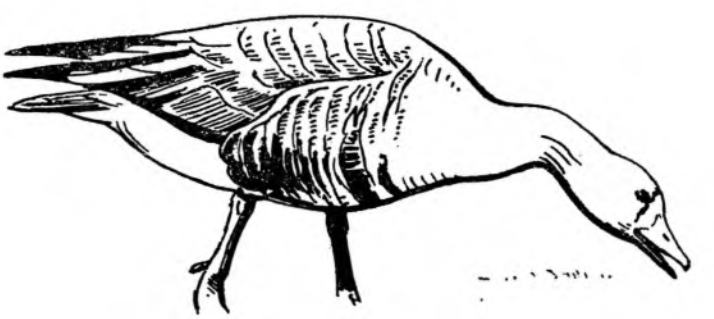
THE TWELFTH ANNUAL REPORT OF

THE WILDFOWL TRUST

1959—1960



HUGH BOYD AND PETER SCOTT

Price Seventeen Shillings and Sixpence Net

Printed for the Wildfowl Trust by
F. BAILEY & SON, LTD.,
Dursley, Glos.
1961

THE WILDFOWL TRUST

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The collections of the Trust are at:

The New Grounds,
Slimbridge,
Gloucestershire.

The Waterfowl Gardens,
Peakirk,
Northamptonshire.

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SECTION I

TRUST ACTIVITIES, 1959-60

GENERAL

Officers and Council

In May 1960, after serving as President of the Trust since its foundation, Field Marshal the Rt. Hon. The Viscount Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O., retired from the Presidency and His Royal Highness, The Prince Philip, Duke of Edinburgh, K.G., K.T. graciously consented to accept nomination as President for a term of three years.

In July the Trust lost another of its original officers through the death of the Rt. Hon. the Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C., who had been a Trustee since the foundation.

The Rt. Hon. the Earl of Mansfield has accepted the nomination of the Council to fill the vacancy.

The Officers and Council of the Trust (as at 1st April 1961) are shown on page 2. Council Meetings were held on 22nd September 1959, 15th March 1960, 1st November 1960 and meetings of the Finance Committee on 16th September 1959, 17th February 1960, 3rd October 1960 and 6th December 1960. The annual meeting of the Scientific Advisory Committee was held on 6th April 1960.

Annual General Meeting

The Thirteenth Annual General Meeting was held at the Royal Society of Arts on 24th May 1960. The minutes are recorded on p. 179.

Annual Dinner

The Annual Dinner was held at Bush House on 24th May 1960. Field Marshal the Rt. Hon. the Viscount Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O. was in the chair and the speakers were Professor Gustav A. Swanson, Mr. Peter Scott, C.B.E., D.S.C., the Rt. Hon. the Lord Howick of Glendale, G.C.M.G., K.C.V.O., and the Rt. Hon. the Lord Boothby of Buchan and Rattray Head, K.B.E., LL.D.

Gosling Party

The annual Gosling Party was held at Slimbridge on 21st December 1960 and was attended by 65 Goslings.

Membership

Comparative figures showing the membership of the Trust for the last four years are set out on p. 177. From the figures it will be seen that the total membership declined by 215 during 1960.

In Bulletin No. 30 issued in February 1961 the Council asked all Members to make strenuous efforts to enlist new members. At the time of going to press it was too early to assess the results of this appeal.

Visitors

The numbers of visitors to the Trust's collections during the last three years have been:

	1958	1959	1960
Slimbridge	120,191	129,092	102,555
Peakirk	23,495	31,135	26,531
Totals	143,686	160,227	129,086

As a result of the drop in 1960 our income from gate takings fell by £4,415. It seems unlikely that this drop was entirely due to the bad weather. Since greater numbers are desirable both in fulfilment of our educational objects and as a source of essential revenue, steps are being taken to attract more visitors by increased publicity.

THE COLLECTIONS

STAFF

Slimbridge: Curator S. T. Johnstone. Wardens: P. J. Henshaw, M. Davy, L. T. C. Shakespear, M. W. Henchman, I. Fairbairn and A. A. Milne. L. P. Alder is the gardener, with G. Huggins, J. Parsons and W. Hancock as groundsmen. Miss J. E. Overman is secretary to the Curator.
Peakirk: Curator N. Dudley. Warden: G. Cole.

THE GROUNDS

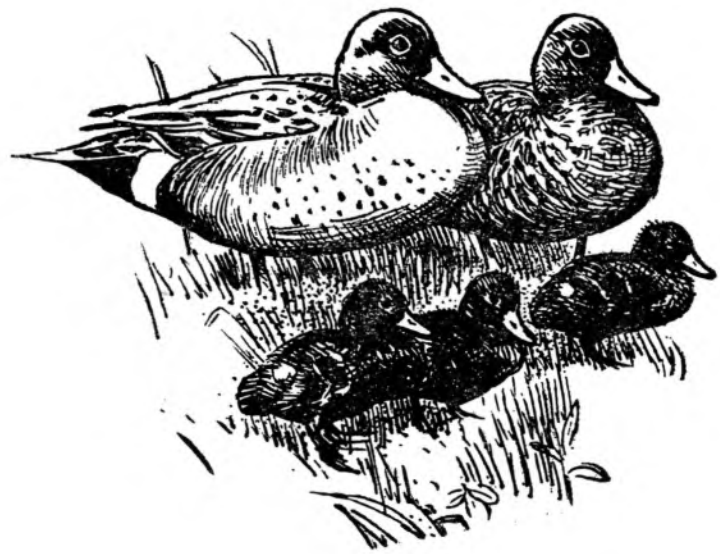
No major extensions or alterations to the enclosures at Slimbridge and Peakirk were made in 1959-60. At Slimbridge, improvements included the rebuilding of the new-arrival pens and the construction of four quarantine pens. A new incubator shed, much larger than that previously used and with several improved features, was ready for the summer of 1960. The old aviary in the Wood pen was completely rebuilt and its pens planted most attractively. Several ponds were dredged and reconstructed, and the appearance of the enclosures greatly enhanced by planting of trees, shrubs and other goose-resistant flowering plants.

At Peakirk, too, the attractiveness of the gardens has been increased. New lavatories were completed and some waste land reclaimed for use as additional pens.

THE BIRDS

New additions to the collections in 1959-60 included a flock of Steller's Eiders *Somateria stelleri* and four New Zealand Shoveler *Anas rhynchotis variegata*. Reinforcements of other species included Indian Pygmy Geese *Nettapus c. coromandelianus*, White-backed Duck *Thalassornis l. leuconotus* and Blue Ducks *Hymenolaimus malacorhynchos*.

The Steller's Eiders were caught at Cold Bay, Alaska by Mr. R. D. Jones of the U.S. Fish and Wildlife Service and came to us by way of Delta Waterfowl Research Station in Manitoba. They settled down well and have already provided new information on the moult and behaviour of the species, never previously kept in captivity.



THE BREEDING SEASON, 1960

S. T. Johnstone

SOME twelve hundred birds of ninety different kinds were reared in the two Collections in 1960, the largest number yet, despite the wet weather that marred the summer. Details of the results obtained with each species are set out in Tables 2 (Slimbridge) and 3 (Peakirk). A comparison of the success of artificial rearing among species belonging to the major taxonomic groups (Table 1) is also of interest. The proportion of eggs set which hatched successfully was about one-half, both at Slimbridge and at Peakirk. Differences between the major groups were insignificant, with three exceptions.

The hatch of swan's eggs was very poor. Unfortunately the failures included five Trumpeter Swan eggs, three of them fertile, but none of which hatched. Six Bewick's Swan eggs removed from the nest also failed to hatch, but a brood of four was reared by the parents. The breeding pair of Black-necked Swans at Slimbridge reared a handsome brood of five, now in the Orchard Pen.

The hatching and rearing success of the true geese were also appreciably below the average for all species. This has been found in earlier years too. By contrast, the pochards were unusually successful. The hatch of Mergini (Barrow's and European Goldeneye, Smew and Hooded Merganser) was quite good, but few survived to fledging. Three Hooded Mergansers hatched at Slimbridge, the first to do so, but lived for no more than three days. Most of the other losses of Mergini were due to an outbreak of aspergillosis traced to the accidental use in the nesting boxes of some straw heavily contaminated with fungal spores. This also caused deaths among Ross and Emperor goslings.

The production of eggs by the Hawaiian Geese was 150, against 91 in 1959, but the hatchability fell again, only 25 goslings emerging, of which 20 were safely reared. Five more were reared at Peakirk and four by Mr. Terry Jones at Leckford. The total stock derived from the 1950 importations

now (early 1961) stands at 122, 103 at Slimbridge, 2 at Peakirk, the remainder dispersed in seven other collections. It is intended to keep the Slimbridge population steady at 100. Though none have yet been returned to Hawaii the likelihood of this being permitted has increased. The number in Hawaii is thought to be 125, 76 in captivity and 49 wild.

We have, since 1957, received great co-operation from the New Zealand Government in our effort to acquire a comprehensive collection of waterfowl that are indigenous to the Dominion. In that year four species were caught and sent by polar air route to us at Slimbridge. These were the Grey Duck *Anas superciliosa superciliosa,* Scaup *Aythya novae-seelandiae,* Brown Duck *Anas aucklandica chlorotis* and Blue or Mountain Duck *Hymenolaimus malacorhynchos.* Early in 1960 we heard that the Department of Internal Affairs had hatched and reared some Shoveler *Anas rhynchotis variegata* and in June two pairs of these interesting birds duly arrived. They settled down well after the rigours of quarantine and it is hoped that they will breed. A further two male specimens of the exciting Blue or Mountain Duck also arrived and it is hoped to dispatch us some females of the species in 1961. Having regard to the generosity and trouble taken by the New Zealand authorities on our behalf, we are pleased to report that three of these species have now been bred here: the Scaup since 1958 (and now one of our most prolific ducks), the Grey Duck at Peakirk in 1959 and 1960, and now in 1960 the Brown Duck at Slimbridge.

Breeding of the New Zealand Brown Duck *Anas aucklandica chlorotis*

The two pairs of Brown Duck that came in 1957 have never become very tame and spend a great deal of the daylight hours hiding in the grass and rushes of their enclosure. One pair share a pen with a pair of Cereopsis Geese but neither shows any interest in the other. Nesting sites were provided in the shape of boxes at ground level, cover fabricated from willow wands and cider barrels raised some two feet from the ground. All these were used a great deal as refuges from the public gaze and it was this habit that accounted for the failure to find the nest before the duck commenced incubation. The missing duck was thought to be merely hiding in the cider barrel but when she moved she was seen to be covering some eggs. It was decided to leave her to her own devices and she was undisturbed for three weeks. On going to the barrel after this interval four large creamish-buff eggs were found deserted, two of which were addled and two infertile. These averaged 52 gms. in weight and measured 57 mm. x 42 mm. A point of interest was that there were no broken shells in the nest and a complete absence of down. Although the whistling ducks pull no down and the swans very little, one would not have expected this to be characteristic of a dabbling duck such as the Brown Duck. During this investigation of the nest both birds were invisible in the undergrowth and we assumed that we would have to wait for another year for successful breeding. Two days later, to our immense pleasure and surprise, the duck appeared on her pond with three dark brown ducklings. Both parents and babies were caught up and put into the Guinness Aviary in order to keep them free from the attentions of the Cereopsis and vermin. The food offered consisted of ant's eggs, biscuit and turkey starter crumbs. Some of the crumbs disappeared overnight and may have been

eaten by the ducklings, but from the state of the turf in the aviary it was also apparent that a great deal of nocturnal "worming" was taking place.

The downy duckling shows little contrasting pattern; save for four light spots on the back and a small area of the belly, the overall appearance is of dark mahogany. The bill is large and slate blue in colour and the tarsus is grey. My impression is that they are quite different from any other ducklings we have reared at Slimbridge. Hatched about 17th September, the young appeared to be fully grown by the middle of November.

Other notable successes include the rearing of four young Magpie Geese, twelve Spotted Whistling Ducks, three Laysan Teal, three Hartlaub's Ducks and three Cape Shoveler. Amongst the species breeding most freely, over fifty Marbled Teal and 26 New Zealand Scaup were reared at Slimbridge.

Table 1. Breeding success in 1960 of members of the major taxonomic groups in the collections at Slimbridge and Peakirk. (Records for artificial rearing only).

Tribe	eggs set	eggs hatched	proportion hatched %	young reared	proportion reared %
Dendrocygnini— whistling ducks	47	23	**49**	18	**78**
Anserini (part)— swans	22	3	**14**	1	—
Anserini (part)— geese*	242	98	**40**	65	**66**
Tadornini— shelducks & —geese	113	60	**53**	42	**70**
Anatini— dabbling ducks	1016	539	**53**	405	**75**
Aythyini—pochards	368	230	**62**	188	**82**
Cairinini— perching ducks	347	180	**52**	122	**68**
Mergini— goldeneyes, mergansers	58	27	**47**	7	**26**
Total (including other tribes)	2393	1198	**50**	879	**73**

*excluding Hawaiian Goose

Table 2. BREEDING ANALYSIS 1960—SLIMBRIDGE

The species and subspecies in the following table are listed in the order used in Peter Scott *A Coloured Key to the Wildfowl of the World* (1957). Entries in the column "reared by parents" are additional to those in "reared artificially." No details of eggs laid are given under "reared by parents," because in many cases the numbers laid and lost are not known.

Species and race	reared artificially			reared by parents
	eggs set	hatched	reared	
Magpie Goose	9	3	1	4
Spotted Whistling Duck	12	2	0	12
Wandering Whistling Duck				10
Fulvous Whistling Duck				25
Cuban Whistling Duck	10	4	3	
Red-billed Whistling Duck	25	17	15	
Black Swan				5
Mute Swan	6	0		
Black-necked Swan				5
Bewick's Swan	6	0		4
Trumpeter Swan	5	0		
Swan Goose	15	8	7	
Western Bean Goose	4	2	0	
Pink-footed Goose	6	0		
European White-fronted Goose	7	0		
Greenland White-fronted Goose	8	2	1	
Lesser White-fronted Goose	9	4	4	
Western Greylag Goose	4	0		8
Eastern Greylag Goose				2
Bar-headed Goose	17	10	10	
Lesser Snow Goose	12	7	7	
Blue Goose	8	4	2	
Greater Snow Goose	28	11	3	
Ross's Goose	31	13	7	1
Atlantic Canada Goose				3
Gt. Basin Canada Goose				3
Taverner's Canada Goose				3
Dusky Canada Goose				4
Hawaiian Goose	150	25	20	
Barnacle Goose	19	8	8	14
Black Brant	12	3	1	
Red-breasted Goose	25	12	9	
Ruddy Shelduck	8	8	8	
Cape Shelduck	5	2	2	1
New Zealand Shelduck	6	4	3	
Common Shelduck	7	3	3	
Orinoco Goose	14	3	3	
Abyssinian Blue-winged Goose	17	9	5	
Ashy-headed Goose	6	4	4	5
Ruddy-headed Goose	4	0		
Lesser Magellan Goose	4	2	0	1
Greater Magellan Goose	4	3	2	4
Cape Barren Goose	6	0		1
Andean Crested Duck	6	0		
Bronze-winged Duck	6	0		
Marbled Teal	111	88	53	
Cape Teal	14	9	9	5
Silver Teal	11	0		
Puna Teal	5	0		
Bahama Pintail	7	4	1	
South Georgia Teal	2	0		
Chilean Pintail	10	6	6	
Northern Pintail	29	15	11	
Kerguelen Pintail*	7	5	5	

SLIMBRIDGE, contd.

