pumpings, hunched-rushes, plonk-kicks, kinked-neckings and post-copulatory burps.

We are certainly glad that the Slimbridge Collection provided Paul with his opportunities, and through his work, one of the scientific justifications for its existence.

The Giant Canada Goose by H. C. Hanson. 1965. xxiii + 226 pp. Photographs and line drawings. Carbondale: Southern Illinois University Press. $9.75.

The taxonomy of the Canada Goose has given rise to many controversies and the exact number of intermediate races that are described varies with individual taste. The situation has been complicated, perhaps hopelessly, by attempts to re-establish the bird in areas from which it had been wiped out. One race which was thought to have gone for ever was the largest, *Branta canadensis maxima.*

This book tells the entertaining story of the author's rediscovery of the race and his subsequent finding that it was still moderately abundant, its numbers exceeding 60,000. He also shows that much of the research work thought to have been done on other races of large Canada Geese should be referred to the Giant. Consequently the book develops into a very useful account of what is known of the breeding range, migration, wintering grounds, nesting, feeding habits, physiology, behaviour, population dynamics and management of the race. To this research the author has contributed extensively.

The 74 photographs are excellent, clear, and helpful in illustrating in detail the finer points of the text, figuring the bird in all its places, postures and parts, from bill to genitalia.

Waterfowl in Australia by H. J. Frith. 1967. xxi + 328 pp. Diagrams, photographs and coloured plates. Sydney: Angus and Robertson. 100s.

The introductory chapters, with the very fine ecological photographs, give the feel of a fascinating, rather frightening, sub-continent to those of us not fortunate enough to have visited it. Then come species by species accounts in full detail. The use of sonograms to illustrate vocalisations is a useful novelty. The sections on distribution, migration and breeding are especially valuable, revealing many strange facts; strange that is to those familiar with northern wildfowl. Thus the Australian wildfowl tend to be nomadic rather than migratory; their movements and their breeding cycle determined by water levels rather than daylength; females may be larger than males; hole nesting is common; few species have dull 'eclipse' plumages.

The author himself prepared a series of black-and-white identification plates with birds on the water, in flight and overhead. Rightly he disclaims artistic ability but these sketches do get the 'jizz' of the birds. The colour plates by Betty Temple Watts have a certain originality about them, but they should have been to scale within the confines of each plate; the downy young are less pleasing. There are some outstanding 'portrait' photographs and, quite unrivalled, shots of ducks under water.

A Wealth of Wildfowl by Jeffery Harrison. 1967. 176 pp. Diagrams and photographs. London: Andre Deutsch. 30s.

If anyone can be said to epitomise the 'modern wildfowler,' zealous in defence of his sport but urging moderation to ensure its continuation, then this is our Council Member Jeff Harrison. He has long been a link-man between shooters and protectionists, striving tirelessly to turn both into balanced conservationists. This book tells the story of the efforts that he, and others, have successfully made to bring about the present degree of *rapport*; he takes the reader behind the scenes of wildfowl 'politics.' It is a tale worth telling, and it is well told. With his scientific background and a flair for exposition he also makes a fine job of explaining to the man-in-the-field the purpose of research into wildfowl biology and what has been achieved. He covers wildfowl counts, ringing, habitat ecology, breeding biology, predator control, oil pollution, lead poisoning, sex and age ratios, conflicts with agriculture, pesticides, food requirements, and the establishment and management of reserves. In many cases the wildfowlers, urged and led by the author, have co-operated with the researchers of the Wildfowl Trust.

Waterfowl: their Biology and Natural History by P. A. Johnsgard. 1968. vii + 138 pp. Photographs (including colour) and line drawings. Lincoln: University of Nebraska. $8.95.

After his Handbook on waterfowl behaviour and a student's text on animal behaviour, the author sought to turn his prolific pen to making known to a wider audience the group of birds which had become so much a part of his life. It is rather doubtful if his text will succeed in this, largely because he has tried to do too much in too small a space.

But the photographs are quite a different matter. Nearly all the living species of ducks, geese and swans are reproduced, mostly from his own camera, and many taken at Slimbridge. Sometimes, alas, the printers have been less than kind, bleeding off a beak here, a tail there. The black-and-white reproductions tend to lack the contrast of the original (a common fault with the process used). But such gripings aside, many of the colour plates are masterpieces which cannot fail to convey the magic quality of wildfowl to those who view them for the first time. Outstanding are the White-faced Whistling Duck, the Red-breasted Goose and, best of all, the Comb Duck male in all its sheeny glory.

Handbuch der Vögel Mitteleuropas. Volumes 2 and 3. Anseriformes. By K. M. Bauer and U. N. Glutz von Blotzheim. 1968-69. pp. 535 and 504. Many diagrams, maps and line drawings. Colour plates. Frankfurt am Majn: Akademische Verlagsgesellschaft. DM 48.50 per volume.

David Lack has written elsewhere: 'This is unquestionably the greatest handbook on birds yet written, and the sooner it is translated into English the better.' This statement cannot be bettered.

The title of the series is somewhat misleading as an indication of its scope. Middle Europe is taken to include Benelux, Germany East and West, Switzerland, Austria, Czechoslovakia, Hungary and Poland. Any bird which has occurred in that area, even as a rare vagrant, receives the full treatment; the Ring-necked Duck does, for instance. So as far as wildfowl are concerned, these volumes cover virtually all the holarctic species. And what a coverage; the older texts of Kortright and of Delacour do not hold the proverbial candle to these volumes.

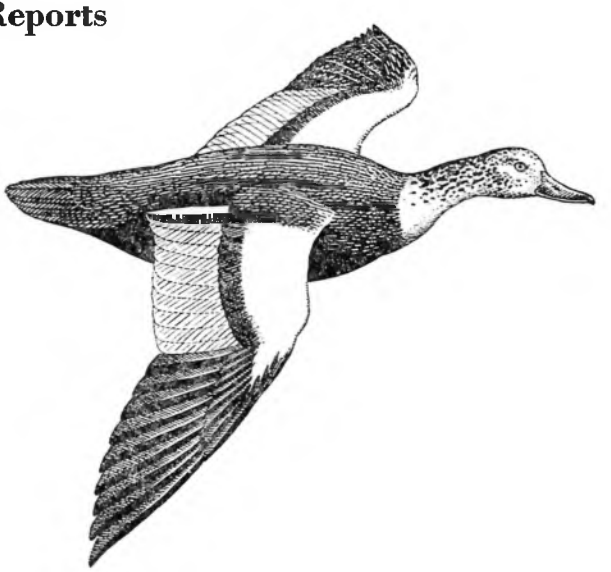
Under each species very clear, detailed and fully referenced information is given on field characters, dimensions, moult, vocalisation, breeding distribution, population size and fluctuations, migration, biotope, growth, survival, behaviour, food and feeding. There are no procrustean limitations to these sections; where there is a lot of information available on a species or a subject, a lot of space is allowed. Thus the Mallard is given virtually monographic treatment for 73 pages. But even that of the Marbled Teal (one of the shortest) runs to seven.

One of the exciting things about this pair of volumes is that they are not just superb compilations of published data. The authors have shown great ingenuity and persistence in cajoling unpublished information from biologists sitting, as they all too frequently do, on mounds of data. The staff of the Wildfowl Trust in particular were happy to be milked in this way, both by correspondence and in the course of an action-packed visitation from Urs Glutz.

We hope that the fervent prayers one hears on all sides will ensure long life to the authors so that this great work may run through to completion. At least we can give praise to Wetmore, whose Order ensures that the real birds are treated first and the little brown jobs are the ones in distant prospect.

G.V.T.M.

Current Reports



Wildfowl survey in south-west Asia: progress in 1968

Introduction

The continued support of the World Wildlife Fund has again been invaluable in extending and consolidating the survey. The mid-winter counts were well supported and these and previous results were used to prepare a series of sixteen papers for submission to the International Regional Meeting on Wildfowl Conservation, held in Leningrad in September 1968. Preparation of these papers, the accompanying maps and the working papers which preceded them took up most of the time available during the spring and summer, particularly as the majority of the correspondents of the Asiatic Wildfowl Working Group took an active part in their preparation.

An International Wildfowl Research Bureau Mission started an eight-month survey of wildfowl and wetlands in the Middle East and south-west Asia. The mission was led by Jacques Vieilliard, and included Hubert Kowalski of the Station Biologique de la Tour du Valat and Fred Koning of the Netherlands. It was financed by a generous grant from Dr. L. Hoffman and a substantial personal contribution from Jacques Vieilliard and his colleagues.

Plans for 1969 include consideration of the work of the survey, particularly the intensification of efforts in priority areas, co-ordination of the mid-winter census, and development of the White-winged Wood Duck *Cairina scutulata* Project in Assam.

Progress and prospects in the region are summarised below country by country:

Egypt (U.A.R.)

There have been indications that increasing numbers of palaearctic wildfowl have been using the new reservoirs in upper Egypt and the Sudan. In spite of obvious governmental interest in the tourist value of wildlife, as evidenced by the International Festivals of Duck Shooting, it has not yet been possible to arrange official or private participation in mid-winter counts.

Jordan

A valuable report was prepared by the Royal Society for the Conservation of Nature for the Leningrad Meeting, and again records of wintering wildfowl at Azraq Oasis have been provided by Ainsworth Harrison of the British Embassy, Amman. His most interesting record was of a female Falcated Duck *Anas falcata* shot by a local wildfowler on 10th January 1969. Other records in 1968-69 of Falcated Duck from Iraq and near Delhi suggest that in such years of exceptional drought in India and Pakistan this species may stray over a very wide range.

Iraq

The I.W.R.B. Mission spent three weeks

in Iraq in connection with the 1968-69 International Wildfowl Census. They were well looked after by the Director of the Iraq Natural History Museum, but found procedural difficulties for travel in Iraq almost insurmountable. Ultimately one week was spent in the field but the numbers of wildfowl seen were disappointing. This was no doubt due to the very heavy rain which had earlier been experienced in Iraq and southern Iran which appears to have caused the wildfowl populations to be more dispersed than usual. The Mission concluded that further exploration of the wildfowl situation in Iraq required a well planned survey using helicopters and light aircraft. This will need planning several years in advance with the support both of the Iraqi Government and the Oil Companies.

Persian Gulf States

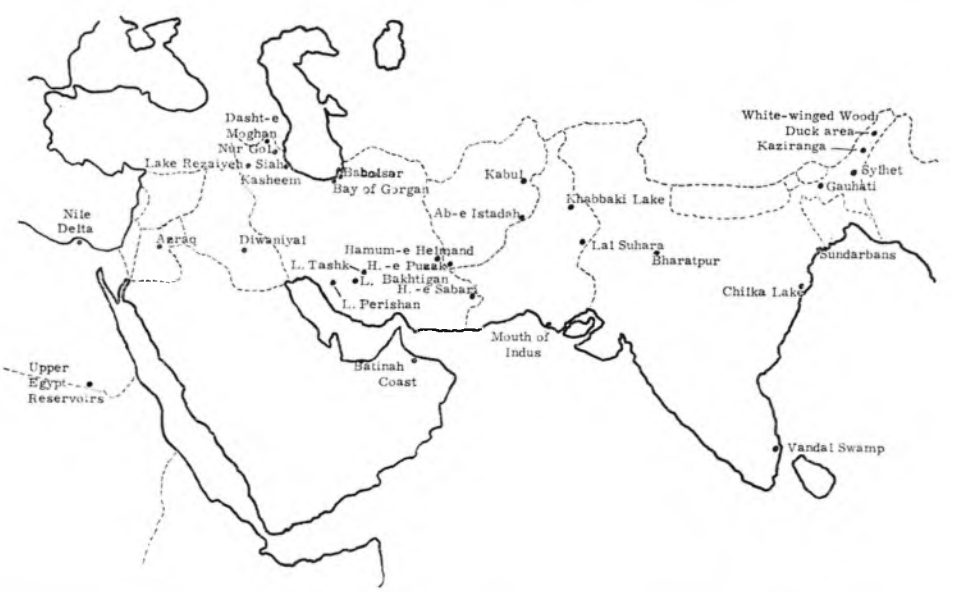
A valuable paper was published during the year by Seton-Browne and Harrison (*Bull. B.O.C.* 88 : 59-73) on the wildfowl of the Batinah Coast. It revealed a wealth of small but valuable wetlands in the south-eastern corner of the Arabian peninsular. Some of the most interesting records were of White-fronted Geese *Anser albifrons*, Greylag *Anser anser*, the African Spur-winged Goose *Plectropterus gambensis* (first record in Arabian peninsular), Indian Cotton Teal *Nettapus coromandelianus*, Common Shelduck *Tadorna tadorna*, and Common Scoter *Melanitta nigra*.

Elsewhere reports from occasional observers in the Gulf States have been largely negative except that occasionally large numbers of duck have been seen during passage on sewage sludge ponds of oil company compounds. Pintail *Anas acuta* and Garganey *Anas querquedula* were also recorded from the Batinah coast on passage.

Further observations from these areas could lead to valuable discoveries, and the Batinah Coast is recommended as an offbeat objective for an enterprising expedition.

Iran

Once again, thanks to the enthusiastic support of the Department of Game and Fisheries, valuable surveys were carried out both along the southern Caspian seaboard and in south-western Iran. The Caspian surveys were more detailed than any previously carried out. Many additional wetlands were covered, in some cases for the first time. The I.W.R.B. Mission visited Lake Rezaiyeh and the Dasht-e Moghan on the U.S.S.R. border, and then joined forces with the Game and Fish Department for the survey of the southern Caspian wetlands. Lindon Cornwallis from the Edward Grey Institute joined the Game and Fish Department team for the surveys in Khuzistan and Fars while the I.W.R.B. Mission were



Place-names in SW. Asia mentioned in the text, and in the previous progress report in WILDFOWL 19.

visiting Iraq and making an independent survey along the northern shore of the Persian Gulf before going to Pakistan.

The mid-winter counts produced much new information. Although it is still too early to judge changes in numbers, the absence of the huge flocks of Lesser Whitefronts *Anser erythropus* from their former wintering grounds was remarkable. Also, taken generally, the numbers of wildfowl seen appears to have been far less than previously assumed from the accumulated observations of the last twelve years. Meticulous observations failed to reveal any Scaup *Aythya marila*, or Bean Geese *Anser fabalis*, and very few Ferruginous Duck *Aythya nyroca* and Red-crested Pochard *Netta rufina*, which were formerly characteristic of certain parts of Mazanderan. On the other hand for the first time in recent years large numbers of swans were recorded, namely 843 Bewick's *Cygnus columbianus*, 1,663 Whooper *Cygnus cygnus* and 214 Mute *Cygnus olor*.

The mid-winter counts also showed the importance of the Siah Kasheem reserve in the Pahlavi Mordab. It is now in its second year and appears to be benefiting from its protected status. The increase in numbers of swans and geese was particularly noticeable.

It was of particular interest that during the summer Professor Rhys Davies, the geologist, found a large flock of Ruddy Shelduck *Tadorna ferruginea* at the small high altitude lake of Nur Gol. This lake is not shown on maps due to a drafting error in the old Survey of India series which has never been corrected. The existence of gatherings of Ruddy Shelduck at this lake was reported to Peter Scott in 1938, but Professor Davies has been the first observer to visit the area since. The possibility of it being a moulting ground cannot be overlooked.

Proposals were under consideration to create a national park around Lake Tashk (a potential 'Category A' MAR site) and Lake Bakhtigan in the Province of Fars, and also a protected area in the Bay of Gorgan.

It must also be noted that during the season a total of 565 ducks were ringed. This was a very creditable effort and only made possible through the help of young Iranian trainee game biologists who are making very promising progress.

Afghanistan

There were no significant developments during 1968, but subsequently the I.W.R.B. Mission spent a month in Afghanistan surveying proposed MAR wetlands and developing relations with the Afghan authorities. There is great scope here for visiting naturalists to contribute to knowledge of the country's fauna as well as to participate in the wildfowl counts, and any expeditions to Afghanistan may be assured of full co-operation from the newly formed Wildlife Conservation Committee.

Pakistan

The Wildlife Enquiry Committee, proposed by the World Wildlife Fund expeditions led by Guy Mountfort, started work in November with eighteen months in which to complete their report. Some progress was also made with the establishment of a Pakistan national appeal of the World Wildlife Fund. In September the First Seminar on Wildlife Management was held in Bahawalpur. As the immediate result of one of the resolutions of this Seminar, an 83,000 acre Game Sanctuary was set up near Lal Suhanra twenty miles north-east of Bahawalpur (29° 22′ N, 71° 57′ E). This area included 7-12 square miles of shallow ponds, mudflats and islands which hold up to twenty-five thousand ducks in a drought year such as 1968-69, and always large numbers on spring and autumn passage. It is now regarded as a potential category 'A' MAR wetland; a conclusion since endorsed by the I.W.R.B. Mission. The value of the sanctuary has great importance for species other than wildfowl and it is hoped to re-establish Blackbuck *Antilope cervicapra*, Nilgai *Bosephalus tragocamelus* and Chikara Gazelle *Gazella gazella* in the savannah and desert parts. Houbara Bustard *Chlamydotis undulata* occur in winter and many species of raptor and waterbirds.

Lal Suhanra sanctuary is the site of a World Wildlife Fund Project to re-introduce the Marbled Teal *Anas angustirostris* to Pakistan. It has declined almost to the point of extinction in most of its former range in SW. Asia. Breeding stock will be reared at the Wildfowl Trust and flown out to Pakistan in the autumn of 1969. The initial stock are to be kept in a large aviary for breeding purposes, young stock only being released. The species used to occur in the area and the prospects of their successful re-introduction under sanctuary conditions appear to be good.

The Khabbaki Lake sanctuary has been guarded by two resident game watchers of the Forest Department and the waterfowl population was noticeably larger than

in previous years. The numbers were enhanced by about ten thousand Common Pochard *Aythya ferina* which may have been displaced from elsewhere by the drought. The I.W.R.B. Mission have, however, confirmed the exceptional value of this lake. Numbers of White-headed Duck *Oxyura leucocephala* were almost the same as in 1967-68.

India

There was again a good response from observers in India during the 1968-69 mid-winter counts, but many important wildfowl areas remain unexamined. It is now apparent that these can only be covered by specific expeditions and it is hoped that with the help of the World Wildlife Fund Indian National Appeal such expeditions led by experienced Indian ornithologists can be sponsored in future years.

One important mid-winter expedition, financed by private donations, was made to the wetlands of the Kaziranga Sanctuary. A very thorough survey was made of 'bheels' and creeks from elephant-back, but the results, however, belied previous assumptions of 'large numbers'. The total count only amounted to 2,608. A tentative conclusion was that if there should be so few birds in this best controlled and least disturbed area in Assam then numbers outside must be even less than previously supposed. This supports a general conclusion that in the present state of knowledge extrapolation can be dangerous unless observers can commit themselves to estimates if not counts. Two further points of interest were the sighting of a Lesser Whitefront (only the third record for Assam) and the sight of a tiger killing a deer within twenty-five yards of them while they were counting ducks on a 'bheel'.

In Assam a special project was launched to save the White-winged Wood Duck. This was implemented by M. J. S. Mackenzie with the blessing of the World Wildlife Fund. The species occurs mostly in the low-level primary forest where streams debouched on to the plain with occasional deep pools left buried in its depths. Such forest is the most easily worked for timber or cleared for agriculture so it is not surprising that inroads have been made into the habitat of the Wood Duck in the last few decades. Small numbers are still seen regularly in Upper Assam whereas in other parts of its range occurrencies are now exceedingly rare. It is noteworthy also that the I.U.C.N./I.C.B.P. accepted the species for inclusion in their 'Red Book', as a species severely threatened with extinction.

The project provides for the survey of potential habitats to locate an area for a viable reserve; the capture of young breeding stock, part of which will be established in the care of the Wildfowl Trust and part at a suitable location in Upper Assam; and finally the establishment of a reserve with reinforcement of the breeding stock from captive bred birds. Five males and one female were successfully reared, and, with the concurrence of the Project's advisory committee, safely dispatched to Slimbridge.

The probability of finding a small viable reserve now appears to be remote and it is becoming obvious that the only permanent solution would be the establishment of a new national park in this low-level primary forest The selection of such an area is a major and specialized task. It is being proposed therefore that this should be subject of a separate W.W.F. / I.U.C.N. / Bombay Nat. Hist. Soc. project to be financed by the forthcoming Indian National Appeal of the World Wildlife Fund. The national park however would protect far more than the White-winged Wood Duck. It might save in the nick of time some of Assam's most spectacular butterflies which have almost vanished due to destruction of this same biotope, and also fabulous orchids many of which are still undescribed. The forests abound in other wildlife most of which is not in such danger as yet.

Ceylon

With the help of correspondents in Ceylon a very comprehensive paper was submitted to the Leningrad Meeting. Besides this there have been no further developments.

Leningrad Meeting

Due to cost of travel involved only five members of the Asiatic Wildfowl Working Group registered for the meeting. However, when it became apparent that the European delegates would not be able to attend, the delegates from Asia also decided not to attend. The resolutions made at Leningrad have, however, been drawn to the attention of the Governments of India, Pakistan and Iran, and have received wide publicity in these countries. It is hoped that a further meeting on wildfowl conservation can be held in the near future in a more accessible location.

CHRISTOPHER SAVAGE

Wildfowl Ringing, 1968

Swans

A number of amateur studies of the Mute Swan in Britain involving ringing continued with the help of the Wildfowl Trust. A joint study of the Mute Swan population of The Fleet and Radipole Lake, Dorset, was begun by the Edward Grey Institute, Oxford, and the Wildfowl Trust. Marking of the birds includes the use of large plastic coloured and numbered rings. A further 47 Bewick's Swans were caught and ringed at Slimbridge bringing the total now marked to over 100.

Geese

The Canada Goose was the only species to be ringed during the year. The Trust continued its support for ringing projects in Shropshire where the local Ornithological Society caught 250 birds, in the west Midlands where Dr. C. D. T. Minton and his team handled 871 birds, and in Yorkshire where Mr. A. F. G. Walker and his helpers rounded-up 425 birds. Associated with this last study was a catch made of 223 moulting Canada Geese on the Beauly Firth, Inverness-shire, organised by the Hon. D. Weir.

Ducks

The Table gives the details of the 8,720 ducks ringed by the Wildfowl Trust, or by people using rings supplied by the Trust, during 1968. The total is somewhat below last year's record, largely because of a planned decrease in the numbers of Mallard caught at Borough Fen and Slimbridge at certain times of the year when there is little now to be gained from ringing. Features of the Table include the continuing success of Nacton Decoy in catching Pintail and Wigeon, and the useful numbers of Tufted Duck ringed at three stations.

Small but valuable numbers of Mallard and Teal were ringed at Abbotsbury Decoy, Dorset (Mr. F. Lexster), Valley, Anglesey (Mr. R. Palethorpe), and Orielton Decoy, Pembrokeshire (Mr. P. Stuttard). We are grateful to these people for ringing duck for us and for allowing us to make use of the results.

Ducks ringed, 1968.

	Abberton	*Nacton*	*Borough Fen*	*Deeping Lake*	*Dersingham*	*Slimbridge*	*Loch Leven*	*Other stations*	*Totals*
Shelduck	26								26
Pintail	1	349		1	1	2			354
Teal	475	384	713	5	423			39	2039
Mallard	1277	862	1434	199	888	326	238	68	5292
Gadwall	1				20	1	7		30
Wigeon	46	203		2	5		6		262
Garganey	8		1		3				12
Shoveler	31		4	3	2		3		43
Pochard	7			32					39
Tufted Duck	104			141	1		370	3	619
Scaup					1			2	3
Smew	1								1
Totals	1978	1798	2152	383	1344	329	624	112	8720

M. A. OGILVIE

Abberton Ringing Station, 1968

The reservoir had a significant addition to its wildfowl population with the arrival of 63 White-fronted Geese on 1st February. Attracted by the large acreage of winter wheat west of the Top Section, they fed there most days until their departure in the second week of March, flighting out to roost at night on the coast in the Bradwell area.

Frequently up to 30 Bewick's Swans grazed with the Whitefronts, often being in view from the public roadway and attracting much attention from bird watchers and also the public in general. Certainly they were a great asset to the Reservoir in its Bird Sanctuary role.

We were naturally delighted when 19 White-fronted Geese arrived again in December, but although they eventually built up to 35 in number they were much more free-ranging than in the previous winter. This was because of the acute shortage of available winter wheat due to the extremely unsuitable autumn conditions for cultivating and sowing cereals. Nevertheless, geese had returned for two winters, although in small numbers, an unusual phenomenon for this part of Essex. An exciting prospect presents itself of Abberton becoming a regular goose place.

Early in the year we took 46 Wigeon. The spring produced two pairs of Garganey. Several Shoveler were ringed, both passage and breeding birds, and later we marked 11 of their ducklings from three different broods. We also got a lead of Shelducks, mostly immature non-breeders. Being protected and inedible they produce a low recovery rate.

During the year several good runs of catches were obtained with Tufted Ducks. These will often readily come in to those already ringed and left in the traps; the large deep water trap on the Top Section was particularly successful in this respect. A Smew trapped in a circular American type diving duck trap had the distinction of being the first male of the species to be ringed in England.

During the summer a large number of Mallard passed through the eclipse stage on the Top and Middle reservoirs, hiding in the dense marginal vegetation. They trapped fairly easily, and information on the length of flightless period, weights and subsequent wing growth rates was obtained from over 150 ducks.

A considerable drop in the water level during the summer, exposing the Island and marginal mud flats, is needed at Abberton Reservoir to attract and hold large numbers of migratory ducks and to allow them to be caught throughout the autumn and winter. This failed to happen in 1968. Heavy summer rains, with 6 inches of rainfall on one day early in September as a climax, resulted in heavy flooding and an abnormal intake of water from the River Stour. Consequently the catching suffered; 1,981 ducks were ringed, most of which involved very hard work in unpleasant conditions.

A large influx of ducks occurred in early September, with probably a maximum of 6-7,000 during the first two weeks. The dabblers were quick to find and take advantage of the large acreage of sodden cereal stubbles adjoining the reservoir, and fed heavily on these until the spilt grain was exhausted or the fields were again cultivated. With the loss of this food supply there was no alternative available at the reservoir. The water level was rising fast and the few shallows disappearing, so most of the ducks quickly dispersed on to the vast flooded areas throughout SE. England with their huge food supplies. This resulted in the smallest Abberton October Wildfowl Count ever. Reports came to us of more Teal than normal on coastal and inland marshes. This was certainly not true of Abberton. Teal made up a much larger proportion of the catch in the past but, as in recent years, this was again not so, the number ringed not reaching 500.

Apart from the wildfowl, 3,209 other birds were ringed during the year. Perhaps most remarkable was the ringing of 724 Yellow Wagtails, a figure far in excess of any other yearly total. They produce many recaptures, the same birds being caught year after year. Recoveries are less easily come by; indeed after ringing over 8,000, we have only just had our first report from abroad, in Senegal. Eight Kingfishers were mist-netted throughout the autumn and winter, all juveniles excepting one, and no retraps were made. As never more than two Kingfishers were seen, there is some suggestion of movement. A Slavonian Grebe, a bird little ringed, was almost the first in a new trap experimentally sited in deep water. Ten Little Grebes were also ringed.