Species and race	eggs set	reared artificially hatched	reared	reared by parents
Chilean Teal	7	0		
Australian Grey Teal	14	5	2	
Chestnut-breasted Teal	52	?	25	
New Zealand Brown Teal				3
Hawaiian Duck	4	3	3	
Laysan Teal	6	0		3
N. American Black Duck	16	6	6	
Indian Spotbill				3
Chinese Spotbill	28	15	15	
Australian Black Duck				1
Philippine Duck	22	13	13	
African Yellowbill	7	7	3	
African Black Duck	6	5	3	
Gadwall	9	3	3	3
European Wigeon	19	14	14	
American Wigeon	12	4	4	
Chiloe Wigeon	?	?	7	2
Northern Cinnamon Teal	19	7	2	
Garganey				3
Argentine Red Shoveler	14	7	4	
Cape Shoveler	10	2	0	3
Common Shoveler	18	2	0	
Ringed Teal	64	36	22	5
European Eider	9	4	3	
Red-crested Pochard	35	21	11	2
Rosy-bill	42	18	18	3
South American Pochard	14	6	4	
Canvasback	4	3	3	
European Pochard	4	4	4	
Redhead	32	18	18	
Ferruginous Duck	22	?	17	
Australian White-eye	7	6	6	
New Zealand Scaup	30	29	26	
Tufted Duck	13	5	3	
Lesser Scaup	14	7	7	
European Greater Scaup	11	4	1	4
Mandarin Duck	14	4	4	
N. American Wood Duck	212	127	80	20
Comb Duck	10	3	1	
S. American Comb Duck	5	3	3	
Hartlaub's Duck	10	10	3	
Barrow's Goldeneye	9	6	0	
European Goldeneye	16	9	4	
Smew	24	9	3	
Hooded Merganser	9	3	0	
N. American Ruddy Duck	23	?	2	35

*hybrid Kerguelen x (Kerguelen x Pintail)

Table 3. BREEDING ANALYSIS 1960—PEAKIRK

Species and race	reared artificially			reared by parents
	eggs set	hatched	reared	
Black-necked Swan	5	3	1	
Swan Goose	8	4	1	
Lesser White-fronted Goose	1	0		
Western Greylag Goose				7
Eastern Greylag Goose				3
Bar-headed Goose	6	0		
Blue Goose	9	1	1	
Ross's Goose	5	4	3	
Dusky Canada Goose	8	5	1	
Hawaiian Goose	12	6	5	
Barnacle Goose	13	0		
Cape Shelduck	6	6	5	
Common Shelduck	14	8	6	
Lesser Magellan Goose	9	8	1	
Greater Magellan Goose				1
Cape Barren Goose	3	0		
Marbled Teal	9	7	7	
Cape Teal	20	15	10	
Puna Teal	13	2	0	
Bahama Pintail	74	50	32	
Northern Pintail	21	7	7	
Chilean Teal	11	3	3	
Chestnut-breasted Teal	12	9	6	
N. American Black Duck	15	12	10	
Chinese Spotbill	38	15	13	
N. Zealand Grey Duck	24	17	17	
Philippine Duck	62	5	5	
African Yellowbill	8	5	5	
African Black Duck	10	5	5	
Gadwall	45	36	27	
European Wigeon	16	8	3	
American Wigeon	11	10	9	
Chiloe Wigeon	14	0		
Northern Cinnamon Teal	17	15	12	
Garganey	12	5	3	
Cape Shoveler	2	0		
Common Shoveler	47	32	21	
Red-crested Pochard	33	11	8	
Rosy-bill	51	39	28	
Ferruginous Duck	7	7	7	
Australian White-eye	20	19	12	
New Zealand Scaup	8	0		
Tufted Duck	14	10	9	
Lesser Scaup	7	6	6	
Mandarin Duck	9	0		
N. American Wood Duck	87	33	31	
Ruddy Duck				7

THE RESEARCH UNIT

THE research programme is under the guidance of the Assistant Director (Research), Dr. G. V. T. Matthews, whose particular research interests are in the experimental study of migration and navigation. Other members of the Unit, with their main interests are: Senior Biologist, H. Boyd (ringing and population studies); G. L. Atkinson-Willes (wildfowl counts and refuge network); Dr. J. V. Beer (pathology); P. J. S. Olney (viscera analyses and habitat improvement); Dr. S. K. Eltringham (aerial surveys); Dr. Janet Kear (feeding behaviour and nutrition); M. A. Ogilvie (ringing assistant); Miss E. Temple Carrington (secretary); W. A. Cook (Borough Fen decoyman); N. Phillips (laboratory assistant).

Major General C. B. Wainwright, C.B., who operates the ringing station at Abberton, is assisted by R. King and (temporarily) R. Dennis.

March 1960 marked the end of a five year period of grant aid by the Nature Conservancy. Detailed plans for the next quinquennium were therefore drawn up and submitted to the Conservancy. Subsequent action by the Conservancy is described in their Annual Report:-

" The Conservancy have followed other Research Councils in adopting the practice of appointing Visiting Groups, composed of members of the Conservancy or Committees or, in special cases, of other highly qualified individuals, to visit, report and advise on the work of institutes in receipt of grant-aid from the Conservancy. In January, the first of the Conservancy's Visiting Groups, consisting of Mr. A. B. Duncan, Professor J. E. Harris, Lord Hurcomb, Professor C. F. A. Pantin, Professor V. C. Wynne-Edwards, with the Director-General, spent two days at the Wildfowl Trust. They examined the research in progress and talked to all the research staff and discussed the future of the Trust's research programme with the Honorary

Director, Mr. Peter Scott, and the Assistant Director, Research, Dr. G. V. T. Matthews. As a result of their Report the Conservancy have renewed the grant to the Trust in an increased sum for a further five years. The report recommended that the link between Bristol University and the Trust on the research side should be strengthened and that specialised work on parasitology would more appropriately be centred at Bristol than Cambridge University. It was also recommended that application for inclusion in the Federated Superannuation Scheme for Universities should be made on behalf of the scientists engaged in this work, and this has been successfully done."

The grant for the year ending March 1961 was £9,775 (compared with £7,500 in the previous year) and for the year ending March 1962 will be £11,435. There is no need to stress the importance of such massive and increasing support of the research programme; without it nothing like the present breadth of investigation could be maintained. The Trust is indeed grateful. Members would perhaps wish to be reminded that a substantial contribution towards running costs still comes from the Trust's general funds, and all laboratory and other headquarters accommodation is provided by the Trust, together with the research facilities of the collections and decoys. Indeed this is a fine example of a typically British blend of private and government enterprise. The Trust's successful application for inclusion in the Federated Superannuation Scheme for Universities means more than the welcome fact that its officers will now receive superannuation benefits. Membership of the Scheme is restricted to University Departments and to a small number of non-University research institutes. The implicit recognition of the Trust's enhanced scientific standing is thus most gratifying.

As has been the case from the Trust's formation, an important part of our research has been based on the capture, marking and release of birds. 1959-60 was the best season ever for duck trapping (p. 18). Partly as a move to reduce the surplus Mallard population, some twelve hundred birds were released at various distances from Slimbridge. This has given rise to some fascinating observations on orientation behaviour which are summarised on pp. 137-9. Most of the ducks caught at Slimbridge and at Borough Fen were weighed and measured in great detail. These provided normal data to compare with post mortem material and, possibly, to discriminate between individuals of British and Continental origin and to distinguish age classes. A collection of Mallard skins of precisely known age has been built up to assist in the difficult task of discovering age criteria which are reliable after the first few months of life. There are several papers based on duck ringing studies in the present report, at pp. 125, 140 and 144. Under the increased Conservancy grant it has been possible to appoint a Ringing Assistant, Mr. M. A. Ogilvie (from 1st October 1960) at the Slimbridge headquarters to help speed up the correlation and analysis of the growing volume of ringing data. In October 1959 the catch of Pinkfeet fell back to the level before the bumper seasons of 1957 and 1958. As this completed ten years effort on this one species, a full analysis of the results was made. From this it was decided that the value of results was diminishing and the equipment and man-power could be more profitably used for catching other species. The experiments in wader-netting (p. 19) were the first outcome of the change of policy. A liaison visit was made to Gotland in the Baltic to

observe cannon-nets being developed by Swedish game biologists for use on the migrating Barnacle Goose flocks.

A very good idea of the numbers and distribution of the wintering flocks of Barnacle Geese in Europe was obtained by a co-ordinated effort under the auspices of the International Wildfowl Research Bureau (p. 116). The British and Swedish surveys were carried out from the air. The present season's flying (see p. 19) concluded the Trust's period of experimental investigation of aerial survey under British conditions and a very fully documented report was submitted to the Nature Conservancy. Based on 433 hours of flying, this showed that for coastal and riparian species survey from the air is effective and economic and recommends that such surveys should be employed for Barnacle, Brent and Greylag Geese, Shelducks and Swans. The duck population is best covered by the unique network of volunteer ground observers who make the National Wildfowl Counts. These have continued at full strength but with emphasis on the more important, ' priority ' waters. As explained in pp. 40-57, not only are we enabled to circulate a quick assessment of the status of each species *before* the next month's count, but at last it has been possible to arrive at a realistic appreciation of population trends over a long period of years.

The accumulated material of the wildfowl counts has formed the basis of a long series (now almost complete) of appreciations of the distribution of wildfowl stocks throughout the country. These appreciations in turn are the basis of a sound policy of conservation through strategically placed refuges which is now maturing (pp. 23). Co-operation with wildfowling interests has been close on this score (pp. 26). Another very concrete form of co-operation was the supplying of 585 viscera from shot birds for the continuing analyses of food contents. Sufficient material has now accumulated to justify the preparation of papers dealing with the main ecological habitats exploited by Mallard, Teal and Wigeon. Qualitative and quantitative assessments were made of the flora and fauna of the Kent marshes, from which the bulk of the material has come. Other areas were likewise investigated and an experimental planting of known food plants carried out. A complementary approach to the problems of wildfowl food is being made through the study of feeding behaviour and of nutritional requirements. This is possible through the appointment to the staff in October, 1959 of Dr. Janet Kear from the University of Cambridge Ornithological Field Station at Madingley.

Dr. R. B. Klopman, working at Madingley, completed a Ph.D. thesis on social behaviour in Canada Geese. The Trust provided the experimental flock of geese and facilitated and partly financed the field work in Norfolk. At Slimbridge itself the study of behaviour, especially in relation to systematics, received a great impetus from the work of Dr. Paul A. Johnsgard from Cornell University. He came in August, 1959 under a National Science Foundation Fellowship and additional support from a Public Health Fellowship has enabled his studies to continue to April, 1961. Some of the fruits of his efforts are incorporated at pp. 58 and 92. Mr. W. van der Wall from the Max Planck Institute, Seewiesen, W. Germany, spent five weeks at Slimbridge in the autumn of 1959 and another three in the spring of 1960 studying and filming behaviour, particularly of hybrids in relation to the genetics of innate behaviour patterns.

The collection of trachea/syrinx preparations that Dr. Johnsgard has built up for us provides yet one more use for those birds from the collections that die. The collection of skins continued to grow and an appeal for cabinets although answered will have to be repeated in the near future. The interesting method of mounting used by our preparator is illustrated in the photographic section. Mortality in the collection was kept, however, to a reasonably low level. This was largely due to the constant check by post-mortems which are now mainly carried out at the Trust, though Mr. A. R. Jennings, Department of Animal Pathology, Cambridge, continues to give invaluable advice. Weights, detailed measurements and notes of feathering stages were made and systematised. An important development was the progressive ringing or re-ringing of all the adult birds in the collections with the new, very durable, monel leg rings, and the card-indexing of each individual bird so that its history could be followed. This necessary development had hitherto been frustrated by the want of rings that would last as long as the birds.

Dr. F. Steiniger, of the Niedersachsisches Landesmuseum, Hanover, spent several days at Slimbridge taking two thousand specimens of droppings for his investigations of salmonellosis. His findings were reassuringly negative. Miss E. Corning, of Cornell University, spent six weeks at the Trust assisting in physiological research. Dr. P. J. Chapple, Bacteriology Department, Bristol, made a survey of soil and droppings to check on the occurrence of tubercule spores. Outside assistance in the preparation of material, most welcome in view of our limited laboratory facilities, came from Dr. Mary Lobban, Medical Research Council (endocrine organs), Dr. G. W. Storey, National Temperance Hospital, London (routine histological material) and Mr. R. H. Poulding, Pathology Department, Southmead Hospital, Bristol (aspergillotic material). Dr. A. S. King, Veterinary Anatomy Department, University of Bristol, prepared latex air sac casts of species used in the aspergillosis research of Dr. J. V. Beer, whose thesis for a Ph.D. has been accepted by Bristol University which had awarded the studentship under which he worked. The funds for the studentship and, subsequently, salary for two years were provided by the Bristol, Clifton and West of England Zoological Society.

From October, 1960, another Ph.D. student, Mr. R. A. Avery, is working in the Department of Zoology at Bristol University on the parasites of ducks, using material and facilities at Slimbridge. The exhaustive check list of the parasites of the *Anatidae* prepared by Dr. G. Lapage for the Trust on a grant from the Nuffield Foundation is in press.

Liaison with other workers was maintained by exchange of publications and by personal visits. The reference library continued to expand and a new method of binding journals is described (p. 157). Institutes in Sweden and Finland, in Holland and in the United States and Canada were visited by Trust personnel. Among visiting scientists from overseas were, in chronological order, Dr. Paul Errington (U.S.A.), Mr. Boomsang (Thailand), Mr. L-A. Esping (Sweden), Dr. K. Lorenz, Dr. J. Nicholai (Germany), Dr. H. Poulsen (Denmark), Dr. G. Bergman, Dr. L. von Haartman (Finland), Dr. E. Fabricius (Sweden), Dr. W. C. Dilger, Dr. G. Boucher (U.S.A.), Mr. R. Leveque (Switzerland), Dr. J. Koskimies (Finland), Mr. J. A. Eygenraam (Holland).

Wild Geese at the New Grounds, 1959-60

European White-fronted Goose *Anser albifrons albifrons*

67 arrived on 1st October, 1959. They increased rapidly to 130 on 3rd and 710 on 5th. There were 765 on 16th October and the number remained unchanged for nearly a month, increasing to 800 on 11th November, and to about 950 on 20th. By 10th December there were 1430, on 15th 1500. Another influx in mid-January 1960 took the total to 2500 on 16th, and to about 3000 on 22nd. Peak numbers were found in late February and early March—4200 on 21st February, over 4000 on 4th March. Over 3000 were still present on 16th March, dropping to 1600 by 18th and 600 by 22nd. 500 were seen flying off on 1st April and the last three left on 4th or 5th April, 1960.

Though the numbers seen were rather smaller than in 1958-59, 1959 had evidently been a better breeding season than 1958, with 33% of young birds in the early arrivals, 37% in December and still 31% in March, the mean brood size early in the autumn being 3.0.

Greenland White-fronted Goose *Anser albifrons flavirostris*

A group of five (four adults, one first-winter) present from 15th December, 1959 until 4th April, 1960. Another first-year bird seen 12th March, and two more adults from 1st to 4th April, 1960.

Lesser White-fronted Goose *Anser erythropus*

At least three adults seen: one from 27th January to 16th March, another on 11th and 21st February, the third from 7th February to 19th March, 1960.

Greylag Goose *Anser anser*

One on the Dumbles from 22nd to 31st March, 1960.

Pink-footed Goose *Anser brachyrhynchus*

Not seen until 20th October, 1959 when 22 appeared. There were 34 on 31st October, two on 11th November, 15 on 27th November and 18 on 4th December. On 4th March, 1960 a single wounded bird was seen on the river. These were the smallest numbers seen at Slimbridge for many years and their stay was abnormally short. As the rocket-netting teams discovered arrivals in Britain were unusually late and the breeding season had been exceptionally bad, with only about 14% of young birds in the flocks.

Bean Goose *Anser fabalis*

One first-winter bird seen from 17th January to 18th March, 1960. This appeared to belong to the tundra form *rossicus,* rather than the typical yellow-billed *fabalis* more frequently seen at Slimbridge.

Ringing 1959-60

Duck Ringing

Over 9200 ducks were ringed in 1959-60, by far the largest total yet ringed in Britain in a season, thanks especially to an extraordinary catch of Teal at Abberton by Major General C. B. Wainwright and to very good catches of Mallard at Borough Fen and Slimbridge (Table 1). There were no great changes in the marking of other species, except an unusual catch of Garganey at Abberton.

Table 1. Ducks ringed 1959-60.

Species	Abberton	Slimbridge	Borough Fen	Deeping Lake	Other stations	Total 1959-60	Total 1958-59
Shelduck	23	—	—	—	—	23	*38*
Pintail	—	11	2	2	—	15	*15*
Teal	4112	20	210	10	103	4455	*1112*
Mallard	532	1085	2589	—	302	4508	*2705*
Gadwall	2	9	—	10	—	21	*10*
Wigeon	32	2	10	48	—	92	*26*
Garganey	48	3	—	—	—	51	*10*
Shoveler	13	5	9	3	—	30	*51*
Eider	—	—	—	—	—	0	*34*
Pochard	13	—	—	—	—	13	*27*
Tufted Duck ..	25	—	—	3	1	29	*59*
C. Scoter	1	—	—	—	—	1	*0*
Total 1959-60 ..	4801	1135	2820	76	406	9238	—
Total 1958-59 ..	*1110*	*659*	*1866*	*158*	*294*	—	*4087*

No new permanent ringing stations were brought into use, though a sample of 87 Mallard marked at Boulston, Pembrokeshire by A. J. Birt Llewellin, promises to be of some interest. Trapping at Newburgh, Aberdeenshire by Miss E. A. Garden continued to be dogged by difficulties, yielding only 45 Mallard and one Teal. At Deeping Lake, Lincolnshire, too, the catch was small: though it included a welcome number of Wigeon, the numbers of diving ducks marked dropped almost to zero.

Goose Ringing

The tenth autumn expedition in October, 1959 to ring Pink-footed Geese in Scotland and northern England was a disappointing one. Only 1219 geese were caught. There were various reasons why only seven catches could be made: the geese were unusually late in arriving and they included unusually few young birds so that they were less plentiful and more wary than usual, and bad weather, particularly fog, spoiled several chances. The catch included 14 geese marked by the Trust in Iceland in 1953 and 77 marked in Britain between 1952 and 1958, six of the latter having been caught in two previous years.