A large amount of maintenance was carried out during the spring and summer months. All of the traps had to be inspected and where necessary repaired and rewired. The portable traps need to be in excellent condition as they are sub-

ject to a great deal of pulling back and forth through reeds and deep mud in constant pursuit of a variable water level, particularly on the Island when it appears. Carrying out emergency repairs during unfavourable winter conditions is not a job sought after.

The very large deep water trap on the Top Section had to be completely rebuilt, a formidable task. Readily available willow poles were used for this purpose and little carpentry was involved, but we used a great deal of wire netting. The existing trap, in spite of its poor condition, was catching Mallard well, and it is satisfying to note that the three weeks of repair work was carried out so that only two days catching were lost. With a view to increased diving duck catching, an additional deep water trap was constructed amongst willows below the weir on the Middle Section. Again natural willow poles were used, and, being an experimental site, old wire netting was utilised for covering. By the end of the year some Tufted Ducks had been caught, but unfortunately the numbers of diving ducks feeding in the area in previous winters had not materialised.

The yearly task of overhauling and painting the 18 ft. clinker built motor launch 'Gadwall' was accomplished and she was relaunched with usual ceremony in June. The dinghy also had to be painted and other equipment for trapping on the Island had to be maintained in spite of not being used. This also applied to the ringing and storage hut on the Main Section.

The maintenance programme coupled with continuous operating of duck traps and intensive small bird trapping, keeps me busy between duck catching seasons, and the popular conception of most of the locals that my summer is spent in quiet contemplative relaxation is not strictly accurate.

1968 was irrevocably marred by the sudden death of General Wainwright. I was privileged to serve as his assistant for nearly 13 years. Lady Craven has given us the use of the General's study, and of the boats and caravan, and is helpful in many other ways. Mrs. Ireland continues as loyal and efficient a secretary as ever.

Mr. Fred Trust, Assistant Chief Officer of the London Fire Brigade and formerly of the Romford Ringing Station, joined the team in June. An expert mist-netter, he motors down from London whenever his duties allow. His skilful netting soon produced exciting results, and since October he has taken over complete responsibility for the small bird aspect of the work at Abberton. Permission was obtained for him to site a cedar hut close to the caravan. This was essential to prevent confusion and some rather odd records. A Sedge Warbler recorded with a wing measurement of 273 mm. and a weight of 1,120 gm. was treated as mighty suspect and more likely to be a Mallard!

R. KING

Borough Fen Decoy, 1968

January was an open month with the decoy pond frozen for only four days from the 10th to the 15th. As in the previous January, the proportion of duck dogged into the pipe (32%) was higher than the general winter level, perhaps indicating an influx of naive birds. Deeping Lake trap was operated throughout the month; besides the duck, 80 rails were ringed. During the period 10th to 17th about 850 surface feeding ducks were roosting on Deeping Lake, but the majority of the diving duck left. Unfortunately the area of open water was not near the trap, and the waterfowl did not seem prepared to make a big trek over the ice.

The birds in the Decoy ignored the dog almost completely in February. Plenty of frozen potatoes were made available but grain appeared to have a greater attraction. Once the duck were in the pipe feeding, however, they would stay and dibble amongst the potatoes. Catches in the Deeping Lake trap were disappointing considering the numbers there.

The season ended in March with a total of 3,695. Early migrants at Deeping were Sand Martins on the 25th, and Chiffchaff 27th. They preceded the first Lepidoptera, Tortoiseshell and Brimstone butterflies on the 28th. The first passerine nest found with eggs was a Dunnock with two on the 21st, followed by a Song Thrush with one egg on the 23rd. Twelve nests had been found by the end of the month including three Mallard.

Maintenance commenced in April with a biting easterly wind and squalls of sleet and snow. The approach roadway was repaired with broken limestone. Fifty

bundles of reed were cut from the Decoy reed bed for screen repairs, and the willow and poplar off-cuts bundled for rebuilding backwalls. Some big willows were felled on the north side of the pond, and about 50 poles of willow and poplar taken out for use at the Peakirk Waterfowl Gardens. A concrete post was incorporated in the screens rebuilt this year. The wooden posts used in the past rot just at ground level after about six years. The peat appears to preserve the buried portion whilst the part which is high and dry also remains solid. Overhanging branches at the little ends of pipes were ruthlessly cut back and the whole system of paths mown prior to the Open Weekend on the 25th-26th May. In superb weather conditions 172 visitors were shown the techniques of decoying, plus recovery maps and other display material.

A diaphragm-type pump was hired to remove the mud from each of the eight pipes which were badly silted up, there being only a few inches of water over a foot or so of mud. This very shallow water evaporated very quickly and necessitated frequent topping up in the traditional way from the River Welland. Each pipe was dammed off, and all the sludge and water therein pumped over the back bank into the vegetation. The water then filtered back into the pond whilst the residue was quickly hidden by a strong growth of nettles and goose-grass.

The first catch of the new season was made on 3rd July and 38 duck had been taken by the end of the month. There was considerable storm damage after 4 inches of rain in 24 hours on the 10th. A mature white poplar fell on to the NE. pipe completely demolishing the first 5 hoops. Some repairs were made to the trap at Deeping Lake, materials and labour provided by the owners, Messrs. Dandridge. As well as the Mallard 40 Mute Swans were ringed.

Assisted by the Spalding and District Wildfowlers' Association a round-up of flightless Canada Geese was carried out at Grimsthorpe Park, Lincs.

An analysis of Decoy-ringed Mallard over the past 10 years was completed. As a policy decision, an experimental quota limit had been set to the numbers of Mallard to be caught in September and October when the origin of the birds caught is very much in doubt. However, the weather took a decisive hand and gale force winds with heavy rain reduced the number of duck roosting on the pond from 1,000 to less than 100 on 14th September. Several more trees were uprooted during this period: one ash, falling across the mouth of the West pipe, fortunately caused no structural damage. There was also considerable disturbance due to late harvesting operations, with combine-harvesters and strawbalers frequently becoming bogged down.

In October heavy and frequent rain made the approach paths to the pipes very muddy and great difficulty was experienced in moving around the decoy quietly. There was a lot of local flooding and the duck became very lethargic when on the pond, probably due to the abundance of food in the unharvested cereal and root crops.

Some improvement in the weather occurred in November and the catch was quite satisfactory. Blood samples were taken for the Ministry of Agriculture, Fisheries and Food from the ducks and rails for the Duck Plague virus. No positives were discovered.

The early frustrations of the season carried on to the end of the year, and no duck were caught after 19th December when the pond froze and remained so until the New Year.

However, one cheerful point was that the Deeping Lake traps had succeeded in catching a record lot of diving ducks, including 101 Tufted Duck.

A Curlew Sandpiper I ringed in 1963 was recovered in Tunisia in May; two Black-headed Gulls ringed in 1965 were found in Finland during the year; a long-lived Goldfinch met its end in Northumberland nearly seven years after being ringed in September 1961. 181 Nest Record Cards covering 23 species were completed and also 50 Moult Cards from 25 species. A total of 1,771 birds other than wildfowl were ringed.

Monthly totals of ducks caught at Borough Fen Decoy and Deeping Lake, 1968.

	Borough Fen Decoy	*Deeping Lake*
Jan.	131	99
Feb.	120	28
March	47	58
April	—	—
May	—	—
June	—	—
July	38	22
August	284	17
Sep.	707	29
Oct.	526	15
Nov.	420	39
Dec.	91	41
Totals	2364	348

W. A. COOK

Dersingham Decoy, 1968

Throughout January the Decoy maintained a regular evening flight of Mallard, although the pond was frozen over for a number of days. Several large catches of duck were made and by the end of the month each catch produced a retrap rate of 60%.

The breeding survey showed a slight decrease in the number of known breeding pairs, to 13 Mallard, 3 Gadwall, 2 Shoveler and one possible Teal. May brought a period of dry weather which resulted in a low mortality among ducklings compared with previous years. Out of 59 Mallard 36 were reared; of 28 Gadwall, 13 reared; of 18 Shoveler, 11 reared.

During the summer repair work and improvements to both pipes were completed. By the end of September the duck population on the Decoy was at its maximum for 1968 with 768 Teal, 179 Mallard, 11 Gadwall, 5 Garganey and 20 Wigeon.

Exceptionally heavy rain during September and October flooded most of the surrounding stubble. These conditions were excellent for dabbling duck and resulted in very few being caught during the first half of the season. By the end of October the Teal population dropped to between 100-200, this level being maintained until the end of December. Mallard stayed at between 200-300 until the end of November, dropping through December to 100-125.

The total number of duck ringed during 1968 was 1,344, made up of 888 Mallard, 423 Teal, 20 Gadwall, 5 Wigeon, 2 Shoveler, 1 Pintail, 3 Garganey, 1 Tufted and 1 Scaup. Of these 171 were caught in cage traps. 1,265 birds other than wildfowl were ringed.

A first batch of 50 W.A.G.B.I.-reared Mallard was released in July and by November all had dispersed from the area. Further releases will be made during 1969 in the hope that some of them will stay and increase the breeding population in the area.

A dog was obtained for training as a piper at the Decoy. All through his training Mallard and Teal were decoyed to the pipe entrance, at times as many as 40 duck. Another red letter day in the history of the Decoy came on 24th February 1969 when the first two duck, both Teal, were caught by decoying with a piper. With this additional method of catching, 1969 should be a most interesting season to say the least.

Monthly totals of ducks caught and ringed in Dersingham Decoy, 1968.

	Mallard	*Teal*	*Others*	*Totals*
Jan.	146	8	5	159
Feb.	52	—	1	53
March	—	—	—	—
April	2	—	—	2
May	—	—	—	—
June	—	—	—	—
July	21	2	1	24
August	98	29	18	145
Sep.	65	110	8	183
Oct.	150	94	—	244
Nov.	194	127	—	321
Dec.	160	53	—	213
Totals	888	423	33	1344

R. BERRY

Wildfowl censuses and counts

Goose censuses

Pink-footed Goose *Anser brachyrhynchus*. About 65,000 Pinkfeet were counted in Britain at the time of the annual census held on 9th/10th November 1968. This figure shows no change from that for the previous year. Also similar was the low breeding success as measured by the percentage of young birds counted in the flocks (11.7% young birds; average brood size 1.4).

European White-fronted Goose *Anser albifrons albifrons*. Peak numbers in Britain were reached in mid-January 1969 when 11,200 birds were counted. This was a somewhat earlier peak than normal; by the time of the census held on 8th/9th February numbers had dropped to 8,800. Although the previous winter's exceptional peak of 12,000 was not repeated the general level of population was above the average of recent years. Breeding had been poor (13.2% young; average brood size 1.6).

Greenland White-fronted Goose *Anser albifrons flavirostris*. No census was carried out but counts at major Scottish and Irish haunts showed no change from the levels of recent years. In Scotland a sample of 450 contained 16.4% young; in Ireland a very much larger sample of several thousand had 35.0% young.

Greylag Goose *Anser anser.* 61,000 Greylags were counted during the annual census on 9th/10th November 1968. This represents a slight increase over the previous winter, but breeding had been the poorest recorded in twelve years of counts (5.9% young; average brood size 1.3).

Barnacle Goose *Branta leucopsis.* The flock wintering on the Solway, which breeds in Spitsbergen, reached a peak of 2,200 during the season. For the second year running breeding had been good (23.2% young).

The Greenland population of Barnacle Geese was not fully censused. Increased numbers were found to be wintering on Islay, with over 12,000 present through the winter, but it is not known whether this represents an overall population increase, or merely a redistribution. Breeding had been poor (9.5% young; average brood size 1.3).

Light-bellied Brent Goose *Branta bernicla hrota.* The highest count at Lindisfarne, Northumberland, of the Spitsbergen population reached 1,000. In Ireland censuses were held in November 1968 and February 1969 of the Greenland stock when 7,765 and 5,982 birds were counted respectively (1.5% young).

Dark-bellied Brent Goose *Branta bernicla bernicla.* The highest count in Britain was 13,700 in mid-January 1969. This is over 2,000 below the peak for the last two winters, and counts from the rest of the wintering range in France and Holland show that there has been an overall decrease. The main reason is the almost total breeding failure (<1% young) following the poor production of 1967 (6.0%).

M. A. OGILVIE

Duck counts

Shelduck *Tadorna tadorna.* This species was more plentiful than usual in the early part of the winter (especially December), but less so from January onwards.

Teal *Anas crecca.* The counts in October, November and March were the highest since 1964-65. A marked improvement was noted in Scotland during the early part of the winter, and later there were relatively large numbers in the south-west. The seasonal index topped 50 for the first time in four years.

Mallard *Anas platyrhynchos.* Throughout the winter the species was rather less plentiful than usual in the eastern and northern parts of the country, and noticeably more plentiful in the west.

Wigeon *Anas penelope.* This was the best season since 1955-56 and the second best on record. Large numbers were present in all districts throughout most of the winter, and in November and January the counts were the largest recorded for the time of year. This is now the fifth consecutive season to show an increase in the seasonal index.

Pochard *Aythya ferina.* This species was not as numerous as in recent seasons, but still well above the level of the early 1960s. Very large numbers were recorded in Scotland from October until January, but elsewhere results were generally disappointing.

Tufted Duck *Aythya fuligula.* This species was plentiful throughout the winter in southern and western districts and very plentiful in Scotland during the first half of the season. The seasonal index is the highest since 1965-66, and slightly above the average level of the last ten years.