Attempts to catch Whitefronted Geese at Slimbridge in February 1960 were unsuccessful.

Swan Ringing

The Trust staff made no large-scale attempts to mark Mute Swans during the season, but General Wainwright caught 17 at or near Abberton, Essex and Miss E. A. Garden continued her most interesting ringing in Aberdeenshire.

Wader Ringing

An exploratory catch on the Wash near Terrington, Lincs. in August, 1959, showed that in special circumstances large numbers of waders could be caught with rocket-nets. Further experiments were made in the same area in August, 1960, when seven catches resulted in 2893 waders being caught. The great majority (2110) were Dunlin *Calidris alpina,* but there were useful totals of Knot *C. canutus* (482), Redshank *Tringa totanus* (167), Oyster-catcher *Haematopus ostralegus* (93) and Turnstone *Arenaria interpres* (33), with odd individuals of four other species. The catch of Dunlin included no fewer than 38 already ringed: one from Finland, eight from Sweden, four from Norway, two from Denmark, the rest British, including 17 from the catch in the same area in August, 1959. A British-ringed Oyster-catcher and a British-ringed Turnstone were also retrapped.

The use of rocket-nets for catching waders other than Dunlin requires the development of special skills in the siting of nets, but it is clear that the technique is of great promise, holding out the hope that Britain may at last begin to do as much in this field as the Scandinavians have done. The experiments so far made were undertaken at the request, and with the very active assistance, of the Wash Wader Ringing Group, and have been observed by the Bird Ringing Committee of the British Trust for Ornithology. Future work in this field will also be co-operative, rather than wholly sponsored by the Wildfowl Trust.

Coot ringing

A novel technique was successfully used in the Rushy Pen when 57 Coots (fully capable of flight) were gently walked into a large funnel trap. Already there have been two recoveries in Denmark.

Aerial surveys 1959-60

S. K. Eltringham

OVER 118 flying hours were spent on aerial survey in the twelve months 1st September, 1959 to 31st August, 1960. The largest portion of this time, over 57 hours, was occupied in a further series of flights over the Bristol Channel and Bridgwater Bay, Somerset, to follow up the previous season's surveys of the breeding and moulting Shelduck populations. An important survey was flown in late November and early December, 1959, when 38 hours were spent on a nearly complete census of the Barnacle Goose throughout its range in Scotland and Ireland. The remainder of the flying time was divided between a variety of smaller projects. Some 8 hours were devoted to two surveys of Brents on the east coast of England in December and February, 1959, and a further 8 hours to experimental flights to test the utility of aerial counts of the Mute Swan. These various surveys will be discussed at greater length below.

As in previous years, most of the local flying was carried out from Staverton Airport, between Cheltenham and Gloucester, using an Auster 5D of the Cotswold Aero Club. Our previous experience having taught us that

it is unwise to take hired aircraft away from base because of the possibility of bad weather delaying the return, the Brent surveys in Essex and Norfolk were made with aircraft hired from flying clubs at Ipswich, Skegness and Fakenham. The Barnacle survey was flown with aircraft hired from Skycraft Services Ltd., Dublin. The survey was commenced with an Auster Aiglet but, following an accident, was completed in a de Havilland Rapide, a twin engined biplane which proved to be an effective survey machine. The risk of damage to light aircraft operating from unsuitable fields is such that in future only longer-range twin-engined aircraft will be used in Ireland. Their extra safety in the event of an engine failure and their greater power under turbulent conditions are also of considerable value over the sort of country in which the geese are found.

Details of surveys flown

Mute Swans

These surveys were made in May and June, 1960, and were intended to test the technique of counting nesting swans and non-breeding birds. A repeat census of the Mute Swan is planned for 1961, following the publication of the results of the 1955/56 census conducted by the British Trust for Ornithology, and it was hoped to find whether aerial survey could make an important contribution to the proposed census. The aerial method was found to be highly successful. The number and location of nests and breeding pairs, brood size and the distribution of non-breeding birds are easily assessed from the air. The method is most effective in studying the distribution along rivers, which are much less easily followed on the ground. An average of about 150 swans per hour were recorded on the surveys flown over rivers and canals in the midlands and southern England.

Barnacle Geese

The results of the survey are included in the paper on pp. 116-124 of this Report. The importance of this survey lies in the fact that it is the first time that a near-simultaneous count of the Barnacle Goose has been made throughout its entire wintering range.

Brent Geese

Some counts of the Atlantic Pale-bellied race of the Brent Goose were made during the Barnacle survey in Ireland. The census of the Irish wintering population of this race could not be completed because of operational difficulties, but the searches made formed a useful preliminary to combined censuses from the ground and the air to be carried out in the winter of 1960-61.

Two surveys of the Brent Geese (predominantly of the Dark-bellied race) in eastern England were attempted. This race is found chiefly on the Essex and north Norfolk coasts and the Wash. The first survey in December, 1959, was seriously affected by the weather. Greater success attended the second survey flown in late February, 1960, when the flying was completed as planned on two consecutive fine days. A total of 4,600 Brent were recorded of which 3,170 were in Essex. The existence of an extensive cover of the Essex coast by the Essex Bird Watching and Preservation Society has enabled interesting comparisons to be made between aerial and ground counts.

In general, agreement has been good; for instance the present aerial figure of 3,170 on 27th February, 1960 fits nicely between totals of 3,790 and 2,320 recorded on 14th February and 13th March by the Essex bird watchers. An attempt to follow this survey by an aerial census of Brents in Northumberland and Durham was abandoned after two fruitless days spent in watching the weather from Newcastle-upon-Tyne Municipal Airport. There did not appear to be many geese in northern England at that time since a ground search found only 120 Brents on Fenham Flats, Holy Island, and none at all at Teesmouth on the Durham/Yorkshire border, the only places where Brent might have been expected in any number.

Shelduck

The extensive series of flights over Bridgwater Bay in 1959 were reported in the *Eleventh Annual Report,* pp. 107-117. These results suggested that there were two or possibly three waves of immigrants in July, (August) and September of which the first left without moulting. Moulting birds were found from August with a peak in early September. There was evidence of a further concentration of moulting birds in October. The repetition of these surveys in 1960 has enabled us to put these early conclusions upon a firmer footing. There were, as in 1959, two well defined peaks in the total number of birds, falling in July and September. A smaller August peak, suggested in 1959, was more clearly seen this year. The concentration of birds in August tends to be obscured by a larger influx arriving throughout the latter part of the month and reaching a peak in mid-September. An interesting feature of the 1960 results was a prominent increase in numbers towards the end of October. Although numbers were high at this time in 1959, no definite peak was detected.

The concentrations of moulting birds were found chiefly in August and September although the first to be found were seen on 26th July. There was again no evidence to suggest that the majority of the Shelduck present in July were other than passage birds. There was less apparent fluctuation in the numbers of moulting birds in 1960 than in 1959, but this is probably a reflection of an improved technique in assessing them. The previous method of estimating the proportion of flightless birds from a low level run was abandoned in favour of a direct count of all birds that remained on the water as the aircraft passed over at 300 ft. It has been found from experience that Shelduck are in moult if they do not fly under these conditions. The 1960 results tend to confirm the 1959 conclusion that there were three peaks in the number of moulting birds, falling in August, September and October. The August and September concentrations occur within a few weeks of each other with the September birds arriving before the August flocks have completed the moult. There was, however, a pronounced gap between the September and October moulting populations since no flightless birds were seen between 15th September and 25th October. The Shelduck which are going to stay in the area must shed their flight feathers very soon after arriving in Bridgwater Bay, since the periods of maximum numbers of flightless birds coincided with those of the total population.

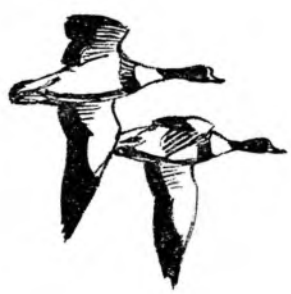
Although the pattern of Shelduck movements in Bridgwater Bay during 1960 was similar to that of 1959, the total numbers present were rather less. The maximum number recorded in September, 1960 was 2,000 compared with

the 3,300 counted in the same month in 1959. The maximum number of moulting birds was correspondingly lower (1,760 : 2,750).

The breeding populations in the Bay and the upper reaches of the Bristol Channel were again studied earlier in the season. The more frequent flights in 1960 revealed an interesting decline in numbers during May. This phenomenon can be interpreted as being due to the absence of females from the area on nesting duties, and raises the somewhat novel possibility of measuring the breeding intensity from negative evidence. This " breeding dip " was most marked along the northern shore, suggesting that this was the more important breeding area. The departure of the local Shelduck, presumably to the German moulting grounds, was clearly detected and occurred in the early part of July. The number of juvenile Shelduck in 1960 showed a decline in July and early August similar to that recorded in 1959. This decline is unlikely to be entirely due to mortality; dispersal may be of equal, if not greater, importance.

Miscellaneous flights

Few other flights were carried out during the period under review, but one survey of value was made of wildfowl and habitats on the shores of Cardigan Bay. The flight was made from Staverton with refuelling stops at Swansea and packed over 6 hours flying into a short January day. Its main purpose was to supplement data from areas of West Wales, for which information on wildfowl was incomplete, for a national review being prepared by G. L. Atkinson-Willes. The survey showed close agreement with ground counts in the better known localities but found no large, hitherto unknown, flocks of wildfowl. The advantages of aerial survey were clearly demonstrated on this flight which established information that would have required several days of difficult travel to confirm from ground observation.



SECTION II

CONSERVATION AND RESEARCH

NATIONAL WILDFOWL REFUGES

Wildfowl Conservation Committee

In 1954 the Nature Conservancy began to hold a regular series of informal meetings with leading wildfowlers and conservationists, including representatives of the Wildfowlers' Association of Great Britain and Ireland, the British Field Sports Society and the Wildfowl Trust. At that time the feelings aroused by controversial parts of the Wild Birds Protection Act of 1954 had produced deep divisions between wildfowling and "protectionist" interests, but the meetings have been notably successful not only in achieving the reconciliation of diverse views but also in achieving active co-operation. It is now recognised that an adequate and suitably administered series of wildfowl refuges form a desirable and, in some conditions, an indispensable means of conserving and increasing wildfowl stocks, in which wildfowlers are no less interested than protectionists and scientists. Three refuges have already been set up, on the Humber, at Southport and at the Caerlaverock National Nature Reserve. It is intended to develop a National System of Wildfowl Refuges which will form the main British contribution to a projected international network of European refuges. The plan for this system has been in recent years one of the principal concerns of the informal group.

In December, 1960 the Nature Conservancy announced that, in view of the importance of the work of the group in this respect, it was to be formally constituted as the Wildfowl Conservation Committee, with the status of a special advisory committee of the Conservancy. The terms of reference of the Committee are: "To consider all matters affecting wildfowl, in particular the establishment of a National System of Wildfowl Refuges, and to advise the Nature Conservancy accordingly." The committee consists

at present of nineteen people with Mr. E. M. Nicholson, C.B., Director-General of the Nature Conservancy, as its Chairman. Three other members of the Conservancy staff also sit on the Committee: Dr. J. Berry, F.R.S.E., Dr. E. B. Worthington and Mr. R. E. Boote. The Wildfowlers' Association has six representatives: Colonel J. N. Vallance, O.B.E., T.D. (Chairman of W.A.G.B.I.), Lieut. Cdr. J. W. Anderton, V.R.D. (Hon. Sec. of W.A.G.B.I.), Mr. J. L. Hirst, Brigadier G. D. Holmes, O.B.E., Mr. E. L. Parish, M.B.E., and Dr. G. W. Storey. The British Field Sports Society has three representatives: Major J. G. Morrison, T.D., D.L., J.P., M.P. (a member of the Nature Conservancy), Brigadier A. H. Pepys, D.S.O., and Colonel Sir Ralph Clarke, K.B.E. There are two independent members: Colonel H. J. Cator, M.C. and Major General C. B. Wainwright, C.B. General Wainwright is of course a member of the Council of the Wildfowl Trust, which is officially represented by the Hon. Director, Mr. Peter Scott, C.B.E., D.S.C., and three members of the staff, Dr. G. V. T. Matthews, Mr. G. L. Atkinson-Willes and Mr. H. Boyd.

During 1960 an informal working party drawn from the group met on three occasions to consider in detail the present distribution of wildfowl in Great Britain and to make preliminary suggestions about the policy for wildfowl refuges and about possible sites. This working party comprised Mr. E. M. Nicholson, Dr. J. Berry, Lieut. Cdr. J. W. Anderton, Dr. G. W. Storey, Mr. Peter Scott, Mr. G. L. Atkinson-Willes and Mr. H. Boyd. Their discussions resulted in a statement on general policy which was subsequently accepted by the Committee and which is reproduced below.

A Policy for Wildfowl Refuges

1. **The Purpose of Wildfowl Conservation**

   (a) To safeguard the species of wildfowl. Although no British wildfowl are in danger of world extinction, the moral responsibility of preventing such a possibility must be set above all other issues.

   (b) To maintain existing stocks in at least their present strength and *in their present distribution*; this being not only a human requirement based on the pleasure that wildfowl give to many people, but also a biological necessity in order to maintain the ecological relationships between wildfowl and other animals and plants. The main factor to be considered is not so much immediate disturbance as the outright loss of habitat through development or unsuitable management.

2. **The Role of Refuges in Wildfowl Conservation**

   (a) In the case of a species with a limited distribution in this country, Refuges may be needed to safeguard some or all of its main resorts. Should the species be readily identifiable, statutory protection may be a more suitable measure; if this is not practicable or adequate the necessary Refuges should be given priority.

   (b) More usually a Refuge will serve as a strongpoint for a number of species to ensure their status in the district. Such Refuges will form wildfowl reservoirs, increasing the stock to the advantage of sportsmen and naturalists alike, and will also provide centres from which some of the less common species may be encouraged to extend their range.

(c) Refuges may likewise be used to mitigate the local effects of overshooting or unsporting practice, while still affording controlled shooting to responsible wildfowlers.

3. **International Co-operation**

Finally, as wildfowl are migratory, there is the international aspect and the need for Great Britain to continue to play a full part in the European field of conservation, so that all countries may be brought to fulfil their responsibilities for conserving and increasing the stocks.

The Wildfowl Trust and Refuges

It may be helpful to place on record the ways in which the Trust seeks to promote wildfowl conservation. It is a major function of the Research Unit to obtain and present the factual evidence on which sound policy decisions must be based. In particular, Mr. G. L. Atkinson-Willes has prepared a long series of regional reviews of status and distribution which are now being revised and re-cast for publication in 1962, or as soon as possible, to provide a yardstick against which future changes in the wildfowl scene can be measured. Several hundred collaborators in the National Wildfowl Count scheme have made an indispensable contribution to this review, as have the members of most of the wildfowling clubs affiliated to W.A.G.B.I. Many other parts of the Trust research programme are also intended to increase knowledge of how wildfowl populations behave and so bear directly on conservation practice. In too many cases it is still necessary to act on opinions rather than a sufficiency of facts. In such cases the Trust is at least able to draw on a breadth of experience unlikely to be attained by more than a very few private individuals.

The Trust does not itself seek to establish and maintain refuges, though actively interested in the management and research plans of the Conservancy for those National Nature Reserves of importance to wildfowl. The Trust is eager to help and support local schemes for refuges, providing that these appear to be in conformity with the national needs. It is particularly anxious to encourage plans which are the concern of a variety of interests such as, for example, those produced by a wildfowling club and a naturalists' trust acting together. Individual members of the Trust can do valuable work for wildfowl conservation in this field, by keeping watch on activities threatening existing wildfowl haunts and by actively encouraging " combined operations " to stave off or minimise such threats.

THE WILDFOWLER'S ASSOCIATION'S CONSERVATION PROGRAMME

Lt. Cdr. J. W. Anderton

Hon. Secretary, Wildfowlers' Association of Great Britain and Ireland

I welcome the opportunity of being invited to contribute an article on the work of the Wildfowlers' Association of Great Britain and Ireland, the more since the invitation recognises, in particular, the contribution we are making in the interests of conservation of wildfowl, and the efforts being made to educate the new entrant to the sport along the proper and recognised path of true gun sportsmanship.

W.A.G.B.I., formed in 1908, has always appreciated the need for reserves or refuges for wildfowl but until recent years has found itself unable to assist in their creation since it felt that in a number of cases there was a likelihood of proposals emanating from persons who were more interested in stopping shooting altogether than catering for the genuine needs of wildfowl. W.A.G.B.I. also recognises the need to control the activities of irresponsible persons whether carrying a gun in the guise of a shooting man or carrying binoculars in the guise of a bird watcher.