Seasonal Indices, 1968-69 (1959-60=100)

Shelduck	102	Wigeon	124
Teal	52	Pochard	162
Mallard	104	Tufted Duck	102

International wildfowl census

The third international wildfowl census was held in mid-January 1969. Counts were made in Britain at 1,291 sites producing the following numbers of duck:

Shelduck	36842
Pintail	8660
Teal	36054
Mallard	148181
Gadwall	492
Wigeon	150233
Shoveler	2925
Eider	10289
Pochard	28517
Tufted Duck	29029
Scaup	17893
Common Scoter	3823
Velvet Scoter	27
Long-tailed Duck	284
Goldeneye	7897
Smew	64
Red-breasted Merganser	3394
Goosander	1385
Total	486029

Counts from other countries total over 4,860,000 ducks from 4,800 sites.

G. L. ATKINSON-WILLES
C. J. BEALE

Loch Leven, 1968

The intensity of nest searching on St. Serf's Island was reduced to a level sufficient to detect seasonal changes in egg size, clutch size and hatching success. In all, nests of 363 Mallard, 192 Tufted Duck, 31 Gadwall, 23 Wigeon, 5 Shoveler and a Teal were marked and checked. Clutch size was determined for those clutches with at least two records of the maximum clutch size and no inconsistencies such as egg loss whilst the clutch was being laid (Table I). In both species the clutch size was found to decline through the season in all three years. This may well be an age effect, the younger less prolific birds laying later. It will take some years of ringing to see whether this or some other factor is the cause. Measurements were taken of several hundred eggs, since in several species egg size has been found to increase with age, providing another check on the hypothesis. The mean clutch sizes showed no significant difference between the years, the lower figure for Mallard in 1966 probably being due to the late start in nest-searching that season.

Table I. Clutch size of Mallard and Tufted Duck, 1966-68.

		Clutch size	
Year	*No.*	*Mean*	*s.e.*
Mallard			
1966	126	8.16	0.18
1967	181	8.58	0.25
1968	109	9.00	0.17
Tufted Duck			
1966	118	9.51	0.27
1967	158	9.49	0.25
1968	165	9.69	0.18

Of 103 Mallard nests 66% hatched (cf. 49% and 78% in the previous years), while of 126 Tufted 71% hatched (cf. 53% and 40%). The season was an unusually fine one in Scotland. Other factors which might have contributed to the good success could be the lower intensity of nest-searching and changes in the degree to which the fledging of Jackdaws, one of the main egg predators, coincided with the peak of egg laying. Several more seasons are needed to check such correlations. Once again it was found that better hatching success was achieved in those nests situated in or near the massive gullery on the island. Both species showed preference for nesting in association with gulls, this being less marked in the case of Mallard, many of which start to lay before the gulls.

Two attempts were made to measure the extent to which nest searching and marking might increase predation. A 50 m. square in the *Deschampsia* zone was kept free of visits from early in the season; and a series of false nests was made up with hens' eggs, some marked with canes in the usual way, some unmarked. Neither test was wholly conclusive and both will need repeating, but the indications were that no very great increase in predation resulted from our normal activities.

After the nesting season 30 transects two metres wide were closely searched through the various nesting zones. The nests then found, compared with those marked by flushing visits once a week in each area, give an estimate of the total nests (including re-nests) on the island. For Mallard the calculation gave 391 and for Tufted Duck 452. The latter accorded closely with counts of 468 females on the Loch early in May just before the main nesting of this species. This suggests that most females of this species do lay in their first year. Previously there were suggestions that they did not breed until more than two years old, i.e. in their third summer. The point is clearly an important one in the understanding of population dynamics and must be further investigated.

Catching females on the nest with hand nets continued successfully. Including recaptures from previous years, 111 Mallard, 82 Tufted Duck, 11 Gadwall, 7 Wigeon and 8 Shoveler were caught in this way. The precise location of their nests were determined by distance and bearing from the posts of the permanent grid of 50 metre squares. This will enable interesting data to be gathered on the preciseness with which duck return to the nesting area in following years.

Much time and energy went into attempts to fill one of the main gaps in the study, the extent to which hatched ducklings survived to fledging. The marking of young with coloured tags would necessitate frequent visits to the island to catch them in the short interval between hatching and leaving the nest. This would create too much disturbance. The females caught on their nests were marked with conspicuous wing tags, in the hope that the broods could be identified from the accompanying adult. But the broods split up or amalgamated and different females left their young at different stages. The only remaining method

was to assess post-hatching mortality by the declining numbers of young in the later stages of development. Even this did not give satisfactory results.

More definitely it is known that 218 Tufted at the very minimum reached fledging, for this is the number caught in the diving duck traps erected in the shallow waters of the loch. Undoubtedly the true figure is higher, but, even with the outstandingly good weather of 1968, Loch Leven would appear not to be a good place for duckling rearing, however good the nesting conditions are on St. Serf's. Many young Tufted Ducks were captured more than once and the changes in weight and wing length are being analysed in relation to those reared at Slimbridge by Dr. Kear from the 80 near-hatching eggs taken from St. Serf's.

I. K. MARSHALL
C. R. G. CAMPBELL

Geese at Loch Leven

Every year several thousand Pink-footed and Greylag Geese winter in the area of Kinross, Scotland, roosting on Loch Leven and feeding in the surrounding farmland. In 1967, the main arrival of the Pinkfeet began on 29th September; numbers reached a peak of 7,000 by 5th October, and thereafter fluctuated around 2,000. The Greylag arrived from mid-October and reached a mid-winter peak of around 4,000. Single specimens of Ross's, Greenland Whitefront, Lesser Snow, Barnacle, and Light-bellied Brent Geese were recorded among flocks of the main species. In addition, up to 400 Whooper Swans wintered in the Loch Leven area.

From September 1966, these birds have been the subject of a special study by Hugh Boyd and Colin Campbell, both of the Wildfowl Trust. However, the following summer, Hugh Boyd emigrated to Canada and his place was taken by Ian Newton of the Nature Conservancy, Edinburgh. Help was also received from J. Swan and A. Allison. The aim of the project is to study the feeding ecology of the geese in relation to agriculture, throughout the winter and over several seasons.

The area around the loch comprises various types of farmland, and is used daily by both geese and swans. In September, a study area is mapped to show the crops available on the fields when the birds first arrive. Thereafter, once each month until the birds depart in April, the fields are again mapped to show any changes that had taken place. On a regular circuit, note is made, several times a week, of the location, size, and species-composition of all the goose and swan flocks encountered, the fields being numbered for ease of recording. In addition, a count at dawn flight of geese roosting on the loch is made once each week.

All types of fields are visited by the geese, and grass figures largely in the diet of both species throughout the winter. However, their main food for the two months after arrival is spilled grain which they obtain from harvested cereal fields. Later in the autumn, unharvested potatoes become important, but more to Greylag than to Pinkfeet. During snow, the Greylag feed on turnips when other foods are unavailable. This is one of their main points of conflict with agriculture, as the turnips are needed for outwintered sheep. Both species make greater use of grass fields in the New Year, when other forms of food are diminishing; and in late March and April this again causes conflict, because the farmers then require the fresh spring grass (the 'early bite') for milk cows and lambing ewes. The geese also feed on sprouting cereals but this habit is fairly local and limited in extent, and does not present a problem around Loch Leven.

The Pinkfeet feed mostly within six miles of the loch and the Greylag mostly within two miles. However, both species favour traditional fields, which are used again and again, while other, apparently suitable, fields nearby are used only to a small extent, or not at all. Over the area as a whole, less than one-third of the suitable fields within flighting distance of the roost are used by the geese.

Our data on the feeding of Whooper Swans are incomplete. It seems, however, that they also feed mostly on spilled grain and waste potatoes in autumn and early winter, and take more grass and growing cereals towards spring.

I. NEWTON
(Nature Conservancy, Edinburgh)

C. R. G. CAMPBELL
(Wildfowl Trust)

Greylag Geese at Loch Druidibeg

In 1968, on behalf of the Nature Conservancy, I began to study the Greylag Geese nesting on the National Nature Reserve at Loch Druidibeg, South Uist, Outer Hebrides. The intention was to assess their numbers and breeding success, and the damage they cause to agricultural crops, in the hope that the information gained might help to plan an appropriate management policy for these birds.

The Outer Hebrides are one of the last strongholds of the indigenous non-migratory Greylag in Britain. The birds nest mostly among tall heather growing on the islets of remote moorland lochs, and flight chiefly to farmland to feed. Their main centre in the Hebrides has long been at Loch Druidibeg, which is one of the largest lochs on the islands and provides an abundance of suitable nesting islets. Soon after the young hatch, however, they are taken by their parents to two neighbouring lochs, a'Machair and Stilligarry, with better grazing nearby. In 1958, these three lochs became a National Nature Reserve, managed jointly by the Estate Owners and the Nature Conservancy.

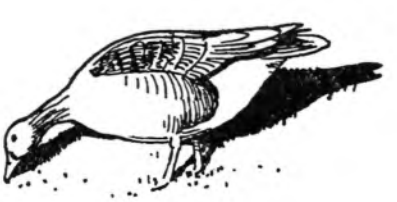
In 1968, 71 nests were found in three square miles of the reserve. All these nests were on the loch islets, and some were only 3-4 yards apart. Most clutches contained 5 eggs, and the range was 3-7. Only 38 clutches hatched successfully; three were deserted and the remaining 30 were lost to predators. Crows were proven culprits, and Great Black-backed Gulls and otters were also suspected. There was no evidence of mortality among goslings, in that there was no significant decline in the number of broods seen on the water, nor in the mean brood-size, from the time of hatching until the young were on the wing. One hundred goslings were marked with numbered wing-tags on hatching, and three have since been recovered during organised wildfowl shoots. Together with previous ringing recoveries on the islands they confirm that the birds are resident in the area throughout the year.

Large numbers of non-breeding Greylag also assemble to moult on Loch Druidibeg, and in this year a maximum count of about 300 individuals was obtained. Probably these birds had come from the whole of the islands, for no other large flocks were seen elsewhere at this time.

In the ten years since the reserve was created, the number of geese breeding there has probably almost doubled, though earlier counts are much less reliable. The establishment of the reserve has also brought an increased sympathy for the geese among the islanders, as a result of which the birds are now allowed to breed successfully on at least ten other lochs in the area from which they were formerly absent or present only in occasional years. At the same time the birds have withdrawn from three of the more remote hill lochs, with poor grazing, to which they had presumably been driven in the past by persecution.

The islanders still complain because the geese eat their corn which, following local tradition, is grown in unfenced plots down to the water's edge. Both the stems and heads of the corn are eaten; and this delays the harvest and lessens the yield of grain. The geese are reluctant to fly into standing corn, but walk into the corn plots from the water or from the surrounding grassland. Further, for much of the time the damage is being done, the birds are unable to fly. I therefore tried to protect the crops with fences. These were wholly effective, but the damage was anyway slight in this year, with less than 1% of the corn in unfenced plots grazed. After harvest, the geese also attack the stooks and pull out the seed-heads. By this time, the birds are on the wing and crops over the entire islands are liable to damage. No attempt has been made to assess or prevent this damage, but this also seems to have been negligible in this year, for the weather was good and the stooks were out for only a short time.

I. NEWTON
(Nature Conservancy, Edinburgh)



Wild Geese at the New Grounds, 1968-69

European White-fronted Goose *Anser albifrons albifrons.*

The first arrivals of the winter were 10 on 27th October, the second latest date recorded. The next six weeks produced a trickle of additional birds until there were 114 on 9th December. The onset of a cold snap signalled a great surge in arrivals with 303 counted on 10th December, 690 on the 11th, 1,300 on the 12th and 3,000 on the 15th. Further influxes occurred later in the month to give a total of 3,900 on the 28th. This is the highest end of year figure since 1952. Arrivals continued over the next two weeks producing counts of 5,000 on 3rd January and 6,300 on the 14th. The flock remained at or near this very high level for the rest of the month with a peak count of 6,600 on the 29th. This is very close to the record count of 6,700 in February 1968. The very high numbers present in the 1967-68 winter we partly attributed to the decrease in disturbance during the foot and mouth epidemic. There was no such obvious reason this winter, unless there was a carry-over of the good effect from the previous year with the geese 'remembering' the better than usual conditions they found. However, the conditions did not remain so favourable during 1968-69, as in early February a cold spell with snow cover over the fields caused many of the geese to leave the area. The total dropped to 4,100 on 6th February. About 3,500-4,000 birds remained for the rest of February, the main departures starting in early March. There were 3,500 present on 6th March, 1,100 on the 7th, 600 on the 8th and 15 on the 9th. These last few stayed on during the cold weather of the next two weeks, being last seen on the 24th.

1968 was one of the worst breeding seasons for the Whitefronts since we began collecting records in 1947. Only 13.2% young birds were counted in the flocks; average brood size of 1.6. This compares with the 22-year average of 28.1%.

Lesser White-fronted Goose *Anser erythropus.*

A pair of adults was first seen on 24th January and these stayed for the rest of the winter. Another adult, paired to a European Whitefront, was seen on 28th February and again on 5th March.

Bean Goose *Anser fabalis*

An adult of the Russian race *rossicus* was first seen on 15th December and subsequently to the end of January.

Pink-footed Goose *Anser brachyrhynchus.*

Two adult Pinkfeet were seen on 23rd January and frequently during February. They stayed on with the last 15 Whitefronts, departing with them on 24th March.

Barnacle Goose *Branta leucopsis.*

A single Barnacle Goose appeared on 10th December. Two were present on 15th January and five on the 23rd. Only two were seen during February and a single bird was last seen on 5th March.