The coming together of wildfowlers and naturalists under the auspices of the Nature Conservancy has led to the establishment of a certain amount of confidence, which is growing, and W.A.G.B.I. does recognise that one of its main responsibilities is the provision of sensible and properly sited refuges which will cause the least inconvenience to the genuine wildfowler since without proper provision growing industrialisation, drainage of habitat and the ever-increasing demands in the interests of sailing, fishing, water ski-ing etc. will, in a very short space of time, mean that the minimum level of undisturbed waters will have been reached. For this reason W.A.G.B.I. is prepared to co-operate for this purpose with persons and organisations which have no axe to grind and which are prepared to make reasonable allowance for the wildfowler's point of view. W.A.G.B.I., accordingly, has been, and is, working in close harmony with the Trust and Nature Conservancy on an overall review covering the entire country, and we have already made the first approaches to those of our affiliated local clubs and associations in whose areas refuges have been suggested. The reactions generally have been excellent, with the affected organisations submitting their own suggested schemes.

The entire success of the National Wildfowl Refuge Scheme depends upon a number of basic principles and in order to name them in their proper sequence I would say that firstly the confidence and assent of the affected local club or association is essential. This, so far, has been forthcoming, since on each occasion we have experienced a desire by the true wildfowlers to see that the sport in its proper form be maintained and, therefore, they are eager to see certain areas closed to so called 'fowlers who, so very frequently, are nothing more than 'gun toting' irresponsibles who have little or no regard for the law, or respect for the real spirit of an ancient but honourable sport.

Other basic principles are that a statutory refuge shall be completely effective and inviolate and to this end we are insisting that every refuge shall be properly wardened and maintained by a joint committee comprising, in

equal representation, sportsmen and naturalists. Finally, all refuges must have the full support of the police which hitherto, in certain areas, has not been as effective as it might have been. Unless a refuge can be safeguarded we are, all of us, wasting our time.

The wildfowler will support any reasonable and sensible scheme that in turn will provide more 'fowl but what he will not tolerate is underhand and completely insincere motives. He realises, as does the enlightened conservationist, that only by joint action can the wildfowl of these islands truly prosper and it is this vital factor that must be continually recognised and strengthened. However, the wildfowler is also a practical conservationist with more and more of our clubs and members coming to realise the importance of, and indeed tremendous satisfaction in, ' putting back.' They have taken the place of the disappearing estate owner who reared duck in large numbers prior to the last war.

The W.A.G.B.I. sponsored conservation programme is based upon a series of reserves controlled by local clubs and associations. These are non-statutory and therefore have no connection with the national reserves or refuges already referred to but are used for establishing hand-reared wildfowl in order that the local nesting and winter holding potential shall be improved. The scheme is a means of improving sport in areas beyond the confines of reserves. Lakes, bogs, saltings and ballast waters already are in use and are proving of the greatest value, particularly in the case of the latter. It is on new ballast waters that experiments in habitat improvement are being carried out and with natural habitats all the while decreasing in both size and number the importance of such experiments can be appreciated.

The rearing and release of Mallard on to reserves has been given top priority by The Wildfowlers' Association since its importance affects us all. So also has the all-important ringing of released duck, providing a vast additional potential of interest both elementary and scientific. In 1958 when the scheme formally began, 1,043 mallard were liberated with a 4.6% first year recovery rate, whilst in 1959 releases totalled 3,389 with a 4.5% first year recovery rate. Figures for 1960 are not yet complete but it is hoped that the target of 5,000 releases will have been achieved.

Ringing recoveries have confirmed that the majority of birds released remain fairly sedentary, the low recovery rates indicating the true value of local reserves. 86% of recoveries are in the county of release, but the remainder have been proved to disperse far more widely than was expected of them, since recovery details have been forwarded from Latvia, Poland, Sweden, Denmark, Holland and Belgium, no doubt most of these being abmigrants. Even so a surprising number of recoveries have been made abroad in the autumn of the year of release. Recoveries within the British Isles show that the movements represent a dispersal in all directions but with an easterly bias. Studies are now progressing into the breeding successes of hand-reared birds, into summer mortality and whether there are any significant differences resulting from different rearing methods or between the sexes, and in due course movements of hand-reared birds will be compared with those that are wild-caught. On a smaller scale the scheme may well be extended to other species of duck, the Gadwall being an obvious choice and one which is already being kept in captivity by some of our local associations.

In 1957 the task of removing surplus Canada geese from estates and their subsequent transportation to new areas was handed over to the Wildfowlers' Association by the Wildfowl Trust since which time some hundreds of geese have been moved, adults and young being caught up during the flightless period in late June and July. However, the dangers of this scheme are fully realised, since the quick build up of flocks might well become a menace to agriculture, but to date their controlled introduction and establishment in new areas has proved popular and interesting, not only to wildfowlers and naturalists alike but to the general public also. Canada Geese nesting on artificial rafts placed on ballast water reserves have already been recorded in an early Wildfowl Trust Annual Report.

As a result of the Canada Goose scheme useful experience has been obtained which now has a bearing on our scheme to reintroduce the Greylag into England as a truly wild but home breeding goose. In the summer of 1959 the scheme was initiated with the catching up of some birds from a feral flock in the North of Scotland which have now been established in three sites in England which are wild in the extreme.

From rearing to a form of research that could not have been carried out without the assistance of the wildfowler, mention must be made of the Viscera scheme now, in 1960/61, in its fourth year of operation, during which time well over 2000 specimens have been supplied for food analysis investigations. Initially the majority of these specimens came from Kent and it is there that the first practical results are becoming apparent in the form of a planting scheme based on food preferences as shown by viscera analysis. It would appear that the possibilities resulting from this close co-operation between our two organisations are both manifold and exciting.

The Wildfowlers' Association, then, is advancing along sound lines in the field of conservation but there are many other aspects claiming its time and attention, the chief of which is the constant education of the new entrant to the sport of wildfowling, since we believe that the whole future of the sport depends upon the younger element having a clear understanding of the true art of wildfowling. He must be able, at a glance, to recognise each bird that he is likely to encounter which, coupled with a sound grounding of what is and is not protected, will enable him to remain on the right side of the law. He must know the seasons and abide by them just as he must know when a bird is in range or not. The new—and not so new—entrant must have a sound knowledge in safe gun handling, marshcraft and the necessary equipment which includes life saving gear such as a torch, whistle, compass, etc. He must understand and be able to recognise the foreshore dangers such as tide, fog and wind and above all he must learn to realise that greed is not necessarily the true hallmark of a good 'fowler. 50 geese under the moon in one night may prove him to be a good shot but it does not mean that he has the true interests of the sport at heart.

These then, and others, are some of the vital matters that W.A.G.B.I., through its local affiliated branches, of which there is a total of close on 120 (January, 1961), is trying to encourage and we are more than pleased that our efforts are being recognised and that they are leading to mutual co-operation, understanding and tolerance.

THE IMPORTANCE TO WILDFOWL OF THE RESERVOIRS IN ENGLAND AND WALES

G. L. Atkinson-Willes[1]

DURING the past twenty years the wildfowl of Great Britain have been more seriously threatened by the loss of their natural habitat than by any other single factor. Quite apart from numerous drainage and development projects in every part of the country, there has also been a marked tendency for more and more waters to be rendered untenable by disturbance. The reasons behind this new trend are legion; the big estates which once afforded a great measure of security to wildfowl have now become scarce; farming is more intensive; people have more leisure and greater mobility than ever before; and finally, as a result of all this, there is a new and vigorous demand for water as a recreational amenity. Sailing, fishing, water-skiing, hydroplaning, aqua-lung diving and even bird watching, all these are sports or pastimes in competition with wildfowl interests.

Against this general background the reservoirs stand out as one of the few saving graces; for here the trend is in the opposite direction. Any growth in the human population is at once accompanied by demands for more water, both for domestic and industrial use, a requirement which in many cases can only be met by the creation of great new lakes. The constant encroachment over the natural resorts of wildfowl is thus partly offset by the provision of artificial habitat. The water authorities regard this in a rather different light; their sole duty is to provide pure and wholesome water as cheaply as possible and they maintain, perhaps rightly, that their task is not helped by the presence of large flocks of birds. Wildfowl, however, are more readily tolerated than the general public, and in most places the flocks are encouraged by the freedom from human disturbance.

These preliminary remarks are enough to show that the reservoirs comprise a separate and rather specialised form of habitat. The purpose of this paper is therefore to examine their value from a national viewpoint, and more particularly to assess their possible contribution towards the current programme of wildfowl conservation. In the present context the term "reservoir" refers only to those used for domestic purposes; the much less common canal and industrial reservoirs lack the same strict control of public access, and so fall into a somewhat different category.

The total number of these drinking water reservoirs in England and Wales amounts to just under 550, and their total area to 35,000 acres or nearly 55 square miles. Three-quarters of them, however, may be dismissed forthwith as being either too high and bleak, or else too small to be of any great value to wildfowl. 268 reservoirs, for example, cover less than 20 acres; 51 lie at altitudes of a thousand feet or more; and a further 90, at slightly lower level, are set on open moorland with neither food nor shelter in the vicinity. In the north of England, in particular, the hill reservoirs along the Pennines seem to be almost completely barren. Sample counts show that at

[1]This paper has also appeared in *The Journal of the British Waterworks Association*, vol. XLIII, No. 354 : 151-4. March, 1961.

least thirty of them are most unlikely to carry even 50 ducks, and a further 35, including such big places as Thirlmere (812 acres), Ladybower (504) and Catcleugh (265) almost certainly fall into the same category. Equally unimportant are Lake Vyrnwy (1100) in Montgomery, the three big Birmingham reservoirs (1250) in Radnorshire, and a further ten in Wales and Devon. The effective number of reservoirs in the country is thus reduced to 140, and the total acreage to less than 22,000.

The question now arises as to the population which an inland water must carry before it attains national or even regional importance. Judging from the wildfowl count data, places carrying up to 250 ducks are common enough in all lowland areas of England and Wales; on the other hand gatherings of over 500 are relatively scarce, and ones of a thousand or more can safely be described as main centres of population. This, of course, gives no indication of any special importance a place may have for one particular species, but it does nevertheless help to put the reservoir populations into perspective. If a gathering of 250 ducks is the smallest that can be said to have any real importance, then the list of effective reservoirs is reduced to 50. It would be wrong, however, to dismiss without comment the other ninety places with populations of less than 250; individually their contribution may be small, but collectively they fill a very real need. One of the main problems of wildfowl conservation is to maintain the existing stocks not only at their present strength, but in their present distribution, a task which is made much easier by this network of undisturbed habitat all over the country. At one time it was the big estates which afforded most of the unofficial refuges in Britain, but now the smaller reservoirs have very largely taken their place. It is perhaps unlikely that they will ever be incorporated into the national system of wildfowl refuges, but their good effect is none the less relied upon.

With the more populous reservoirs the situation is rather different; for each is important in its own right, and the loss of any one might upset the whole balance of conservation. The 50 reservoirs that are known to carry more than 250 ducks are therefore treated in greater detail. In Table 1 they are grouped by regions into three categories, according to the peak numbers which are likely to appear on them in the course of a normal season. Where several adjoin each other, they are taken as a single entity; the actual number of pools being shown in brackets.

The most striking feature is perhaps the big concentration of important reservoirs in the southern and eastern districts of England, particularly in Essex, greater London, Northampton, Leicester and Somerset. In these five counties lie no fewer than 24 of the 29 places with over 500 birds, and all but one of those with 1000 or more. Of the others, Blithfield in south Staffordshire, Weirwood in Sussex, and Talybont in Brecknock all fall more or less into the same pattern, leaving only Eccup and Leighton, both in Yorkshire, as the main strongholds in the north.

The reasons for this uneven distribution need not concern us now; suffice it to say that the reservoirs in the south and east have the double merit of being not only suitable for ducks in large numbers, but of being in the right place as well. It is in this part of the country that the great majority of the European migrants make their first landfall, and it is here that many are content to remain, provided that they can find enough places to their liking.

Region	Level of Peak Population		
	250-500	500-1000	Over 1000
SOUTH & WEST	Darwell	Weirwood	—
THAMES BASIN	Wm. Girling Hillfield Foxcote	King George V Walthamstow (12) Hampton & (4) Kempton Lonsdale Road Island Barn W. Molesey (7)	Abberton Hanningfield King George VI Staines (2) Barn Elms (4) Queen Mary
SEVERN BASIN	Barrow Gurney (3) Shustoke (2) Llanishen	Sutton Bingham Talybont	Durleigh Cheddar Blagdon Chew Valley Lake
WASH	Cransley & Thorpe Malsor	Ravensthorpe	Pitsford Hollowell Eyebrook
HUMBER BASIN	Blackbrook Langsett Swinsty Lindley Wood Gouthwaite	Swithland Eccup Leighton Stanford	Cropston Blithfield
BORDER	Lockwood Coltcrag Fontburn Hallington	—	—
N.W. ENGLAND	Stocks Delph Haweswater	—	—
WALES	—	—	—
	21	14	15

Table 1: The distribution of reservoirs known to hold regular peak populations of more than 250 ducks. Five water undertakings in the Wash region are omitted; four comprise areas of the Norfolk Broads, which are classed as natural habitat; for the fifth area near Boston there is no information available, but it is presumed to carry more than 250 ducks.

For them the reservoirs have afforded alternative and in some cases additional habitat in the parts where it is needed most. Diving ducks, in particular, have benefitted from the new feeding grounds at their disposal, whilst for the dabbling ducks, the provision of a secure roost has in many cases open up a fresh tract of country for them to forage over.

Just how valuable the big reservoirs are may be judged from Table 2 which shows the mean level of population for various species during the months that they are most numerous. Calculated from the three highest counts between September and March of each year, the figures are designed to stress the sustained level rather than the temporary influxes which at times occur. Nevertheless some of the exceptional peaks are well worth noting. Abberton, for example, has as various times carried up to 4000 Mallard, 12,000 Teal, 5000 Wigeon and 3800 Pochard; Barn Elms has held up to 2300 Tufted; and Chew Valley Lake more than 1000 Shoveler.

	No. of years counted	Mallard	Teal	Wigeon	Shoveler	Pochard	Tufted Duck	Golden eye
Abberton (1940)	11	1250	2950	1700	150	1200	250	175
Chew Valley Lake (1953)	6	625	525	1275	225	375	350	10
Blithfield (1952)	7	1000	500	850	50	225	250	35
Pitsford (1955)	6	675	325	1525	20	400	200	20
Hollowell	3	975	125	900	10	125	50	5
Hanningfield (1954) ..	5	450	350	225	35	350	250	10
Blagdon	12	350	425	400	40	325	225	10
Eyebrook (1940)	12	700	225	800	10	100	10	5
Staines	9	300	25	100	15	250	550	10
Barn Elms	12	200	50	10	—	350	650	—
Cropston	11	375	325	425	5	25	40	—
Durleigh	11	100	250	225	50	175	75	5
King George VI (1947) ..	9	600	200	100	60	10	75	5
Cheddar (1938)	12	100	175	20	15	500	100	10
Queen Mary	9	425	25	20	25	50	325	10

Table 2: The average carrying capacity of the 15 most important reservoirs in England and Wales, calculated from the three highest counts in each year for which full data are available. The reservoirs are arranged in a rough order of merit, dependent on the total number of birds and on the value to individual species. The figures in brackets after the place names denote the date of first flooding.

Taken as a whole these various population comprise a significant proportion of the national total. From a very rough estimate of the peak numbers occurring in England, Scotland and Wales it seems likely that the 16 reservoirs mentioned above may now hold as much as 3% of all the Mallard in the country, 4% of the Teal and Wigeon, and 15-20% of the Pochard and Tufted. Moreover this is quite a new development; for no fewer than eight of the largest and most important reservoirs have all been flooded within the past 25 years.

In view of this massive contribution towards wildfowl conservation one should perhaps try to forecast what might happen in the event of the water authorities relaxing their present strict control over public access. Information on this and on the effects of various forms of disturbance is not easy to come by; all too often any change in population is equally attributable to other factors, such as the creation of a new reservoir nearby, or the loss of local feeding grounds through development. In the west Midlands, however, A. R. M. Blake found that the canal reservoirs around Birmingham provide a number of fairly clear cut examples. Motor boats, he says, are the worst possible form of disturbance, followed by sailing, fishing from rowing boats, and fishing from the bank. Shooting is seldom if ever a problem, the majority of owners and tenants being only too keen to maintain a good stock of birds.