Red-breasted Goose *Branta ruficollis.*

An adult bird was seen on 19th January and stayed to the end of the month. This is the seventh record for the New Grounds.

M. A. OGILVIE

Wild swans at Slimbridge, 1968-69

Bewick's Swans

The first Bewick's Swans *Cygnus columbianus bewickii* to arrive on Swan Lake this winter came earlier than ever, on 20th October 1968—20 days earlier than in the previous year. These first arrivals were all swans that had been to Swan Lake before: Pepper and Amber, Romeo and McJuliet, and Sahara and Gobi with one cygnet. The numbers built up very quickly and by Christmas there were 266.

The total number of swans identified this season was 439 and the most on one day was 366, 167 more than last season. Comparisons with previous years can be seen from Table I which also shows the percentage of cygnets in the flock each year.

The percentage of cygnets was very low for the second year running. The largest brood was one of three cygnets, that of Lefty and Mr. Wrong. It is probable that this was due to bad weather conditions on the breeding grounds which, according to Russian sources, are on the southern half of the Yamal Peninsula and along the tundra bordering the Kara Sea. (Not all the swans from there

Table I. Numbers of Bewick's Swans at Slimbridge 1963-64 to 1968-69, and annual breeding success.

Season	*Total of different swans seen*	*No. returning from previous years (Adult/2nd yr. only)*	*Cygnets*		*Mean brood size*	*Maximum on Swan Lake on one day*
			No.	*%*		
1963-64	24	—	6	25	2.0	24
1964-65	74	13	16	22	2.7	56
1965-66	148	31	43	29	1.7	125
1966-67	336	68	97	29	2.7	224*
1967-68	342	102	31	9	1.6	199
1968-69	439	130	34	8	1.6	366

* 271 birds were counted on 13th January 1967, mostly on the River Severn and Dumbles.

migrate to north-west Europe.)

The increased total for the number of swans on any one day was probably due to the food being scattered over a larger area of the shallow water than last year, extending all along the shore in front of the house and also along the shore of the bay near the entrance to the pen. It is thought that the feeding areas may have to be limited next season in order to control the number of swans, for the study depends on the observer memorising the name and face-patterns of every bird.

This season a great many more swans stayed consistently after arrival than in previous years. The proportion of swans that stayed for less than eight days was only 10%. It seems certain now that such swans go away because they do not learn about the food, or are kept away from it by the established swans. Where they go to we do not know, although Bewick's Swans are often reported in several places in south and west England including Sedgemoor and Chew Reservoir in Somerset, River Cherwell floods in Oxfordshire, Caldicot Moor, Monmouth, and Walmore Common and Ashleworth Ham near Gloucester. There is also a wet field behind the village of Slimbridge called the Moors, a little over one mile from the Wildfowl Trust Headquarters, where many of our swans regularly feed including a few that seldom come to Swan Lake. We had, for instance, a pair, Cheetah and Chalice, which came to Swan Lake on 31st December and 1st January without finding the food either day, but were seen on the Moors on 6th January and again on 14th February and probably fed there for several weeks. Even more interesting were a pair Oliver and Denise, which had previously only been seen on 1st January 1968. They returned this winter on 31st December, with two cygnets. They again failed to find the food and went away for 65 days. However, they were seen on the Moors on 14th and 18th February and also on the Dumbles on 2nd March. They returned to Swan Lake on 7th March when they found the food and having done so spent a great deal of their time feeding. By this date more than half the swans had left on their spring migration and Oliver and Denise were able to assume a dominant position among those that remained. They were one of the last pairs to leave on migration, on 27th March.

Chance may play a part in whether swans visit Slimbridge on their south-westerly migration. This year, Bertie Bassett, Mom, Prongy and Square, who had arrived very early last winter and in previous winters, did not come this season until the beginning of March, suggesting that they had wintered somewhere else, perhaps having gone there with another flock of swans or having overflown Slimbridge.

The first major exodus took place on 6th March 1969, two days after a full moon. Another major departure date was the 23rd, five days after a new moon (!), and all but the three swans mentioned earlier had left by 29th March.

Table II shows the numbers and percentages of adult and second year swans returning in later years. Cygnets, which cannot definitely be re-identified in subsequent winters, are omitted from the Table. The numbers of birds returning to Slimbridge in the second year are rather lower than might have been expected but after that the proportion returning declines more slowly, presumably through mortality. A provisional annual survival rate of 85% has been calculated from the figures in the Table.

Nine swans returned this winter having not appeared last. Of these Becky, Ivy, General and Red Spot had lost their mates of 1966-67. However, such losses do not necessarily interrupt returns, for Beater, Shieldy and Ambrosia present again this season had lost their mates of last year. Stamp left on the spring migration three days before its mate of last winter, Bertie Bassett, arrived on Swan Lake. This suggests that Bertie might

Table II. Numbers and percentages of adult and second year Bewick's Swans returning to Slimbridge in seasons after the first sighting.

Season of first sighting	*Number seen for first time*	*Numbers and percentages* returning in subsequent seasons*									
		2nd		*3rd*		*4th*		*5th*		*6th*	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1963-64	18	13	*72*	11	*85*	11	*100*	9	*82*	7	*85*
1964-65	45	20	*44*	19	*95*	14	*74*	14	*100*		
1965-66	74	38	*51*	28	*74*	26	*93*				
1966-67	171	51	*30*	33	*65*						
1967-68	209	50	*24*								

Mean annual survival (from percentages returning in 3rd and subsequent seasons) = 85%.

* The number returning in each season is expressed as a percentage of the number present in the preceding season.

have got lost at the beginning of the season. There were also two cases of swans losing their mates during the winter. Pierre was on Swan Lake from 9th to 26th December with his mate Auguste and two cygnets. After two days of the family's absence Auguste returned alone with one cygnet. Muscat came to Swan Lake on 15th, 16th, 24th and 26th December with his mate Grape and two cygnets but they failed to find the food. However, on 14th January Grape alone came back with the two cygnets and having found the food became firmly established.

The photographic coverage of the swans has been much greater this season which will be a considerable advantage next season in identifying them when they return. The swans become more and more individual to us and it is because of their slight individual differences in head shape, posture, etc., that the photographs are of so much more help than just the identikit-type drawings based on bill pattern alone. With greater recognition and more ringed swans we hope that next season the accuracy of the study may be increased.

Ringing

Forty-seven swans flew into trees at night, crash landed and were caught and ringed this season, mostly towards the beginning of the winter when there were several nights with awkward winds. The tall coloured plastic rings with large numbers engraved on them have been used all winter and have proved very easily readable. There was some concern when a swan ringed this year, Bess, was noticed 72 days later without the plastic ring, though still carrying the metal ring on the other leg put on for control purposes. It is believed that the plastic ring was not glued on properly. When correctly used the glue is so strong that rings have had to be cut in order to remove them. Besides serving as a check on identification by individual characteristics, the large rings enable swans to be identified at other places in Britain. A ringed swan, Speckly, which was with us for 20 days at the end of last season, was seen this year on the River Cherwell floods near Banbury, but never came to Swan Lake. We hope that further reports of such ringed swans will give us a better idea of where our birds go when they are not at Slimbridge. We also hope to ring many more next season, perhaps using a decoy pipe catching method.

Out of the 47 swans ringed during the season only four were at all damaged in the crash landings which allowed them to be caught, Brimmer, Momac and Concorde, all caught on 22nd March, and Sahara, ringed earlier in the season. The first three all hit trees in the dark in an east wind and fortunately recovered fairly soon though Momac had to be kept in a pen for a ten day convalescence. Momac and Concorde, together with an undamaged swan, Feather, stayed on Swan Lake until 11th April, Momac leaving last on the morning of the 12th. Sahara was originally caught in the flight net on 23rd November, the only time it was used this season, and he seemed completely unhurt. The next night however a swan crashed into the television aerial of the hostel but managed to fly out to the Dumbles. This must have been Sahara as he was found four days later sitting on the Dumbles unable to walk or fly and surrounded by crows. He was put in a pen for eight days, having already lost over 2 lb. in weight. Put back on the pond to join his mate, Gobi, and cygnet, he then recovered quickly. Before his injury he had been a very powerful swan, almost top of the 'peck order', and on being returned to the pond, although far from fit was still top swan without actually having to assert his authority. The others carefully kept out of his way. One of the Kontiki cygnets was seen to crash

land on the island in Swan Lake and although it appeared all right at the time and managed to fly out with the others, it was missing the next day. Its body was found two days later in the Tack Piece where it had obviously landed and, being injured or too weak to go any further, had been found and killed by a fox. It had been ringed earlier in the season and had a cataract in one eye which may have accounted for its bad flying.

We have had four more recoveries notified of ringed swans: Bootsy, shot at Lake Laidze, near Talsi, Latvia, on 26th October 1967; Mrs. Blount, found dead in Co. Antrim, Northern Ireland, on 14th November 1968; Colin, found injured in Co. Donegal, Eire, on 9th November 1968; and Andy, found injured in Neubrandenburg, East Germany, on 18th November 1968. Andy subsequently flew off.

Behaviour

The increase in numbers this season and therefore in the time spent on daily identification gave little opportunity for the detailed study of aggressive behaviour in the swans. However, large numbers of aggressive encounters were recorded as were courtship displays in sub-adult swans. A cygnet belonging to a powerful pair, even when by itself, can chase off another adult or even a pair of adults which are below its parents in the 'peck order'. This behaviour is interesting because of its parallels in human society.

The behaviour of the swans during two thunderstorms was observed. The first thunderstorm was around midnight on the night of 21st December and the swans all clustered in the middle of the pond calling loudly. The second thunderstorm was just before dusk on 17th January and one thunderclap panicked the swans, 70-80 being put into the air at once and flying very hazardously because of the strong gusting south wind. On that evening all the swans had gone before dusk. There was one other night during the season when all the swans became thoroughly unsettled and went out leaving the pond empty at dusk. This was on 7th January when, with a very strong south-east wind, the first swans to leave found flying very difficult. Many had to land back on the pond, to avoid hitting trees and buildings. Seeing this going on, the remaining swans panicked, walked up the grass and took off.

Whooper Swans (Plate IV)

During the season 14 Whooper Swans *Cygnus cygnus cygnus* came to Swan Lake, the first arriving on 7th November. This bird, Whoopic, stayed on Swan Lake and took up with a Bewick's, Tahiri, until on 19th December he went away with one of three more Whoopers, including one cygnet, which had arrived the day before. He returned on 24th December with another Whooper, Toopic, with which he was apparently paired until he had a collision with a tree on 7th January. Toopic, during Whoopic's subsequent convalescence, gradually lost interest in him, becoming attached to a different swan, Looper, with which she left on 4th February. Whoopic stayed for a further 17 days after which he too left. Three other Whoopers became regulars during this time, a pair, Super and Duper, and also Trooper. They left with Looper and Toopic on 4th February. However, on 3rd March Toopic, Looper and a new bird, Swooper, came back together with the cygnet and six days later another new pair arrived, Snooper and Grouper. These six all left on 1st April. The behaviour of the Whoopers is quite different from that of the Bewick's. Although it is possible that all these Whoopers were sub-adult birds, they seemed to stay with one 'mate' for much shorter periods than do the Bewick's when they are sub-adult, as illustrated by Toopic who at the beginning of the season consorted with Whoopic, then later with Looper and Swooper and finally took Snooper from Grouper.

This is the first winter that Whoopers have come to Swan Lake (except for a pair which landed for ten minutes the year before) and there was little time to study their behaviour in detail, but there seems to be great scope in this field especially in comparison with the Bewick's and we hope to know more next year.

Mute Swans

Up to sixty Mute Swans *Cygnus olor*, mostly sub-adults, were present on Swan Lake throughout the winter, but no particular study of them was possible.

Observation facilities

Plate VI shows Swan Lake now edged with observation windows, the three great sheets of the Honorary Director's studio, the new Administrative Block's and, in between, the long glassed-in verandah of the Swan Observatory. This is open to Trust Members and Swan Supporters who can remain until half an hour after sunset to share the incomparable spectacle provided by the floodlit concourse of great white birds.

DAFILA SCOTT

Breeding Results 1968: Slimbridge Collection.