To quote a specific instance, the 150-acre canal reservoir at Cannock used at one time to carry a small but varied population of both dabbling and diving ducks throughout the winter months, this despite the fairly constant attention of local gunners. Since 1956, however, sailing has been allowed, and the place is now frequently deserted. The most seriously affected are the dabbling ducks; both Teal and Wigeon have virtually disappeared, and even Mallard are reduced to odd pairs. Diving ducks still occur, at times in some strength, but big flocks are less common and there are many days when none at all are present. Other examples of disturbance are found at Belvide reservoir nearby, where fishing takes place both from

the bank and from boats. The effect here is that birds will not remain within 150-200 yards of either a moving or a moored boat, nor within 100 yards of someone on the bank. When there are a number of fishermen, both ashore and afloat, the whole 175 acres of water is rapidly rendered untenable. A great deal, of course, depends on the duration of the disturbance; if it only happens at weekends, and if an alternative resort is available, then no lasting harm is done. This is very much the experience elsewhere. At Cheddar, for example, there has been sailing every weekend for several years, but the Pochard flock is still the third largest on any reservoir in England. When disturbed they usually circle for a while and then make off either towards the coast or else over the Mendip to the other Somerset reservoirs, not returning until all is quiet. In other words the immediate result of disturbance is likely to be the same wherever it occurs, although in some cases the after-effects may be mitigated by other factors.

In summer the situation is more serious, especially on reservoirs with natural banks and a big breeding population. At this time even small amounts of disturbance at infrequent intervals are enough to keep birds away from their nests, and to curtail the potential output. In this respect any place carrying more than 20 pairs of breeding ducks should certainly rank as important.

This discussion on disturbance may perhaps seem academic in view of the present policy of the water authorities, who as a body are firmly set against any form of human interference with their reservoirs. The fact remains, however, that in individual cases there has already been some relaxation. Sailing not only takes place at Cheddar, but is now starting at Pitsford as well, whilst fishing, mainly for trout, is an accepted feature at a number of places. The object of this paper has therefore been to pinpoint the reservoirs which really matter to wildfowl, so that a case can be made for keeping them as they are. There is no use assuming a dog-in-the-manger attitude, demanding that all reservoirs be instantly declared inviolate refuges; all one can ask is that very special thought be given before wildfowl are denied these new resorts as well as the old. Only 15 of the 550 reservoirs in England and Wales are of prime importance to ducks, and only 8000 of the 35,000 acres of water; this at least should leave room for compromise.

Acknowledgements

I am indebted to Mr. Leonard Millis, O.B.E., the secretary of the British Waterworks Association; for permission to use the information on reservoirs contained in the Association's Year Book, and am gratified that this paper should also have been published in the Association's Journal. Information on the wildfowl of the reservoirs is drawn from the Wildfowl Counts; in this case I am equally grateful to the observers who have collected the data, and to the Nature Conservancy for giving financial support to the scheme for so long.

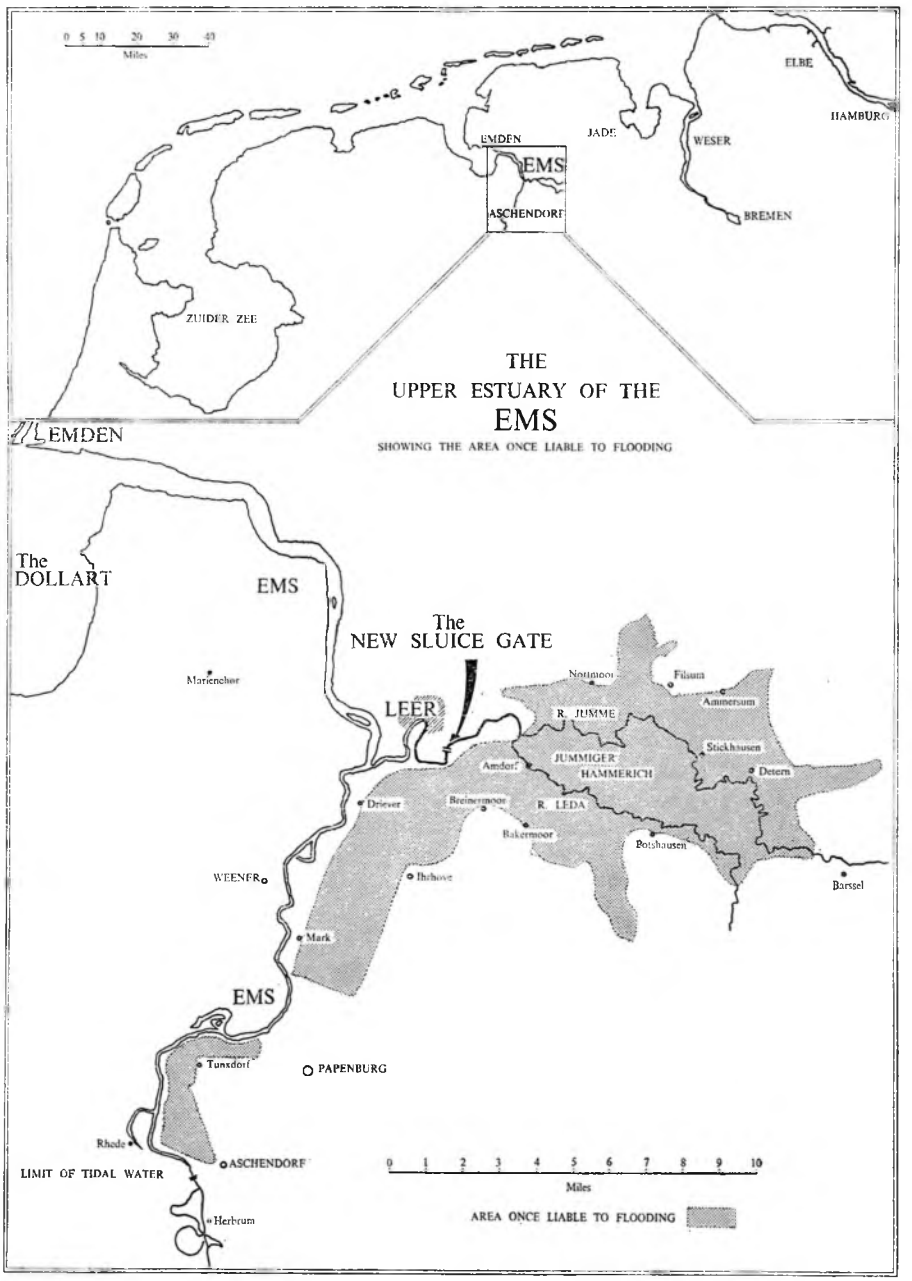
EMSLAND WITHOUT WILDFOWL

G. L. Atkinson-Willes

THIS is intended partly as a piece of nostalgic reminiscence, but more especially as a warning of the constant pressure that is being exerted on wildfowl habitat throughout North-West Europe. It is the story of how, during the past five years, a big drainage scheme on the marshes of the lower Ems has robbed many thousands of ducks and geese of one of their main wintering grounds in western Germany, and thereby upset a tradition of many seasons standing. What the final repercussions will be, it is still too early to say, but for a population of this size alternative resorts must become increasingly difficult to find.

To many people, who served in B.A.O.R. during the first ten years after the war, the Emsland will already be well known as the scene of numerous forays. They at least will have no difficulty in appreciating the great changes that have taken place, but for others, who missed this chance of seeing the area in its heyday, a map and a short description may help to give some idea of what has been lost.

The things that one remembers most about the Emsland are perhaps the sense of space, the soft sadness of the grey-green landscape, and always in the background the long rampart of the dyke which confined the river and its tributaries along the whole of their lower course. The only landmarks were an occasional spire or line of poplars by a distant road, and the red-brown bulk of the great Friesian barns, nestling in their clumps of trees at the marsh's edge. Otherwise there was nothing but watermeadow, stretching out for as much as three miles from the line of the dyke, and broken only by the cut of a drainage ditch every few yards. Then, almost overnight, the scene would change, and vast stretches would be under water for many weeks on end.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AREA ONCE LIABLE TO FLOODING

Altogether the area liable to flooding amounted to more than 50,000 acres, stretching northward from Papenburg along the east bank of the Ems to Leer, and then eastwards again on either side of the Leda and Jümme for another dozen miles to Detern and Barsselermoor. Besides this a further 2500 acres lay somewhat to the south in the neighbourhood of Aschendorf, and formed part of the same complex. Not all of this would necessarily be flooded at the same time, but as the waters ebbed on one marsh they would increase on another, and continue in this fashion from early November until late March.

This rotational flooding made the district extremely attractive to wildfowl. As each marsh in turn became lightly covered, it provided a perfect feeding ground, drawing birds in from a wide area; then as the depth increased, the floods became a secure roost, unapproachable on foot by reason of the hidden ditches; finally, when the level fell again, the place would be deserted in favour of another marsh where the cycle was just beginning. So it went on, until in due course frost drove the birds away, usually sometime in the New Year.

Had it not been for this concentration of the main flocks into a succession of comparatively small areas, covering a few thousand acres, any estimate of the numbers that used to occur would be virtually impossible. As it was, a fairly regular pattern emerged, at any rate for the geese. By far the commonest were the Whitefronts, which started to assemble towards the end of October, and reached their full strength of up to 10,000 by mid-November, A few weeks earlier many of these had probably been on the coastal marshes of the Elbe, where the main influx in October was by now waning, and similarly when the weather hardened, a large proportion almost certainly moved on to southern England and the marshes of the Severn estuary. In the latter case not only did the fluctuation in numbers agree but there were also some recoveries of Slimbridge ringed birds to confirm the link between the two. The Emsland marshes were thus exclusively an early winter resort, but during the eight or ten weeks that the geese were present in force, the flocks may well have amounted to half of all the Russian-bred Whitefronts coming to North-West Europe. Now that the floods no longer occur, the geese have left the district completely, although to the west of the Ems a couple of thousand are still said to roost on the tidal basin of the Dollart, and to feed in the fields around Marienchor. Except for these remnants the main body seems to have shifted westwards into Holland, where there has been a marked increase in the autumn and early winter of recent years. So far there has been no sign of big numbers coming straight through to England at this time.

Besides the Whitefronts some quite large flocks of Pinkfeet appeared each year, presumably of Spitzbergen origin. Dr. Klimmek of Leer considers that at times they must have comprised about a quarter of all the geese present, a total of, say, 2-3000, but from my own notes the largest flock was one of 500. They tended, however, to be overlooked amongst the great mass of Whitefronts, and only became obvious during hard weather, when they stayed on longer than the other species. A few Bean Geese also occurred regularly, but the numbers were always small, probably less than a hundred altogether. A favourite resort was on the Tunxdorf marshes, near Aschendorf, which were more broken by hedges and clumps of willow than the others to the

north. Other species were virtually unrecorded, except for a few unconfirmed reports of Greylags in October.

The behaviour of the flocks of geese varied from day to day, being governed almost entirely by the extent and distribution of the floods. Under normal conditions flighting was limited to short local movements between one marsh and another, but on occasion the same area of floodwater would afford both roost and feeding ground, and the geese would stay there without moving for several days at a time. On the other hand, if disturbance became too much for them, or if a suitable inland roost was lacking, they would flight out to the mudflats of the Dollart, some 15 miles to the northwest. There was even evidence of a flight to and from another coastal roost on the Jade Basin, more than three times as far to the northeast. On the Ammersum marshes, near Detern, skeins were several times seen to arrive from that direction at least an hour after all local movement had ceased, whilst on the Jade itself it was sometimes found that the numbers on the roost in no way tallied with those on the local feeding grounds. On these occasions Harrison (*Pastures New* : 1954) noticed that the flocks observed in the evening were often much smaller than those flighting out next morning, from which he deduced that some birds must be travelling much further afield, and not returning until long after dark. In view of these long flights it is rather surprising that the geese should have deserted the Emsland marshes so completely, and yet continue to feed on the fields to the west of the river, which are also dry.

Detailed estimates of the number of ducks on the floodwater were not possible owing to the wide distribution of the flocks over both the shallow and deeper water. The population was also much less stable, due partly to the constant flow of migrants, and partly to the purely local effects of weather and tide. At times, however, there is no doubt that the peak numbers ran to many thousands, with Mallard, Teal, Wigeon, Pintail and Shoveler all represented in strength.

The river itself, although tidal for more than thirty miles above Emden, was not much used by ducks; for the stream, which was swift and closely confined between its dykes, formed a busy thoroughfare for the barge traffic to and from the Rühr. In several places, however, meanders had been replaced by canals, and the old channel left to silt up. Most of these ox-bows were on the upper reaches above the limit of tidal water, and were used mainly by Mallard in rather small numbers, but lower down near Tunxdorf and Weener there were two large loops, nearly a mile long, that were fully tidal. These were favourite resorts, particularly for Teal, and were always the main centre for ducks in the early part of the season, serving equally well as a roost and a feeding ground. During August and September both Mallard and Teal usually numbered several hundred, but in the first week of October the Teal were reinforced by a tremendous temporary influx, often accompanied by a marked passage of Wigeon, Pintail and Shoveler. Thereafter all five species were normally present, although as the winter advanced the number of Shovelers decreased steadily. In their day both of these two places were capable of carrying 2-3000 birds, but now only the Tunxdorf loop remains; at Weener a new dyke has been built across the entrance, and without the scour of the tide, the open water is rapidly disappearing under a tangle of reed-beds.

Another feature of the Emsland floods were the great herds of Bewick's Swans which were present from early November until the first prolonged frosts. During this time the normal population was probably 3-400, but on one occasion, at the onset of hard weather in January 1949, Colonel Kingsford-Lethbridge saw nearly a thousand in one skein moving high to the southwest. In their case the effect of the drainage seems to have been less drastic than with the geese, for in the past few years quite large numbers have taken to using the Tunxdorf loop of the river. At the end of October 1960 well over 50 were there, and the farmer expected many more to arrive in the course of the next few weeks. Whoopers on the other hand were always rare in this part, although on the Elbe they were by far the commonest swan, often numbering several hundred.

Finally, some mention should be made of the common waders which at times well outnumbered all the ducks and geese. In August and September Snipe were unusually plentiful, especially at Tunxdorf where it was quite common to see a flight lasting upwards of an hour with wisps of ten and twenty moving out one after the other from the meadows to the edge of the falling tide. Later on, when the floods were out, huge stands of Green Plover were the normal background to almost every marsh, and on some of them Golden Plover at times seemed nearly as numerous. What their total number may have been is beyond my power of estimation.

Such was the annual pattern of events in the Emsland before the drainage scheme came into effect in 1956. Up to that time the farmers regarded the flooding as a necessary evil, forced upon them by the dictates of wind, weather and tide; when the river water coming down was met by a spring tide, backed up perhaps by a north-westerly gale, there was no option but to relieve the pressure on the dykes by opening the floodgates. Once this was done, the pumping system was quite inadequate, and the only means of clearing the water was by careful manipulation of the sluices at each ebb tide. There was not even the consolation that the land was being enriched by silt; for in the Leda and Jümme at any rate the water came straight from the peat moors a mile or two upstream, and was intensely acid.

The problem was not so much to get rid of the river water, as to prevent the big tides from backing up along the lower reaches to such an extent that they threatened the dykes. One solution, adopted on the Ems itself, was to raise and strengthen the defences along the whole length of the tideway, but this was a tremendous task, and on the Leda-Jümme it proved easier to build a huge sluice across the river at the point where it joins the main stream at Leer. Now when the tide reaches a certain level the flood gates are lowered, preventing any further flow upstream, and at the same time the river water coming down is diverted into an embanked basin of some 250 acres, where it is held until the ebb. Coupled with this main scheme there has also been a general improvement of the surface drainage on the marshes, by means of new cuts and additional pumping stations.

Once the threat of any further flooding was removed for all time, the countryside immediately took on a new air of prosperity. Now wherever one goes there are signs of recent activity; many of the old mud tracks are freshly metalled; new roads cut straight across the centre of some of the larger marshes; and new houses and barns are springing up by the side of them. Furthermore the drift of labour away from the land is being met

increasingly by mechanisation, and in at least one part the farmer talks of changing over from dairy to arable in the course of the next ten years. So far the best example of what has been achieved is perhaps on the Jümmiger Hammerich, that long cul-de-sac of land tucked away between the Leda and the Jümme, and covering more than 4000 acres. At one time its inner fastnesses were approachable only by the muddiest of tracks or by ferry over the river; now a bridge spans the Jümme at Amdorf, a new road leads through to Stickhausen, and the whole area is wide open to development.

So far as wildfowl are concerned the effect of all this has been disastrous; not only are the geese now gone completely, but the numbers of all other species are enormously reduced. In the absence of any sizeable area of standing water, the only habitat suitable for a large gathering of ducks is on the Tunxdorf loop of the Ems, and even there the amenities are somewhat spoiled by the drainage of the adjoining meadows. Elsewhere the population is limited to scattered pairs of Mallard in the ditches, and to a few small parties of Teal and Wigeon on various ponds and marshy corners. Another aspect is the great reduction in the number of nesting birds, both ducks and waders. The best season ever was perhaps in 1945 when vast areas were deliberately kept under water until well into June, but even in a normal season most marshes remained wet enough to support a large and varied population. Dr. Klimmek recalls that the Jümmiger Hammerich, in particular, was a favourite resort of Mallard, Lapwing, Black-tailed Godwit and many other species; so much so that on one occasion when he drove down the track from Stickhausen to Amdorf he had constantly to halt and allow their broods to cross his path. Now, he says, one can drive the whole length of the new road and never see a single family.