	Date of first egg	*Incubated by hens eggs*	*hatched*	*Hatched in incubator*	*Hatched by parents*	*Reared by parents*	*Total reared*
Magpie Goose	23.7	25	7				1
Fulvous Whistling Duck	7.4	66	37	10			35
Cuban Whistling Duck	28.4	18	4		6	5	9
Javan Whistling Duck	12.7	1					
White-faced Whistling Duck		20	14				12
N. Red-billed Whistling Duck		25	17				15
S. Red-billed Whistling Duck		27	18				16
Black Swan	25.1				3	3	3
Mute Swan						1	1
Black-necked Swan	9.2				5	2	2
Bewick's Swan	8.5	6	5		2		5
Trumpeter Swan	9.4	8	6		2	2	8
Swan Goose	4.4	8	6		5	4	7
Russian Bean Goose	28.4	18	2				2
Pink-footed Goose	21.4				7	6	6
European White-fronted Goose	1.5	7	5				5
Greenland White-fronted Goose	19.4	19	8				6
Lesser White-fronted Goose	28.4	12	11				9
Western Greylag Goose	5.4				17	17	17
Bar-headed Goose	25.4	24	11		5	5	16
Emperor Goose	27.4	16	10	1			6
Lesser Snow Goose		8	6		14	12	14
Greater Snow Goose	30.4				4	1	1
Atlantic Canada Goose	24.3				5	1	1
Moffit's Canada Goose		5					
Giant Canada Goose	29.3				5		
Lesser Canada Goose	21.4	5	3				3
Taverner's Canada Goose	11.4	4	2		1		2
Dusky Canada Goose	15.4				4		3
Cackling Canada Goose	25.5	5	3				2
Hawaiian Goose	16.2	72	30				25
Barnacle Goose	26.4				22	20	20
Black Brant	8.5	11	5				4
Red-breasted Goose	14.5	16	7				5
Ruddy Shelduck	3.4	20	6				5
Cape Shelduck	23.3	10	7				7
New Zealand Shelduck	15.4	6	5				4
Common Shelduck	3.5	7					
Abyssinian Blue-winged Goose	15.5	7	6		2	1	7
Andean Goose	6.4				8	5	5
Ashy-headed Goose	3.5	5	1		2	1	1
Ruddy-headed Goose	7.4	5	3		4	4	7
Lesser Magellan Goose		10			6	1	1
Greater Magellan Goose	19.4	10					
Cereopsis Goose					4	1	1
Patagonian Crested Duck	23.3	12	10		8	8	18
Andean Crested Duck	9.2	20	8				8
Marbled Teal		10	7	55			42
Bronze-winged Duck	3.4	5					
Cape Teal		14	12	5			15
Hottentot Teal	12.7	2					
Versicolor Teal	17.4	25	14	2			11
Red-billed Pintail	11.6	17	9				7
Bahama Pintail	8.5	31	29				29
Chilean Pintail	29.3			12			12
Northern Pintail	22.4	5	2				2
Kerguelen Pintail	16.4	14	4				4
Chilean Teal	25.3	18	11	26			30
Sharp-winged Teal	10.5	5	1				
Falcated Teal	20.5	20	3				1
Australian Grey Teal	1.4	30	14				13
Chestnut-breasted Teal		19	10	4	5	5	14
New Zealand Brown Teal	8.2	17	10				6
Greenland Mallard		6					
Hawaiian Duck	10.4	20	15		3	3	13

	Date of first egg	*Incubated by hens eggs*	*hatched*	*Hatched in incubator*	*Hatched by parents*	*Reared by parents*	*Total reared*
Laysan Teal	12.4	11	8	16	3	3	25
North American Black Duck	21.4			6			6
Indian Spotbill	26.4	13	3				1
Chinese Spotbill		12					
New Zealand Grey Duck				6			6
Pelew Island Grey Duck		8		6			6
Philippine Duck	13.5	13	9	5			14
African Yellowbill	17.3			5			5
Abyssinian Yellowbill	18.3			5			5
African Black Duck	13.2	6	1				
Gadwall	7.4			30			30
European Wigeon				15			9
American Wigeon				7			6
Chiloe Wigeon	20.4	42	26				9
Blue-winged Teal	28.4	34	24	4			14
N. Cinnamon Teal	3.5	19	9				8
Argentine Red Shoveler	4.5	7	5				1
Cape Shoveler	5.5	12	6				4
New Zealand Shoveler	7.5	8	3				1
Common Shoveler	4.5	19	10				6
Ringed Teal	1.5	36	13	5			10
Common Eider	1.5	16	8	4			12
Red-crested Pochard	6.4	8	3	16			15
Rosybill	5.6	22	15	3			13
African Pochard		4					
European Pochard	4.5	7	5				5
Redhead	8.5	7	4	8			12
Common White-eye		18	18	4			16
Baer's Pochard	13.6	7	6				6
Australian White-eye	28.4			17			14
New Zealand Scaup	15.5			8			8
Lesser Scaup		22	16	5			15
European Greater Scaup		6	1				1
Brazilian Teal		8	3				3
Maned Goose	19.3	10	6				5
Mandarin Duck				57			57
North American Wood Duck				142			72
Comb Duck	25.6	42	32	4			22
Hartlaub's Duck	1.7	8	8				6
Muscovy Duck					9	3	3
European Goldeneye	22.4	11	1				1
Smew	1.6	10	8				6
Hooded Merganser	28.4	8	1				
Red-breasted Merganser	20.6	7	2				
North American Ruddy Duck					40	10	10
African White-backed Duck		6					
Crested Screamer	5.4				4	2	2
Rosy Flamingo	15.6				1	1	1

Note: Where no date is given for first egg, nests were not found until the clutch was complete.

Breeding Results 1968: Peakirk Collection.

	Date of first egg	*Eggs incubated*	*Eggs hatched*	*Young reared*
Fulvous Whistling Duck	17.7	8	5	4
Black Swan	27.1	12	6	4
Black-necked Swan	27.2	3		
Swan Goose	8.4	8	2	
Pink-footed Goose	1.5	14	5	3
Greenland White-fronted Goose	2.5	6		
Lesser White-fronted Goose	21.5	6	1	
Western Greylag Goose	29.3	10	7	7
Emperor Goose	24.5	13	1	
Taverner's Canada Goose	3.5	6	1	1

	Date of first egg	*Eggs incubated*	*Eggs hatched*	*Young reared*
Cackling Canada Goose	29.4	11	8	6
Barnacle Goose	5.5	24	1	
Red-breasted Goose	19.6	5	3	2
Ruddy Shelduck	25.4	9		
Cape Shelduck	3.4	5	3	3
Common Shelduck	6.5	13	7	7
Greater Magellan Goose	27.4	4	2	1
Cereopsis Goose	7.2	3		
Marbled Teal	6.7	9	5	2
Bahama Pintail	22.5	22	12	6
Chilean Pintail	28.4	14	8	8
Northern Pintail	4.5	21	12	8
Chilean Teal	10.4	18	11	10
European Green-winged Teal	6.6	7	4	
Falcated Teal	13.6	7	2	1
Chestnut-breasted Teal	16.5	7	2	
North American Black Duck	9.5	7	5	5
Laysan Teal	28.4	20	10	9
Chinese Spotbill	10.5	20	3	2
African Black Duck	31.3	1		
Gadwall	8.5	11	4	2
European Wigeon	30.4	31	18	14
American Wigeon	14.6	11	2	1
N. Cinnamon Teal	7.6	6		
Red-crested Pochard	3.4	44	12	7
Rosybill	1.6	5		
European Pochard	19.5	13	8	5
Australian White-eye	8.5	7	7	6
New Zealand Scaup	11.6	7	7	
Tufted Duck	22.5	35	7	4
Maned Goose	23.4	6	2	2
Mandarin Duck	19.4	25	9	3
North American Wood Duck	28.3	38	17	8
European Goldeneye	5.5	1		
North American Ruddy Duck	15.6	23	7	3

Breeding the Rosy or Caribbean Flamingo at the Wildfowl Trust, Slimbridge

It was not until 1961 that it was decided to add flamingos to the waterfowl collection at Slimbridge. We made a start by having some 12 Chilean Flamingos *Phoenicopterus ruber chilensis* which were put into our South American Pen. These were followed by Greater and Lesser Flamingos *Phoenicopterus ruber roseus* and *Phoeniconaias minor* from Kenya, which went to our African enclosure. The Rosy Flamingos *Phoenicopterus ruber ruber*, which we were most anxious to have, were extremely difficult to come by, and our first birds were a fine pair presented by Antwerp Zoo. Somewhat later we were able to add a consignment from a Florida pet store. It was necessary to learn as much as possible about the husbandry of these beautiful birds, so we sought information from all the Zoos and Collections that kept flamingos. Perhaps the most significant remark was 'Not to worry, it will be seven years before you breed them'—and indeed this proved to be true. But in the meantime we went to a great deal of trouble to give them the right feed. Everyone seemed to have different ideas, but we have evolved a 'flamingo soup' that seems satisfactory for keeping the birds not only in good condition but also in good colour. Initially we bought meals and whole dried shrimps and mixed them together in our cement mixer! We now have a proper food mill and through this are putting equal quantities of wheat, whole maize, poultry biscuit, turkey starter crumbs and dried shrimp. To this is added minced carrot, beetroot and lettuce, along with Canthaxanthin and Rhodophyl for colour maintenance. Special concrete feeding basins were constructed and these are regularly and scrupulously cleaned.

At the same time we were busy working out what we thought would be ideal nesting conditions for all the flamingos, and 'atolls' were built in the middle of their ponds. These consist principally of a concrete ridge forming an oval or circle, rising from the bottom of the pond at a gentle angle and enclosing an area of soft mud out of which they could build the mounds that form their nests. Some concrete 'nests' were added to give the birds the right idea.

The Rosy Flamingos were the first species to show any signs of breeding in 1966, one or two nests were built but these were only half-hearted attempts. Similarly in 1967, although the activity was a little greater and indeed extended to the Chilean Flamingos, it was not the breeding year. However, at the beginning of May 1968 nest building was commenced in earnest by the Rosy Flamingos. Sixteen nests in all were constructed and on the 15th May the first egg was laid. A second bird laid on the 19th. (Plate XVa, p. 165). Entry into the pen was forbidden, the vegetation was allowed to grow rank although overlooked by the restaurant, the nettles proliferated and none of the ducks' nests was visited. But we had forgotten one thing, and that was the periodic cleaning of the restaurant windows. On 7th June the window cleaners came when no member of the staff was near and took their ladders into the pen. Immediately the flamingos left their nests but fortunately a visitor in the restaurant saw this happen and sent for staff help. Needless to say the window cleaners were asked to leave immediately. The birds then returned to their nests but the bird which had been second to lay proceeded to push its egg out of its nest. It was replaced but again was turned out. By this time we felt that much more disturbance would cause the other bird, which had started to incubate again, to leave also. So a wooden egg was placed in the second bird's nest but it would not even tolerate this. Its good egg, which measured 99.6 × 56.0 mm., was put in our incubator as a last hope. We felt the chances of rearing a day old flamingo were remote—even if the egg did hatch—for the birds feed their young by regurgitation and to reproduce the kind of food so supplied seemed to be impossible. However, to our surprise, on listening to the egg on 15th June, there was a distinct tapping and indeed a faint squeak. What to do? It was decided that we must test the egg that was under the first flamingo. It was still being incubated but was overdue for hatching, and we had to see if it were alive. It was obvious on handling the egg, which measured 91.7 × 55.7 mm., that it was addled, so it was removed and the tapping egg substituted in the nest.

On 16th June the male was observed to be incubating with its tail held more erect than previously. The chick finally emerged from the egg between 17.00 and 20.00 hrs. The female 'nibbled' the chick persistently, especially round head and bill, for 15 minutes after preening herself. Similar attention was later shown by the male.

The chick's legs were bright pinkish-red, the bill a flesh pink with darker tip. At 11.25 on 18th June the chick attempted to stand, helping itself up with bill pressed on to the nest and wings held down with head shaking. Finally it stood for a short period. By the tenth day many of the chick's movements had an adult quality. Thus it bowed head forward with wings outstretched after preening. It also stretched its wings and leg sideways and jumped about (see Plate XVb and XVI).

The chick left the nest and fed itself at the food tray on 2nd July at 16 days of age. For a great deal of this time we had the most dreadful weather with torrential rain, and the chick at various times seemed to be covered with mud in spite of the parent brooding it. However, it survived and has now grown into a fine bird. For a considerable time after leaving the nest it took most of its food from its parents. They were obviously being debilitated, particularly the male, for they were completely drained of their lovely pink colour and became virtually like the European Greater Flamingo, with which they are considered conspecific. We therefore decided to remove the young bird at the age of 11 weeks, before the strain on the parents became too great. It was returned after three weeks' absence and from then on the parents appeared to take no interest in it, and the bird fended for itself. During the autumn the parents, or perhaps one should say the foster parents, gradually returned to their full colour, the young bird progressed well, and in five months time was beginning to go pink. At this stage it was decided that the one and only flamingo to be reared in Britain ought not to fly away, so we caught and pinioned it. This was duly done without any ill effect and now it is a happy member of our flock of 37 Rosy Flamingos.

S. T. JOHNSTONE and L. P. ALDER

Philippa Scott

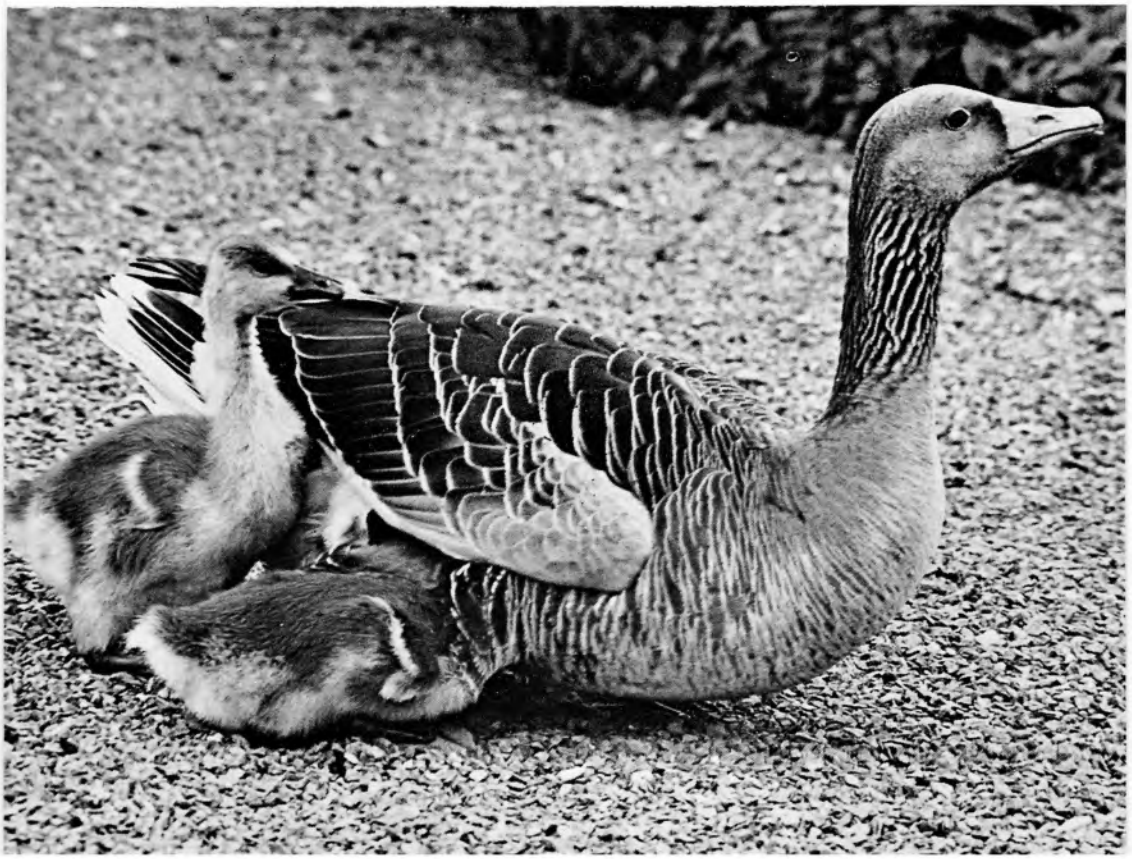
Plate XIII. (a) A downy Crested Screamer *Chauna chavaria* and its parent sharing a meal.
(b) A brood of Maned Geese *Chenonetta jubata* with their bantam foster mother. This species bred for the first time at Slimbridge in 1968.

Philippa Scott

Philippa Scott

Plate XIV. Two charming scenes of parental care in geese. (a) Barnacle Goose *Branta leucopsis*. (b) Greylag Goose *Anser a. anser*.

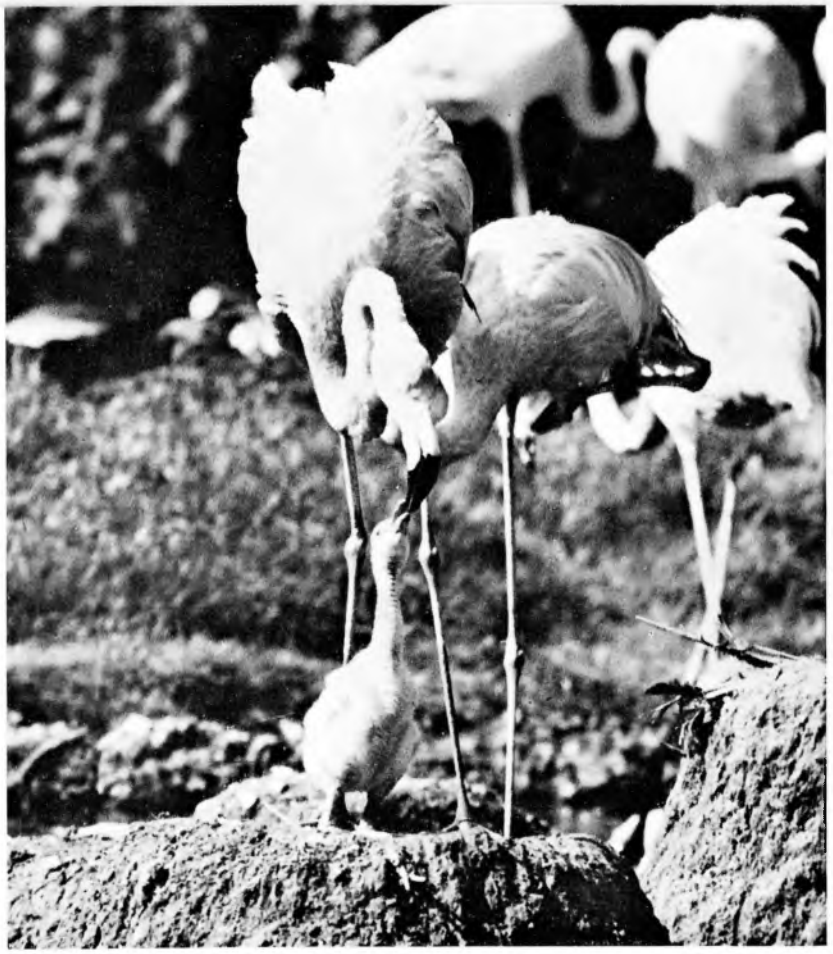
J. A. Middleton



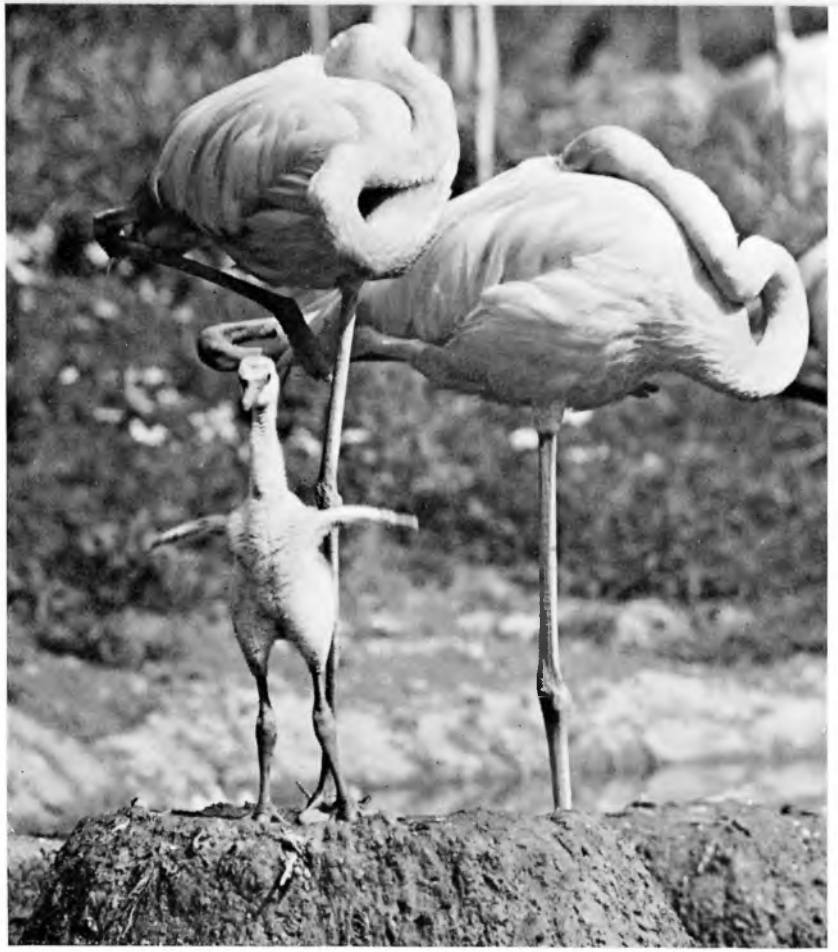
J. A. Middleton

Plate XV. Two pairs of Rosy Flamingos *Phoenicopterus ruber ruber* bred at Slimbridge in 1968, for the first time in Britain. One egg hatched and the chick was successfully reared. (a) The incubating females. The left-hand bird is adding more mud to the nest. The raised plumes indicate slight conflict between the birds. (b) The chick, a few days old. (See p. 163.)

Philippa Scott



J. A. Middleton



Philippa Scott

Plate XVI. (a) The Rosy Flamingo chick at about three weeks old being fed from the parent's bill.
(b) 'I must exercise my wings'.

The Wildfowl Trust

Patron HER MAJESTY THE QUEEN

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G. M. Jolliffe, F.L.A.S.
E. G. Kleinwort
R. E. M. Pilcher, F.R.C.S.
J. P. Williams

Co-opted Members

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Captain P. A. Fergusson-Cuninghame
Miss P. Talbot-Ponsonby
The Hon. Vincent Weir

Invited to attend meetings ex-officio Miss K. M. P. Burton, H.M.I. *(Assessor for the Department of Education and Science)*

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Major-General C. B. Wainwright, C.B.
Professor E. W. Yemm

Trust Activities, Developments and Finance, 1968

Meetings

The Officers, Council and Committees of the Trust as at 31st December 1968 are listed on page 165. The Council met on 11th January, 12th March, 13th July and 28th November; the Finance Committee on 12th March, 27th June and 7th November; and the Scientific Advisory Committee on 21st March. All meetings were at the headquarters of the Nature Conservancy, except that of 13th July which was at Slimbridge.

The 20th Annual General Meeting was held at the Royal Society of Arts, London, on May 14th. The Annual Dinner was at the Hyde Park Hotel on the same day. The Hon. Director presided and the speakers were Sir Paul Chambers, Colin Mackay and Alan Melville.

Amendments to Rules

The full Minutes of the Annual General Meeting are circulated separately to Members. It is thought appropriate, however, to note here changes in the Rules that were passed.

16th May 1967 — Rule 16(i). Delete the words: "A Secretary".

14th May 1968 — Rule 3. Amend last four lines to read: "Provided that nothing contained in these rules shall prevent the payment in good faith of remuneration (including provisions of pensions and superannuation and life insurance benefit) to any officer or servant of the Trust or to any Member thereof in return for services actually rendered to the Trust".

— Rule 5(4)(iv). Amend first line to read: "Up to 31st May 1968 the Council shall have power to elect as Junior Compounded Members . . ."

Membership

Membership increased by 339 over 1967. Thus:

	1967	*1968*
Life Members	317	345
Full Members	4581	5054
Associate Members	1643	1606
Parish Members	254	237
Junior Compounded Members	13	13
Gosling Members	751	642
Corporate Members	99	100
Contributors	32	32
	7690	8029

There was continued interest in the Swan Supporter scheme and the number of supporters increased from 135 to 158. Of the adopted swans 72% returned in the course of the winter. (New swans are allocated to supporters whose swans do not come back.)

Twenty-two members very kindly opened their private collections to fellow members during 1968.

Johnny Morris came to a very well attended Gosling party on 28th December.

It is with regret that the Council learned of the death of 63 members and associates during the year and also of two Council Members — Professor John E. Harris, C.B.E., F.R.S., and Major General C. B. Wainwright, C.B., and a Member of the Scientific Advisory Committee, Mr. R. K. Cornwallis.

Attendances

Although the tropical house, opened at the end of 1967, proved a great attraction, Slimbridge had a slight drop in visitors; Peakirk, however, in spite of the wet summer had a 16% increase making the total for 1968 a record:

	1966	*1967*	*1968*
Slimbridge	200231	209243	206903
Peakirk	46514	46181	53602
	246745	255424	260505

Development

A generous legacy made it possible for a much needed administrative block at Slimbridge to be built; by the end of the year this was almost completed. This new block has room for the offices of the International Wildfowl Research Bureau and for an assistant of the World Wildlife Fund. Rooms in the older buildings, previously occupied by administrators, were freed for bedrooms and to provide much needed additional workrooms and museum space.

In April 1968 the Trust was able to take into its lease the 11 acre field, which had for long served as its car park. Improvements were immediately put in hand to enable it to accommodate coaches, to take vehicles in wet weather and to operate satisfactorily on busy days. Arrangements for free parking for members were instituted and in the autumn trees and shrubs to provide shade and enhance the appearance were planted.

Possession of this field also provided a site for improved arrangements for quarantining wildfowl imported from overseas. By the end of the year two new quarantine pens were completed and construction of a second pair was in progress.

Work was started by the Youth Hostel Association, with the help of a generous grant from the Carnegie (U.K.) Trust, on the building of a Youth Hostel for Field Studies at the Patch, Slimbridge, on a site provided by the Trust. The Trust's educational facilities as well as two well equipped work rooms at the Hostel will be available to field study groups.

An anonymous donation earmarked for improvements to the Waterfowl Gardens at Peakirk was received and allocated for a new entrance building and shop planned for construction in the summer of 1969. The pair of cottages at Peakirk donated by Mrs. Annie Williams were converted to a house for the curator with a bachelor's flat alongside.

Welney

Thanks to the generosity of many kind benefactors, both in this country and the U.S.A., the Trust was able to repay in July the interest free loan made by Arthur Guinness, Son & Co. (Park Royal) Ltd. for the establishment of the Welney Wildfowl Refuge in the Great Ouse Washes, Norfolk. By the end of the year the Trust owned 399 acres, had control of the shooting over a further 100 acres and had agreed the purchase of another 38 acres with the help of an interest free bridging loan generously advanced by Mr. Ernest Kleinwort. A cottage near the reserve was bought for modernisation as a house for the warden.

Finance

During the year £16,729, accumulated in the General Reserve Fund, mostly from legacies and donations, was spent on the new office block and on improvements to the car park. An additional £6,314 of capital expenditure was charged to the Income and Expenditure Account. This together with continued rises in costs produced an excess of expenditure over income of £3,210. Detailed accounts have already been circulated to Members, but an abbreviated set, covering both 1967 and 1968, is given at p. 168.

Although the Trust has always been fortunate in finding benefactors to finance new ventures and activities, it has never been able to expand as fast as it ought. The Council therefore decided to mount a campaign with a target of £325,000 to raise funds for further developments at Slimbridge, Peakirk and Welney and also for the establishment of new wildfowl collections and reserves in areas beyond easy reach of its existing sites. A firm of professional fund-raisers was employed and by 31st December 1968 a grossed up total of £57,000 over the term of the covenants had been raised.

It was clear that even if future expenditure on development were to be limited to the amount available from donations and legacies, increased income would be needed to cover inevitable rises in running costs. The Council therefore decided to institute new admission charges to Slimbridge and Peakirk on 1st January 1969 and to submit proposals to the 1969 Annual General Meeting for increases in the rates of subscription for members.