Not all the farmers were best pleased by the reclamation work; for many of them were ardent wildfowlers and bitterly resented the loss of their shooting. In fact some of them, in one last despairing gesture, went so far as to open the sluice-gates, reflooding some 2000 acres of meadow between Loga and Nortmoor. This was in 1957, in the second season after the floods were stopped. The results, however, were disappointing; for although large numbers of ducks appeared almost at once, the geese made no attempt to return.

So much then for the Emsland, which is now finished as a wildfowl resort. In terms of human benefit, the new project has doubtless been worthwhile, and one can only regret that the wildfowl had to suffer as a result. But a word of warning : this is not just an isolated example; it is typical of a trend that is gaining momentum in every country of Europe. Wildfowl conservation is no longer just a matter of protecting this or that species, it demands the husbanding of every acre of habitat that still remains, and above all the waging of a constant battle against ignorant waste of this most valuable resource.

RECENT POPULATION CHANGES IN BRITISH DUCKS

S. K. Eltringham and G. L. Atkinson-Willes

Summary

A method is described of obtaining indices to represent the relative abundance of ducks in the same month of different years and in each season as a whole. Results are based on the sample which has been used since September 1959 to produce monthly reports for observers in the National Wildfowl Count Scheme. The species investigated are Tufted Duck, Pochard, Mallard, Teal and Wigeon, and the months under consideration September to March inclusive. The period covered is from autumn 1948 to spring 1960.

The Tufted Duck in Great Britain has shown an average annual increase of about 8½% and has doubled its winter population within the period under review. This rate of increase agrees well with two other estimates; one based on an unpublished study of the survival of ringed adults and of breeding success in England during the period 1949-1957. the other on the results of a survey made in the London area between 1950 and 1957. The monthly indices also agree with those obtained by a different method from a much larger sample of Wildfowl Counts.

The increase in Pochard wintering in this country is equivalent to an annual rise of nearly 5% over the full twelve years. The whole of this, however, took place in the three years 1951-1954, and there has been no significant change since.

Of the other species, Mallard increased steadily at an annual rate of about 2½%; Wigeon showed no significant trend; and neither did Teal, although in 1959-60 an unusually large influx occurred. By comparison with previous analyses it seems that the number of Mallard in October 1959 was exceptional, and that the bulk of the Teal entered and left this country about a month earlier than usual.

Introduction

The analysis of data acquired by the Wildfowl Trust under the National Wildfowl Count Scheme has always suffered from a lack of continuity in the observations, and probably always will. In the past this difficulty was met by interpolation of the missing counts (Atkinson-Willes 1955, 1957) but such estimates, however well-informed, were bound to form a source of potential error. An alternative was to restrict the sample to those waters for which an unbroken series of counts was available, but this so reduced the data that comparisons were limited to a very few years. A new technique, however, has now been evolved making it possible to trace with confidence the trend in the British duck population over the twelve years 1948-1960. The following is the procedure adopted.

1. A standard or master year is selected from the seasons under review, for preference the one in which the data are most complete. In the present study the season of 1959/60 has been chosen for the purpose.

2. The counts for each month of the master year are in turn compared with the data from the corresponding months in each of the other years. All waters which were counted in both the master and the paired month are included in the sample, and the numbers of ducks present on each occasion are summed to give two directly comparable totals. These individual samples vary, however, both in size and composition, according to the data available, so that direct comparisons between all years are not, at this stage, possible.

3. To overcome this, the numbers of ducks in the other years are expressed as percentages of the number present in the master year. These percentages can be used as indices to show the relative abundance of a species month by month in all the years under review. By definition the population in the master year will always have a value of 100.

Example: To compare the number of ducks present in September of 1952, 1956 and 1959 (1959 being the master year)

1. A sample of 52 waters held 9000 ducks on 10.9.52 and 10,000 on 15.9.59.
2. A sample of 74 waters held 12,000 ducks on 20.9.56 and 16,000 on 15.9.59.

Therefore:

The waters in pair 1 held 90 ducks in 1952 for every 100 in 1959 and the waters in pair 2 held 75 ducks in 1956 for every 100 in 1959

The relative numbers of ducks in September of the three seasons was thus 90, 75 and 100 respectively.

4. This comparison between months is only the first stage; the method can now be extended to provide a seasonal index, showing the relative abundance of a species over the winter as a whole. These seasonal indices are derived from the data on which the monthly indices are based; for each season the actual numbers of ducks in all the paired months are summed to give two comparable totals. These totals are then expressed as percentages of those in the master season. The advantage of this method is that due weight is given to the months when the ducks are most plentiful; a big relative increase in mid-winter, when thousands of birds are present, is clearly much more important than a similar increase in early autumn, when there may be only a few hundred. It also takes into account the length of time during which large concentrations are present.

As yet no suitable statistical method has been devised to test the reliability of either the monthly or the seasonal indices, but since this is likely to increase with sample size, more weight should be attached to the results of later years. The seasonal index depends upon the differing sampling intensities each month and if these differ, a bias will be introduced. In the present work, the sampling was of a comparable intensity each month, and it is unlikely that the errors introduced by such bias are large.

In the present study five of the commonest British ducks, namely Mallard *Anas platyrhynchos*, Teal *A. crecca*, Wigeon *A. penelope*, Pochard *Aythya ferina* and Tufted Duck *A. fuligula*, have been selected for investigation; the data being derived from counts made on about a quarter of the 600 or more waters which are covered by the Wildfowl Count Scheme. The sample has been specially chosen to include those waters on which the majority of the counted ducks is found. To qualify for inclusion a water has to carry a regular peak of either 750 Wigeon, 500 Mallard, 300 Teal, 200 Pochard or 200 Tufted Duck. This sliding scale reduces the sample of waters to 174. From these, the samples for the individual species are assembled; in the final lists Mallard are represented on 161 waters, Teal on 118, Wigeon on 113, Pochard on 51 and Tufted Duck on 80. In practice, not more than three-quarters of the waters concerned were visited in any one month during 1959-60 so that the actual samples used were always much smaller. A map of the distribution of the 174 places is given in Figure 1.

Results

Each species is considered separately in the following results. At the head of each section there is a table showing the monthly indices in each year since the counts began. This is followed by a graph showing the annual indices

Figure 1. Distribution of places where ducks were counted.

which are derived from the data in the Appendix. The significance of any trends in the annual indices has been tested statistically. When the value of the correlation coefficient justifies its use, the regression of the indices upon the years has been drawn in and used to measure the annual rate of increase in the population.

Tufted Duck *Aythya fuligula*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	54	35	58	69	120	60	73	78	116	103	100
October ..	38	20	15	47	26	28	45	44	61	54	72	100
November ..	67	48	59	—	74	56	84	86	82	124	92	100
December ..	—	75	74	88	107	78	106	107	123	144	101	100
January ..	61	56	88	64	64	70	70	72	92	84	67	100
February ..	—	56	115	51	88	85	93	126	86	106	96	100
March	86	53	87	85	89	79	95	105	103	114	111	100

Table 1: Monthly indices to show the relative abundance of Tufted Ducks on varying samples of waters. The figures show the number of birds present in the earlier years for every 100 present in 1959-60.

It is obvious from the annual indices (Figure 2) that there has been a considerable increase in the Tufted Duck population since 1948-49. Calculation of the correlation coefficient shows that the upward trend is highly significant ($P<0.001$). The regression line has therefore been included

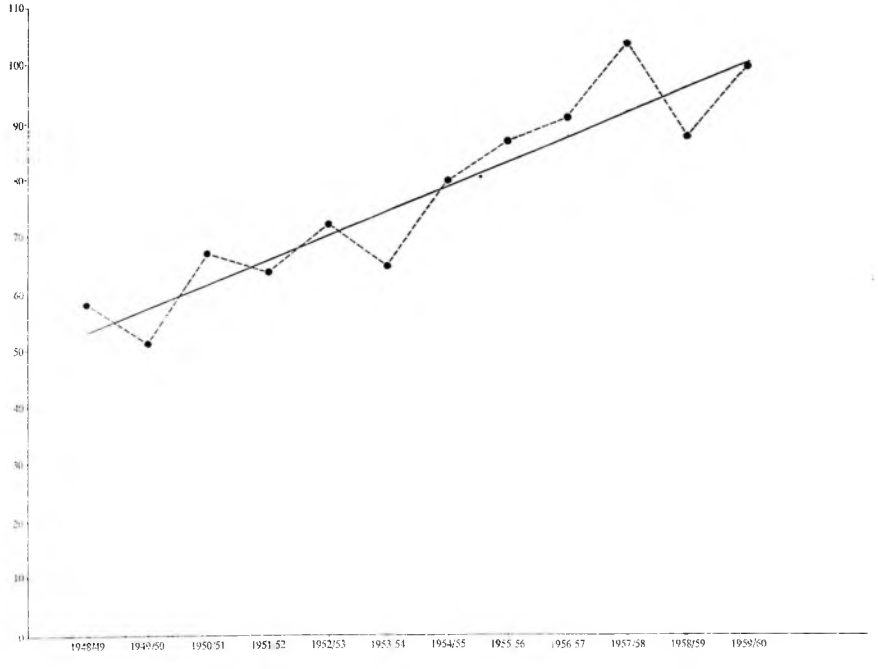

Figure 2. Seasonal indices for Tufted Duck, 1948 to 1960. The fitted regression line corresponds to an average annual rate of increase of about 8½%.

in the figure and used to estimate the annual rate of increase. This amounts to about $8\frac{1}{2}\%$, a very high rate which, if maintained, will continue to double the population every 12 years. The increase has been remarkably steady throughout the period and shows no definite signs of levelling out.

This same spectacular rise has been found by other workers. In a review of duck counts in the London area, Homes (1958) gives figures for the Tufted Duck for eight of the ten seasons between 1947 and 1957. These are based on the average of a variable number of acceptable monthly counts between October and April. Over 30 waters were considered and the peak

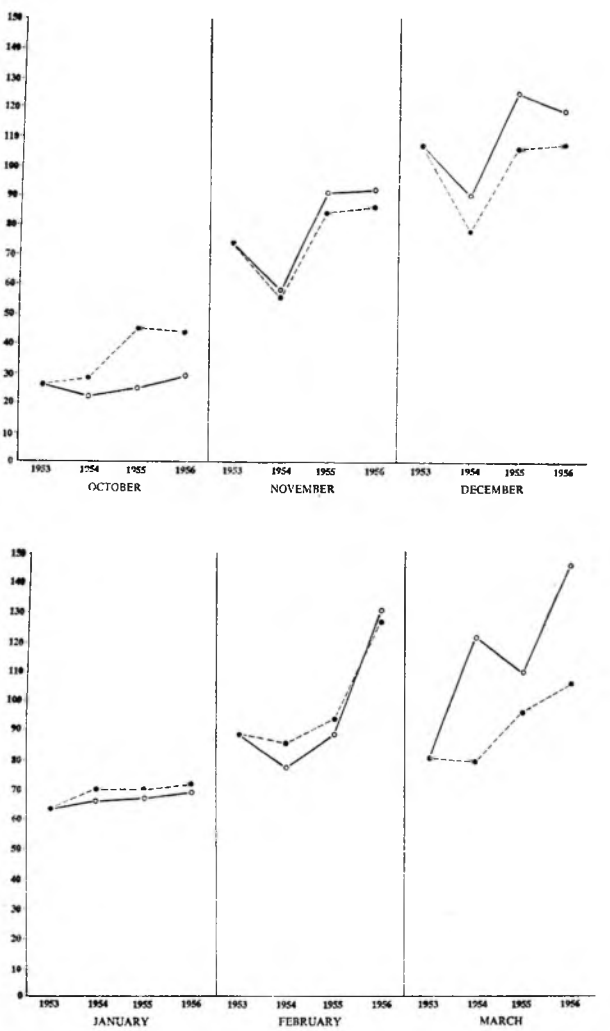

Figure 3. Comparison of the monthly indices obtained in this study with those from a larger number of waters in the seasons 1952 to 1956. Open circles joined by solid lines show indices obtained in this study, closed circles joined by broken lines those obtained by Atkinson-Willes (1957).

number of ducks each year varied from 2,328 to 5,186. A statistical test on these data again shows a highly significant upward trend amounting to an annual rate of increase of nearly 10%.

An independent estimate of the rate of increase has been given by Boyd in an unpublished study made in 1958 of the survival of ringed adults and of breeding success in England. His figure for the annual increase is just over 8½% for the period 1949-1956. A similar trend in the population of the Tufted Duck in the years 1947 to 1954 is also shown in the work of von Haartman (1957) who reports a breeding survey in the S.W. archipelago of Finland between 1935 and 1955.

Atkinson-Willes (1957) in a previous analysis of a much larger sample concluded that the Tufted Duck population level had been steady over the six years 1950-55. This conclusion was based largely on the monthly indices for January, the month in which the numbers were assumed to be most stable. Nevertheless, a trend is discernible in his figures, although not obvious because of the shorter period considered.

These results of Atkinson-Willes can also be used to test the validity of the present method on a restricted sample. He used a somewhat different technique in that comparisons were made not with a single master year but with an average, defined from the results of three consecutive seasons. In Figure 3 the results of the two analyses have been reduced to a common base so that a direct comparison can be made between them. In the earlier study the four year run from 1952 to 1956 provides a sample of 295 waters; it was thus about 5½ times as large as the present one, although it dealt with only twice as many ducks. The trends shown by the two sets of figures are remarkably similar, especially in the mid-winter months when the species is most numerous. The discrepancies in October and March are no doubt due to a dispersal at these times on to the small waters excluded from the present sample. Apart from this, the comparison suggests that the present analysis of counts from fifty or so waters provides results which are at least as reliable as those derived from a sample of nearly 300.

Pochard *Aythya ferina*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	35	21	36	64	41	53	60	32	168	88	100
October ..	102	65	49	82	210	88	110	101	126	115	103	100
November ..	70	74	84	—	136	63	107	109	138	127	141	100
December ..	—	62	63	65	129	56	114	86	87	82	98	100
January ..	73	59	87	73	65	68	111	87	92	57	75	100
February ..	—	43	105	68	90	72	80	97	70	72	85	100
March	24	30	79	24	37	62	63	92	69	50	70	100

Table 2: Monthly indices showing the relative abundance of Pochard on varying samples of waters.

In the case of Pochard the annual indices (Figure 4) show two distinct levels of population, separated by a period of violent fluctuation between 1951 and 1954. Taken over the full twelve years, the increase, which is

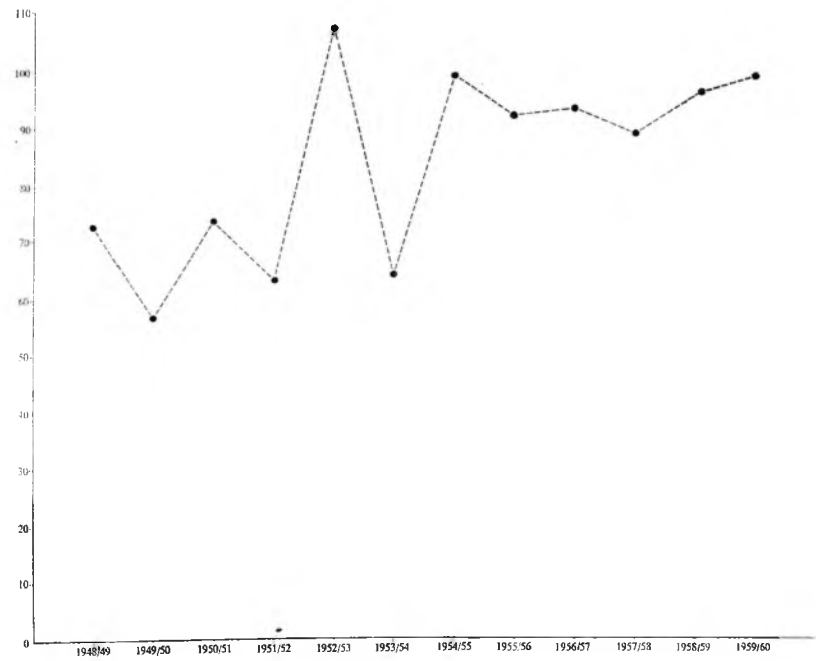

Figure 4. Seasonal indices for Pochard, 1948 to 1960. Population steady since 1954 at a level some 50% above that prior to 1951.

significant ($0.02>P>0.01$), represents an annual gain of nearly 5%, but this is clearly unrealistic. A better interpretation is that the population has remained steady since 1954 at a level some 50% higher than it was prior to 1951.

Mallard *Anas platyrhynchos*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	48	54	58	101	68	66	61	68	75	74	100
October ..	68	53	53	64	61	58	49	67	49	74	56	100
November ..	49	81	83	—	78	69	90	85	91	84	88	100
December ..	—	77	92	97	95	93	87	91	101	94	78	100
January ..	63	76	100	77	77	60	82	72	72	73	81	100
February ..	—	89	98	67	85	88	92	101	95	102	79	100
March	108	63	102	64	96	99	92	117	59	114	88	100

Table 3: Monthly indices showing the relative abundance of Mallard on varying samples of waters.

The apparent increase of Mallard shown in Figure 5 is significant ($0.01>P>0.001$) and amounts to an annual gain of about 2.5%. The most striking feature, however, is the high level of the 1959/60 index, which results from a big increase in the autumn numbers. At that time the counts were almost twice as large as usual, although by February they had returned to normal. This seems to have been due partly to an exceptionally good breeding season in England (Boyd and King 1960) and partly to an unusually early immigration from the Continent.

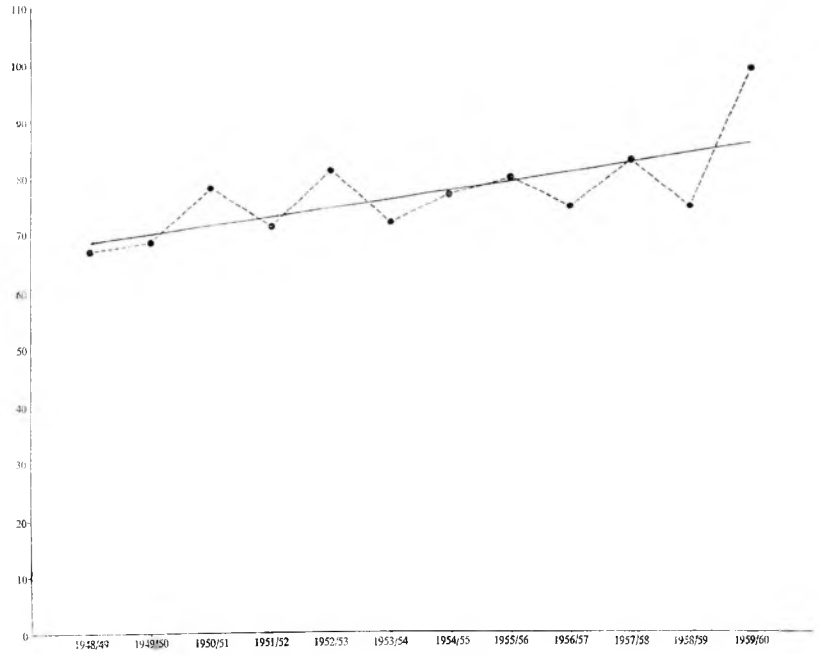

Figure 5. Seasonal indices for Mallard, 1948 to 1960. The fitted regression line corresponds to an annual rate of increase of about 2½%.

Teal *Anas crecca*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	18	32	23	31	16	26	31	24	40	20	100
October ..	34	49	30	25	46	30	26	50	35	59	41	100
November ..	68	19	47	—	32	35	55	69	54	65	23	100
December ..	—	18	36	24	40	27	39	48	54	65	24	100
January ..	44	60	121	73	71	88	120	160	68	73	87	100
February ..	—	135	184	95	76	97	118	102	79	101	107	100
March	304	216	245	64	114	142	168	125	156	89	77	100

Table 4: Monthly indices showing the relative abundance of Teal on varying samples of waters.

The monthly indices for Teal show a pattern similar to that revealed by the Mallard figures. In this case the influx is known to have started as early as July 1959 and by September numbers were from two to five times higher than in previous years. This ascendancy was maintained until December, but thereafter the indices fell steadily to an unusually low level in March. This shift in the seasonal movements of the species may have been due to the same factors which caused the early immigration of Mallard. Thus in September the bulk of the population was concentrated in Essex but afterwards the increase was evenly distributed throughout the country. The influx may also have been swollen by birds which normally winter elsewhere. This second suggestion is supported by the recent recoveries (Leach 1960) in this country of Teal ringed in the Camargue, southern France, during previous winters. Prior to the autumn of 1959 no Camargue-ringed Teal had been reported in Britain.

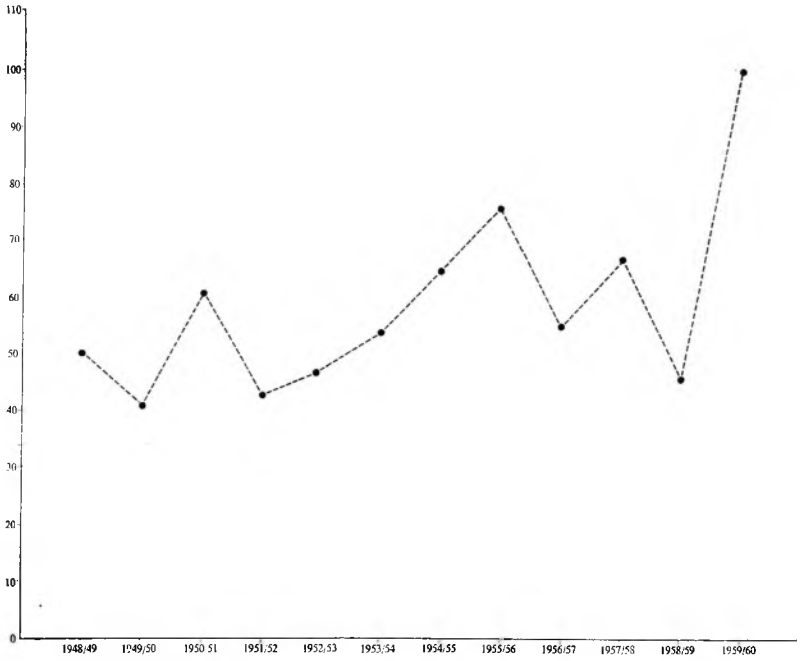

Figure 6. Seasonal indices for Teal, 1948 to 1960. No significant trend in numbers over the whole period.

In the annual indices (Figure 6) an upward trend is just significant ($0.05>P>0.02$). This, however, is due almost entirely to the abnormally high value of the index for 1959-60; the previous years show no significant increase. No attempt is therefore made to assess an annual rate of increase for the twelve year period.

Wigeon *Anas penelope*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
October ..	88	115	82	140	102	74	111	91	72	115	67	100
November ..	108	119	115	—	93	69	144	132	102	115	76	100
December ..	—	92	61	63	72	81	81	80	81	91	53	100
January ..	117	78	83	65	109	115	130	121	74	121	75	100
February ..	—	128	152	70	123	155	226	184	91	115	97	100
March	159	82	94	72	90	123	124	151	41	109	60	100

Table 5: Monthly indices showing the relative abundance of Wigeon on varying samples of waters. Numbers in September are too small to allow comparison.

The annual indices for Wigeon (Figure 7) are evenly distributed around the 1959-60 value, and a statistical test shows that there has been no significant trend in the population over the past twelve years. Throughout the winter of 1959-60 the population remained at an unexceptional level except in December when numbers were well above average. During this month some very large concentrations were reported, including one of 13,500

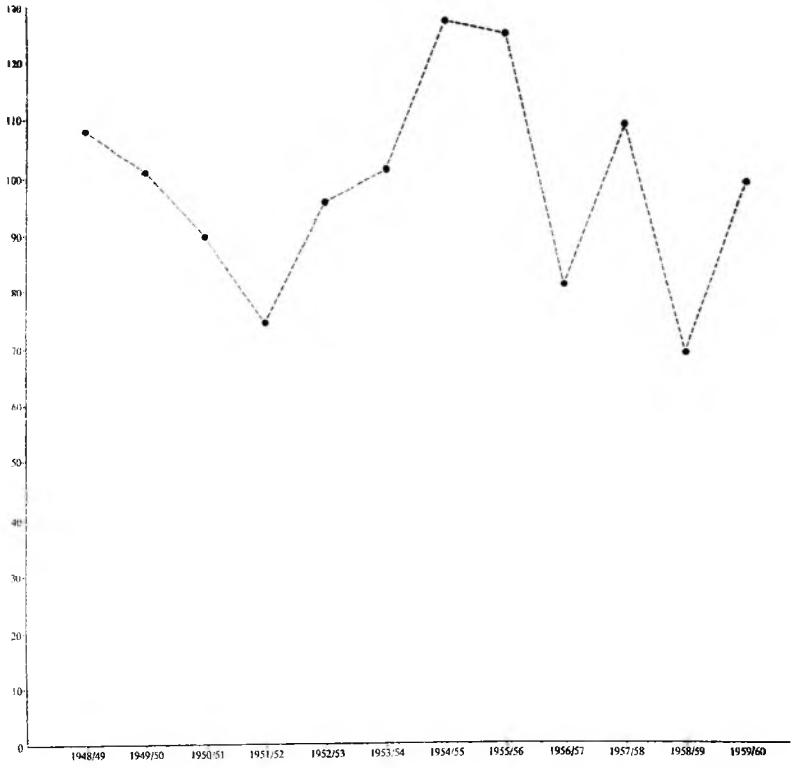

Figure 7. Seasonal indices for Wigeon, 1948 to 1960. No significant trend in numbers over the whole period.

in a single Essex estuary. The late winter decline was most marked in the west of England where numbers were well down for February and March.

Conclusions

The present method of using wildfowl count data to assess trends in populations is the only practical one that has yet been devised. It is simple to use and depends on only one assumption—that a representative portion of the population is sampled on each occasion. This however is unlikely to be a serious source of error; for the present sample already includes the bulk of the resorts known to carry large concentrations of wildfowl.

The results are reassuring from the conservation standpoint; of the five sporting species under review none has decreased since 1948 and in three cases a significant increase has been detected. This is most noticeable with Tufted Duck and Pochard although in the latter instance there has been no important change over the past six years. Increases in the Mallard population have been regular but at a lower rate. Neither Teal nor Wigeon show any significant trend in population during the twelve years under review, although in the case of Teal there is an apparent upward trend, due to the occurrence of quite exceptional numbers during 1959-60. This influx may possibly mark a change to a new population level, similar to that seen in the Pochard in

1951, but more probably the season was an aberrant one. Rather wide fluctuations in the Wigeon indices are probably due to a smaller proportion of the population being sampled than is the case with other species.

Acknowledgements

We are greatly indebted to the many wildfowl counters who, over the past twelve years, have provided the basic data for this paper. We should also like to thank Mr. J. G. Skellam and Mr. M. D. Mountford of the Nature Conservancy for many helpful suggestions.

1960-61

The results of the 1960/61 season have been completed since this paper went to press:

Species	Number in 1959/60	Number in 1960/61	Seasonal Index
Tufted Duck	30,662	30,969	101
Pochard	22,322	27,544	123
Mallard	198,580	167,131	84
Teal	109,045	63,041	58
Wigeon	198,557	191,908	97

The most interesting results are those of Pochard and Teal. The Pochard index has increased by almost a quarter and may presage a further rise in the population level. The Teal index has fallen considerably and is now of the same order as the indices for previous years. This result tends to confirm the hypothesis that the 1959/60 season was an aberrant one for Teal.

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Appendix

Tabular record of numbers of ducks counted which were used to calculate monthly and seasonal indices.

Table A1: Dates on which Wildfowl Counts used in this analysis were made, 1948-1960.

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	—	29	15	7	27	18	3	23	15	27	19	18	17
February	—	—	19	4	24	15	7	20	12	24	16	15	14
March	—	5	19	4	23	15	7	20	11	24	16	15	13
September	—	25	10	30	21	6	26	18	2	22	14	13	—
October	30	23	8	28	19	11	24	16	7	20	12	18	—
November	27	20	12	—	16	8	21	13	4	24	16	15	—
December	—	18	10	2	14	6	19	11	2	22	14	13	—

Table A2: Numbers of ducks counted in 1948-1960 used in calculating monthly and seasonal indices, with numbers of waters visited. " Slave years " compared with 1959-60 as " master year."

(a) **Tufted Duck**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	18	15	18	21	21	26	28	30	33	28	34
	slave ..	—	544	355	554	833	898	1017	1263	1117	2290	1400	—
	master ..	—	1015	1016	961	1198	750	1684	1739	1423	1979	1357	2148
October	waters ..	28	27	30	30	29	38	33	39	37	46	44	54
	slave ..	1575	788	607	1912	1000	1371	1911	2241	2612	2787	3837	—
	master ..	4122	3862	3989	4082	3784	4919	4207	5111	4282	5156	5334	5620
November	waters ..	19	27	30	—	32	38	41	45	43	50	47	58
	slave ..	1048	1544	1938	—	2913	2460	3879	4399	4135	5823	3945	—
	master ..	1563	3214	3301	—	3930	4388	4630	5093	5029	4696	4281	5685
December	waters ..	—	33	31	37	30	35	45	39	44	55	47	58
	slave ..	—	2656	2340	2779	3570	3119	5196	4685	6121	7465	4738	—
	master ..	—	3524	3169	3173	3324	4020	4897	4366	4978	5172	4705	5483

		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	31	38	25	31	37	42	41	48	51	46	52	62
	slave ..	2396	3136	4089	3422	3815	4196	4558	4923	5876	4634	4214	—
	master ..	3905	5632	4669	5364	6004	5979	6537	6819	6364	5491	6333	7541
February	waters ..	—	30	18	36	37	32	35	41	44	52	43	56
	slave ..	—	2292	2549	2167	3892	3248	4324	6322	4387	5595	4005	—
	master ..	—	4199	2213	4208	4438	3843	4654	5028	5084	5262	4174	5567
March	waters ..	21	30	23	35	36	36	42	44	42	47	49	54
	slave ..	1556	1145	1462	1897	2137	2072	3222	3724	3482	3741	3791	—
	master ..	1807	2180	1688	2230	2676	2617	3375	3549	3384	3273	3421	3806

Table A2 (continued):

(b) **Pochard**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	12	13	15	18	17	20	22	23	25	22	27
	slave ..	—	414	242	453	841	510	702	868	436	2538	1321	—
	master ..	—	1178	1170	1249	1308	1253	1321	1437	1366	1506	1497	1516
October	waters ..	17	16	18	20	24	27	23	32	29	33	33	38
	slave ..	1585	1030	669	1751	4871	2058	2262	2676	3480	3272	2917	—
	master ..	1561	1577	1358	2133	2314	2327	2059	2642	2754	2856	2835	3185
November	waters ..	8	17	18	—	26	28	29	34	33	31	28	39
	slave ..	1239	1954	2238	—	4334	2070	4272	4960	5607	5550	6129	—
	master ..	1761	2623	2678	—	3193	3279	4003	4540	4063	4383	4347	4852
December	waters ..	—	17	18	21	25	25	29	28	31	33	30	36
	slave ..	—	2220	2121	2633	4140	2481	5597	4189	4464	4247	5028	—
	master ..	—	3566	3340	4047	3211	4395	4927	4842	5133	5173	5102	6135
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	19	22	19	23	28	29	29	33	33	31	33	40
	slave ..	2242	2229	2775	2679	2716	3030	4920	4577	4598	2859	3979	—
	master ..	3089	3769	3181	3655	4169	4481	4434	5272	4996	4977	5312	5765
February	waters ..	—	18	14	25	26	26	29	33	31	36	32	38
	slave ..	—	881	2033	1439	2208	1790	2240	3205	2504	2663	2898	—
	master ..	—	2067	1938	2112	2444	2474	2815	3300	3575	3707	3412	3832
March	waters ..	12	16	16	19	24	21	27	31	29	29	30	35
	slave ..	236	326	961	275	624	879	1051	1743	1206	847	1282	—
	master ..	963	1085	1220	1134	1690	1420	1673	1899	1743	1704	1842	1938

Table A2 (continued):

(c) Mallard

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	35	33	35	46	43	51	57	62	64	59	85
	slave ..	—	6945	8424	8743	17782	11025	14081	15202	13751	19338	16175	—
	master ..	—	14421	15615	15029	17536	16102	21215	24796	20252	25703	21913	27556
October	waters ..	42	41	46	60	58	63	66	77	71	79	80	105
	slave ..	8434	9894	10772	18370	17780	17842	15802	25999	17544	29512	20338	—
	master ..	12453	18645	20467	28769	29029	30613	32368	38893	35592	39941	36453	46164
November	waters ..	24	37	46	—	59	73	75	88	73	85	81	114
	slave ..	3510	11129	14004	—	17554	18767	28492	29599	25112	28182	28068	—
	master ..	6451	13767	16956	—	22391	27372	31536	34903	27673	33667	31894	42086
December	waters ..	—	44	50	66	60	67	82	78	78	89	76	109
	slave ..	—	11469	16804	21924	18144	20893	26441	26638	28011	32226	22151	—
	master ..	—	14838	18169	22632	19080	22407	30437	29411	27813	34193	28364	42216