C. E. H. SPARROW

Terms of Membership (as from 1st January 1970)

LIFE MEMBERS	A single payment of £100. Entitled to all the privileges of Full Membership (see below).
FULL MEMBERS	£3 a year. Entitled to free entry to the Enclosures and observation hides at Slimbridge and Peakirk, with one free guest, and to a free copy of WILDFOWL and bulletins.
ASSOCIATE MEMBERS	£1 10s. a year. Entitled to free entry to Enclosures and hides, and to a free copy of bulletins.
GOSLING MEMBERS (under 18)	12/6d. a year. Entitled to the same privileges as Associate Members. A leaflet obtainable at Slimbridge or Peakirk gives details of a scheme of grading of Goslings, with appropriate distinguishing marks, and promotion by recognition tests.
CORPORATE MEMBERS	£1 a year. Limited to educational establishments, youth clubs, and bodies which are members of the Council for Nature. Receive a free copy of WILDFOWL and bulletins. Free entry for one adult per each ten members of a party.

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTER
INCOME AND EXPENDITURE ACCOUNT FOR THE YEARS ENDED 31st DECEMBER 1967 and 1968

EXPENDITURE	*1967* £	*1968* £
To **General Expenses**		
Salaries and Superannuation, Administrative Staff	7504	10040
Rent, Rates, Water Rates and Insurance	2092	1600
General administration expenses	4083	5813
Maintenance, including hostel	2792	3441
Printing, including bulletins, stationery	2167	2968
Loan Interest, Bank Charges	241	185
Advertising	5824	7354
	24703	31401
New Grounds and Peakirk:—		
Salaries, Wages and Superannuation	17519	19083
Purchases of Wildfowl	2550	1550
Food for Wildfowl	6971	7569
Maintenance, Fuel etc.	5002	7360
Transport, Mechanical Equipment, Travel	1834	2191
Miscellaneous	761	758
	34637	38511
Gate Houses:—		
Salaries, Wages and Superannuation	4894	6484
Miscellaneous	1980	2266
	6874	8750
Research and Conservation:—		
Salaries and Superannuation	15283	16831
Miscellaneous Research expenditure	4609	4797
Printing 'Wildfowl'	2819	2622
Management and Upkeep of refuges and ringing stations	7166	6461
	29877	30711
Educational:—		
Salaries and Superannuation	1273	2255
Miscellaneous	492	688
	1765	2943
Capital Expenditure:—		
Development	6363	5140
Equipment	1962	1174
	8325	6314
Written off Buildings	100	100
Surplus for year, carried down	2781	—
	£109062	£118730
To Deficit for year, brought down	—	3210
Transfer to Accumulated Fund	2800	—
Balance, carried forward to next year	1003	—
	£3803	£3210

INCOME	*1967* £	*1968* £
By **General Income:—**		
Subscriptions	12121	12247
Donations	4102	705
Income Tax repaid on covenants	2240	2267
Interest received	1398	1819
	19861	17038
New Grounds and Peakirk:—		
Takings	53993	59767
Sale of Surplus Wildfowl	3617	3083
Restaurant	1834	2181
	59444	65031
Gate Houses:—		
Sales	36889	38666
Less: Purchases (with stocks adjusted)	26441	27019
	10448	11647
Research and Conservation:—		
The Natural Environment Research Council Grant	15901	17129
Donations	772	996
Other Receipts	1849	2358
	18522	20483
Educational:—		
County Council Grants	275	275
Increase in Valuation at end of year	512	1046
Deficit for year, carried down	—	3210
	£109062	£118730
By Balance at end of year	1022	1003
Surplus for year, brought down	2781	—
Transfer to Accumulated Fund	—	2207
	£3803	£3210

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTER
BALANCE SHEET AS AT 31st DECEMBER 1968

1967	LIABILITIES	£	£
47100	**Accumulated Fund**		47100
1003	**Income and Expenditure Account**		—
48103			47100
	Special Fund:—		
3420	Specific Projects	18723	
—	Life Membership	1022	
10964	General Reserve	686	
7500	Special Reserve (after transfer of £2,207 to Accumulated Fund and £1,000 to General Reserve Fund)	4293	
21884			24724
1366	**Mortgage on Freehold Property**		1350
	Current Liabilities		
19032	Sundry Creditors and Accrued Charges	16901	
24000	Unsecured Loans	2876	
43032			19777
£114385			£92951

1967	ASSETS	£	£
	Fixed Assets		
12099	Freehold and Leasehold Properties at Cost or Valuation (less depreciation)		13179
	Assets, at Valuation, 31st December 1968		
8209	Transport and other equipment	9175	
10920	Wildfowl	11000	
19129			20175
31228			33354
	Special Funds, represented by:—		
21884	Investment at Cost and cash on deposit		24724
	Current Assets:—		
7505	Gate House and Other Stocks	8563	
7576	Sundry Debtors and Payments in advance	7813	
46192	Cash	8660	
61273			25036
	Fund Raising Campaign:—		
—	Campaign Expenses to date less Covenants and other donations received		9837
£114385			£92951

We have examined the above Balance Sheet of The Wildfowl Trust dated 31st December 1968, together with the accompanying Income and Expenditure Account and find them to be in accordance with the Books and Vouchers produced to us and the explanations given to us.

STROUD, GLOUCESTERSHIRE.
14th April 1969.

S. J. DUDBRIDGE & SONS
Chartered Accountants

1968 Breeding Season: Slimbridge

Some 900 birds of 98 different kinds have been bred. The old breeding female Magpie Goose died, but now her free-winged stock have commenced nesting and have built quite different nests from those of the pinioned birds. These built piles of herbage on the ground similar to swans, but the full-winged birds made several nests in the tops of pollarded willows and even on top of the Guinness Aviary. The full-winged birds comprised two females and a male, and although a large number of eggs were laid, very few were fertile. The Crested Screamers nested and reared two young. Among the whistling ducks, Cuban, Fulvous, White-faced and both forms of Red-billed were reared in considerable numbers. Of the swans, Black, Black-necked, Bewick's and Trumpeter were reared. The Hawaiian Geese hatched 30 young, 25 were reared. Among the ducks, only one sitting of Bronzewing eggs was obtained, and although four of these were fertile, none hatched. What is even sadder is that during the winter two of the potential breeding females have died.

The first breeding of the Rosy Flamingos in Britain is described elsewhere (p. 163). The most interesting other new species to lay was the Falkland Flightless Steamer Duck and out of her five eggs, four were hatched under a bantam. Although the ducklings appeared quite vigorous on hatching, we were unable to get them to feed and in four days all were lost. Other new species to be reared at Slimbridge were Maned Geese and Pelew Island Grey Duck. A Hooded Merganser appeared on the Rushy Pen pond with six young, five of her own and one Mandarin. It is sad to relate that she reared the Mandarin but lost her own young within a week. After a number of years, we again bred the Hawaiian Duck, now possibly the world's rarest wildfowl. Thirteen of these were added to the collection.

We had hoped that the Tropical House would have helped the Pygmy Geese to commence breeding in captivity, but they showed no sign of nesting. Odd eggs were laid therein by the Hottentot Teal and also by the White-backed Duck but neither really completed a clutch, and no eggs hatched. As there were perhaps too many duck for the limited water space, we removed the Eyton's and Spotted Whistling Duck from the House, merely leaving the Javan Whistling Duck, the African and Indian Pygmy Geese and the Hottentot Teal. Whilst unfortunately the ducks have not taken as well as one would have hoped to these new surroundings, always assuming that breeding is the measure of ideal conditions, one must add that the Amazilia Humming Bird built a nest and laid, although the eggs were infertile.

S. T. JOHNSTONE

1968 Breeding Season — Peakirk

The season was regrettably poor and got off to a bad start when the female Black-necked Swan deserted her nest in the middle of a snow storm at the end of February. This was followed until Easter by generally cold conditions with little natural cover available for the birds; during this period a number of eggs were taken by rooks and carrion crows. Much of the remainder of the season was badly affected by extremely wet weather, and heavy flooding took place in the Gardens on several occasions. A very severe rain storm occurred on the night of 10th July and part of the Rearing Ground was under water, with the tragic loss of some twenty ducklings. As a general result of the weather, total figures for 'species laid' and 'young reared' are both well down on previous years. More notable of the young reared during the season were Fulvous Whistling Duck, Red-breasted Goose, Falcated Teal and Australian Wood Duck.

P. B. VARDY

Conservation, Research and Education

International wildfowl conservation received a set-back when events in Czechoslovakia interfered with the large-scale conference arranged for September in Leningrad. Although it was held, delegates from the West did not attend. However, it is understood that the massive documentation prepared will still be published. For reasons of work pressure Dr. Luc Hoffmann indicated that he wished to retire from the Directorship of the International Wildfowl Research Bureau. At the I.W.R.B. meeting in Morges, Switzerland, in September, Dr. Matthews was elected to be the new Director. The post is an honorary one and he will continue as Director of Research to the Trust. Our Council approved the appointment and undertook to provide office accommodation and facilities at Slimbridge from the beginning of 1969 (p. 94).

An important event was the inspection, by members of a Visiting Group of the Nature Conservancy, of the research work and facilities of the Trust. A distinguished group of scientists led by Professor V. C. Wynne-Edwards (now Chairman of the Natural Environment Research Council) carried out a searching survey with a view to recommending what financial support should be forthcoming from N.E.R.C. at the end of their present quinquennial grant in March 1971. Their recommendations were such that it is probable that ten year contracts will be entered into with respect to the wildfowl counts, the ringing programme and the general direction of the research effort. Other studies will be required to seek short term grants in the usual way in competition with Universities and other bodies. This was a welcome indication of continued confidence in the quality of our research and its relevance to nature conservation.

The Trust's long-term research into the populations and ecology of wildfowl continued. Those concerned with censuses and counts, with ringing and migration and with the detailed studies of the wild geese and wild swans at Slimbridge have already been summarised in the 'Current Reports' section (pp. 148 to 160).

The review of Reserves being undertaken by the Nature Conservancy was underpinned, insofar as wetlands were concerned, by massive documentation prepared by Mr. Atkinson-Willes. Threats to wetland habitat were resisted. These arose through development schemes and, particularly in the case of reservoirs, through increased recreational demands. Where possible compromise was advocated, involving a share-out of available waters between the various interests.

This year saw the coming into force of the revision of the Protection of Birds Act. Two important provisions concerning wildfowl, curtailment of shooting in extreme weather and banning of the sale of dead wild geese, owed much to the efforts of the Trust. Indeed several pages of Hansard were devoted to statements based on our researches into goose numbers and feeding habits.

On our new reserve at the Welney Washes, preliminary surveys of breeding ducks and of the vegetation were made. In addition to the study on the feeding of geese on agricultural land in Scotland (p. 155), a detailed study of the grazing and food preferences of the White-fronted Geese was started by Dr. Owen at Slimbridge. He also helped in the planning and execution of related feeding studies at Bridgwater Bay, Somerset, and on the North Slob, Wexford, Ireland.

Besides writing up a final paper on her long series of experimental investigations into the effects of goose grazing on cereals and grass, Dr. Kear was concerned with the growth and nutrition of young birds. These included the exotic species at Slimbridge and also Tufted Ducks in connection with the Loch Leven research. She was involved in the programme of selective breeding of the Ne-ne and, on a visit to New Zealand, called at the various centres in the U.S.A. and Hawaii, where this species is reared, for discussions on techniques. In New Zealand she was especially concerned with the feeding and other behaviour of the Blue Duck.

The health of the wildfowl in our collections continued to be watched over by Dr. Beer. He carried out post-mortems and advised on curative or prophylactic measures. The pattern of disease over the past ten years was analysed. It is to be hoped that the new services and propagation buildings, now being planned, will reduce the losses, especially amongst downy young.

Orientation tests continued with birds caught at Borough Fen Decoy, and Mr. Ogilvie was involved with the Royal Radar Establishment's investigation on the effects of radar on birds and on its use for identifying them on migration. Dr. Matthews' revised edition of his book *Bird Navigation* was published.

University research was again assisted in various ways, facilities or specimens

being provided for Aberdeen, Bath, Bristol, Cambridge, Cardiff, Durham, Leicester, London, Portsmouth and Stirling. From Bristol University, Dr. Miles left at the end of his post-doctoral year, while Mr. M. Penny began a post-graduate study on wader feeding ecology, working both at Slimbridge and on Aldabra Island in the Indian Ocean. Other post graduate studies were begun by Mr. P. N. Humphreys (Cardiff) on fertility in wildfowl, and by Mr. J. Mattocks (Bath) on the micro-organisms in the goose's gut in relation to digestion.

Courses of lectures were again given at Bristol and Cardiff, from which students came for day courses as did others from Leicester, London, Portsmouth and Reading. The four-day Teachers' Course was run in April and four one-day courses were also provided. Mr. Jackson took over the administration and organisation of school visits, which numbered 684. The film *Wild Wings* was shown to 122 parties, and 103 lectures were given away from Slimbridge. The usefulness and interest of school party visits to Slimbridge was greatly increased by the introduction of especially compiled 'work sheets' and of lecture sets of slides loaned to the schools prior to the visits.

A set of display boards for the Holden Tower was designed and prepared. The annual Schools Identification Competition took place in March and had the record number of 147 entrants.

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MILES, S.G. Laboratory experiments on the orientation of the adult American Eel. *J. Fish Res. Bd. Canada* 25 : 2143-55.

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OLNEY, P. J. S. The food and feeding habits of the Pochard. *Biol. Conservation* 1 : 71-76.

POLLARD, D. F. W. and P. WALTERS-DAVIES. A preliminary study of the feeding of the Greenland White-fronted Goose in Cardiganshire. *Wildfowl* 19 : 108-16.

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G. V. T. MATTHEWS