		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	41	53	44	62	71	60	82	72	72	73	81	116
	slave ..	9209	14271	14179	17675	19079	19065	22488	23096	25182	25406	28196	—
	master ..	14686	18792	14170	23025	24744	31549	27385	31903	35001	34760	34952	42383
February	waters ..	—	41	33	64	63	66	67	76	78	88	79	104
	slave ..	—	9872	8622	12630	14497	16804	17986	21998	17697	24062	18742	—
	master ..	—	11062	8829	18971	17139	19176	19498	21753	18687	23473	23812	28736
March	waters ..	30	44	42	62	68	66	71	78	71	78	80	102
	slave ..	3642	3547	6095	5429	9310	9778	10538	13772	5492	12567	10345	—
	master ..	3383	5595	5969	8508	9738	9901	11433	11714	9348	10985	11782	15565

Table A2 (continued):

(d) Teal

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	21	21	27	33	32	37	39	41	44	44	55
	slave ..	—	1669	2807	2144	2865	1609	2662	3288	2523	4221	2216	—
	master ..	—	9015	8630	9228	9252	9839	10188	10565	10653	10500	10782	11488
October	waters ..	23	26	26	44	47	48	49	59	53	54	59	75
	slave ..	1164	5571	3371	3630	7041	4681	3944	7925	5581	9241	6767	—
	master ..	3416	11280	11352	14696	15198	15596	14897	15890	15703	15741	16614	17403
November	waters ..	14	26	27	—	45	52	51	60	56	59	59	79
	slave ..	1434	2487	6051	—	5911	6902	10964	13952	10611	12810	4567	—
	master ..	2110	12909	12939	—	18621	19737	19841	20163	19597	19774	19953	22624
December	waters ..	—	31	33	45	46	52	60	57	60	58	55	75
	slave ..	—	3174	6447	5381	9105	6828	10347	12757	14164	17190	6265	—
	master ..	—	17217	17707	22358	22743	25030	26435	26326	26315	26346	25574	28418
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	26	36	33	51	55	58	60	67	62	62	64	83
	slave ..	3581	5433	10945	8985	8758	11660	16922	22716	9930	10119	12240	—
	master ..	8198	9064	9011	12345	12293	13215	14068	14269	14567	13849	14036	16540
February	waters ..	—	30	26	52	47	57	56	64	59	65	62	78
	slave ..	—	5200	3573	7081	4230	8390	11081	9844	7363	9987	10256	—
	master ..	—	3841	1943	7489	5562	8663	9418	9691	9346	9937	9563	12793
March	waters ..	17	29	30	44	49	46	56	61	57	57	58	76
	slave ..	884	2737	3568	2814	3115	7072	8774	7027	4781	4916	4282	—
	master ..	291	1268	1454	4413	2738	4964	5218	5608	3068	5545	5562	8382

Table A2 (continued):

(e) **Wigeon**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
October	waters ..	29	29	31	41	38	47	47	53	49	53	59	78
	slave ..	7548	11197	5794	20937	15579	11894	18383	15646	11565	18734	13109	—
	master ..	8558	9710	7066	14931	15290	16152	16588	17165	16078	16308	19497	22416
November	waters ..	17	24	31	—	36	48	49	59	52	58	59	81
	slave ..	14164	18807	19247	—	26882	22087	35936	36102	36544	34119	23772	—
	master ..	13065	15844	16772	—	28978	31880	25007	27314	35779	29598	31223	44897
December	waters ..	—	30	36	46	41	46	59	55	55	61	57	81
	slave ..	—	17700	13221	25776	31756	37429	31815	36355	40611	41442	28329	—
	master ..	—	19222	21589	40970	44019	46406	39183	45214	44906	45398	53826	66210

		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	27	36	24	41	49	55	55	60	55	62	68	85
	slave ..	8828	11749	8802	18668	33213	39985	45139	47096	25860	45262	26954	—
	master ..	7554	14988	10630	28836	30582	34614	34812	38754	35092	37393	35960	46426
February	waters ..	—	29	21	50	47	50	49	55	52	64	62	80
	slave ..	—	8974	7766	19931	28345	48427	39535	62453	29432	42919	29853	—
	master ..	—	6993	5093	28420	22998	31270	17458	33914	32298	37263	30864	41453
March	waters ..	19	30	25	46	51	46	54	60	55	58	64	82
	slave ..	3142	3839	4392	5072	7408	24896	28901	37577	5124	26202	8755	—
	master ..	1976	4680	4687	7006	8222	20216	23247	24934	12424	23983	14544	29224

Table A3: Samples used in calculating seasonal indices from numbers in September-March.

(a) **Tufted Duck**

Season	Number of comparisons	Number in 1959-60	Number in previous season	Seasonal index
1948-49	99	11,397	6,575	58
1949-50	203	23,626	12,105	51
1950-51	172	20,045	13,340	67
1951-52	187	20,018	12,721	64
1952-53	222	25,354	18,160	72
1953-54	242	26,516	17,364	65
1954-55	263	29,984	24,107	80
1955-56	286	31,705	27,557	87
1956-57	291	30,544	27,730	91
1957-58 ..	329	31,029	32,335	104
1958-59	310	29,605	25,930	88

(b) **Pochard**

1948-49	56	7,374	5,302	72
1949-50	118	15,865	9,054	57
1950-51	116	14,885	11,039	74
1951-52	123	14,330	9,230	64
1952-53	171	18,329	19,734	108
1953-54	173	19,629	12,818	65
1954-55	186	13,849	13,808	100
1955-56	213	23,932	22,218	93
1956-57	209	23,630	22,295	94
1957-58	218	24,306	21,976	90
1958-59	208	24,347	23,554	97

(c) **Mallard**

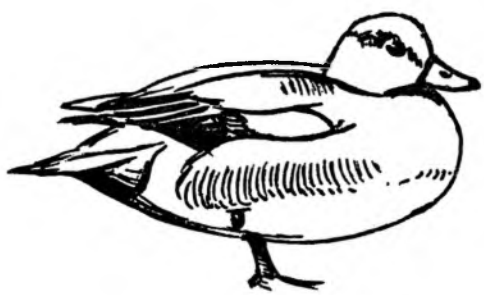
1948-49	137	36,973	24,795	67
1949-50	295	97,120	67,127	69
1950-51	296	100,175	78,900	79
1951-52	349	116,934	84,771	72
1952-53	425	139,657	114,146	82
1953-54	438	157,120	114,174	73
1954-55	494	173,872	135,828	78
1955-56	526	193,373	156,304	81
1956-57	505	174,366	132,789	76
1957-58	556	202,722	171,293	84
1958-59	536	189,150	144,015	76

(d) **Teal**

1948-49	80	14,015	7,063	50
1949-50	199	64,594	26,271	41
1950-51	169	50,097	30,711	61
1951-52	290	83,468	36,086	43
1952-53	322	86,407	41,025	47
1953-54	345	87,205	47,142	54
1954-55	369	100,065	64,694	65
1955-56	407	102,512	77,509	76
1956-57	388	99,249	54,953	55
1957-58	399	101,692	68,484	67
1958-59	401	102,084	46,593	46

(e) **Wigeon** (October-March)

Season	Number of comparisons	Number in 1959-60	Number in previous season	Seasonal index
1948-49	92	31,153	33,718	108
1949-50	178	71.437	72,266	101
1950-51	168	65.837	59,222	90
1951-52	224	120,163	90.384	75
1952-53	262	150,089	143,183	95
1953-54	292	180.538	184.718	102
1954-55	313	156.295	199,709	128
1955-56	342	187,295	235.229	126
1956-57	318	181.577	149.136	82
1957-58	356	189.943	208.678	110
1958-59	369	185.914	130,772	70



TRACHEAL ANATOMY OF THE ANATIDAE AND ITS TAXONOMIC SIGNIFICANCE

Paul A. Johnsgard

Summary

TRACHEAL and syringeal variations in waterfowl are summarized, based on a tracheal collection representing 84 out of the 143 species of Anatidae. Twenty seven species are illustrated with drawings, and photographs of 24 species are also included, comprising 29 of the 43 genera of Anatidae. The following major points are made:

1. The Magpie Goose (*Anseranas semipalmata*) is unique in its externally convoluted trachea, but the syrinx is small and simple in both sexes.
2. Species of the subfamily Anserinae have symmetrical tracheae in both sexes, which either lack bullae (Anserini) or have symmetrical bullae which are larger in males than in females (Dendrocygnini).
3. The Coscoroba Swan (*Coscoroba coscoroba*) and the Cereopsis Goose (*Cereopsis novaehollandiae*) have tracheae of the Anserini type, and the Freckled Duck (*Stictonetta naevosa*) has an extremely simple and primitive type of trachea and syrinx in both sexes.
4. Species of the subfamily Anatinae exhibit sexual dimorphism in the syrinx, and males of most species except stiff-tails (Oxyurini) possess asymmetrically enlarged syrinxes (bullae).
5. Enlargements of the tracheal tubes of male Anatinae occur in a few dabbling ducks (Anatini), most of the pochards (Aythyini) and most sea ducks (Mergini). Tracheal air sacs occur in some stiff-tails, and extra-tracheal sound production is also typical of this group.
6. Although males of most Anatinae possess entirely osseous bullae, partially membranaceous (fenestrated) bullae are found in all pochards and most sea ducks. The Marbled Teal (*Marmaronetta angustirostris*) and Pink-headed Duck (*Rhodonessa caryophyllacea*) also possess fenestrated bullae which are intermediate between the dabbling duck and pochard types.
7. The sea ducks exhibit the greatest variation in shape and structure of male tracheae, and specializations of the bronchi, tracheal tube, and musculature are frequent. The tribal separation of the eiders on the basis of their tracheal anatomy is not justified.

Although practically every genetically determined aspect of anatomy that varies among different species of animals has been used by biologists in attempting to assess evolutionary relationships, students of waterfowl have a particularly rich source of information available in the form of the trachea (" windpipe ") and the associated syrinx, the vocal organ of birds. Through differences in the size, shape, and structure of these organs, the different species (and often the two sexes of the same species) achieve the characteristic qualities of voice that provide for recognition among individuals and between species. Waterfowl of the family Anatidae lack the complex internal syringeal muscular structure of songbirds to achieve this specificity of vocalizations, and probably as a result of this have utilized simpler structural variations in the length, size and shape of the trachea and syrinx to provide auditory distinctiveness. It was realized very long ago that these variations of structure in different species were useful in judging relationships, and many early students of birds (Latham, 1798; Yarrell, 1827; Eyton, 1838) described and illustrated the tracheal anatomy of wildfowl. Heinroth (1911) was among the first fully to realize the value of tracheal variations in assessing waterfowl relationships, and attempted to summarize the major variations found in the Anatidae and relate them to their probable evolutionary relationships.

Delacour and Mayr (1945) also utilized tracheal anatomy in their revision of the Anatidae, and urged that attempts be made to collect and describe these structures from species which were still of uncertain relationships or for which the anatomy was unknown. Since collections of tracheae are very rare in museums, an attempt has been made to accumulate a representative collection at the Wildfowl Trust which may eventually serve as a reference collection for future research. These specimens have been obtained primarily from birds which have died at the Trust, and in somewhat over one year the number of species represented in this collection has reached 84.

Because the tracheae of numerous species have never been described, and also because no recent attempt has been made to summarize the major structural variations in the tracheae of waterfowl, the following summary of tracheal anatomy in the Anatidae is presented here. Since tracheal structure is fairly uniform within each tribe, the family will be discussed in such units, the sequence and composition of the tribes being basically that proposed by Delacour (1954-1959), but with some modifications as suggested by Johnsgard (1960, 1961).

SUBFAMILY ANSERANATINAE

Tribe Anseranatini

The Magpie Goose, *Anseranas semipalmata,* possesses a trachea which is one of the most distinctive of all birds'. Although the syrinx in both sexes is small and simple (Fig. 1), the trachea is extremely elongated, particularly in the male. Young Magpie Geese up to four months old have essentially straight tracheae like those of most other waterfowl, but the trachea soon lengthens by increasing the width of the tracheal rings, and begins to convolute outside the body cavity between the left breast muscle and the skin. This is more pronounced in males; in eight-month-old birds there are already obvious differences in the voices of the sexes, and the male's trachea is approximately half the length found in adult males (see photo section). The adult condition appears to be reached in two years, when a male's trachea is approximately 150 centimeters in length. The lower-pitched voice of adult male Magpie Geese is presumably the result of this greater trachea length.

SUBFAMILY ANSERINAE

Tribe Dendrocygnini

The whistling ducks (*Dendrocygna*) lack convoluted tracheae, but possess fairly complex syringeal structures, at least in males. In all eight species the male tracheae are symmetrically inflated at the syrinx to form rather oval-shaped structures (Fig. 1). The size of these chambers is relatively uniform in all species, but the shape differs somewhat in the various species and provides some clues to relationships. Thus the tracheae of male Indian (*D. javanica*), Wandering (*D. arcuata*) and Plumed (*D. eytoni*) Whistling Ducks are all very similar to one another and, to a lesser degree, to that of the Fulvous (*D. bicolor*). The tracheae of the White-faced (*D. viduata*) and Spotted (*D. guttata*) Whistling Ducks are, on the other hand, distinct from these and from one another. Those of the Cuban (*D. arborea*) and Red-billed (*D. autumnalis*) are not yet available for close comparison.

In the female sex the tracheal structure of all species is simpler and more uniform (see photo section). In two species (*D. arborea* and *D. autumnalis*) the syrinx is entirely osseous, while in the others the syrinx, although it is of similar shape, possesses a narrow membranaceous tympanum on the dorsal surface near the junction of the bronchi. In spite of these differences in the tracheal structure of the sexes in whistling ducks there is no obvious sexual dimorphism in the voices of *Dendrocygna*. Heinroth (1918) has also discussed the tracheal anatomy of whistling ducks.

Tribe Anserini

The true geese and swans are characterized by a remarkably uniform and relatively simple vocal apparatus. In no species are there any complex syringeal structures in either sex, and it is also true that practically no sexual dimorphism is present in the trachea or syrinx. In these species, as in the Magpie Goose, the source of sound production appears to be the vibration of the tympaniform membranes, which are situated where the bronchi join the trachea, and variations in pitch probably result from differences in the tension of these membranes as regulated by the syringeal muscles. In the true geese and the Coscoroba Swan (*Coscoroba coscoroba*) males possess normally higher pitched voices than do females, although the reasons for this are not yet clear. In most of the swans the sexes have voices of roughly the same pitch or the male's may be lower pitched. As is well known, the Trumpeter and Whooper Swans (*C. cygnus*) and also the Whistling and Bewick's Swans (*C. columbianus*) have tracheae which convolute inside the sternum, or breastbone, and it is presumably the increased length of these species' tracheae that is in part responsible for the marvellous trumpeting calls characteristic of these birds (see photo section). In the other swans the tracheae are unconvoluted and are uniform in diameter throughout. The trachea of the Coscoroba Swan is very similar to that of the Mute Swan (*C. olor*), suggesting that the Coscoroba is a true swan rather than a close relative of the whistling ducks (see photo section).

In the true geese (*Anser* and *Branta*) there is relatively little tracheal variation. The tracheae are straight, but vary in diameter in some species. It appears that the tracheal tubes of males tend to vary more than do those of the females. The syrinx is the same in both sexes and basically like those of swans and the Magpie Goose (see Fig. 1 and photo section).

The Cape Barren Goose (*Cereopsis novae-hollandiae*) has a tracheal structure (Fig. 1) like that of the true geese rather than of the very different form exhibited by the sheldgeese, and there are other reasons (Johnsgard, 1960a) for believing that this species provides a true link between the Anserini and the sheldgeese (Tadornini). The Freckled Duck (*Stictonetta naevosa*) has a trachea (illustrated in Fig. 1 after Campbell, 1899) with a simple syrinx and a tracheal tube which varies only slightly in diameter. As indicated earlier (Johnsgard, 1960a), it is possible that the Freckled Duck is more closely related to the true geese than to the ducks. The Freckled Duck and the Cape Barren Goose exhibit certain other primitive features that suggest that both species have been derived from early offshoots of the waterfowl stock and have no close living relatives.

SUBFAMILY ANATINAE

Tribe Tadornini

In the shelducks and sheldgeese, as well as in almost all the true ducks (Anatinae), there is considerable sexual dimorphism in tracheal structure and a corresponding difference in the adult voices of the two sexes. Females tend to have loud and low-pitched honking or quacking voices which are produced in the same manner as described for the preceding tribe. Males tend to have high-pitched, often whistling, voices, although they vary greatly. The whistling calls of males appear normally to originate in the tracheal "bulla," an enlarged area of the trachea in the region of the syrinx that acts as a sound chamber. In most species this is asymmetrical in shape, being enlarged towards the left side. The whistling sound appears to be produced by the rapid expulsion of air from the lungs, which rushes past the sound chamber and produces a whistle in the same manner as a mechanical whistle functions. Males of many species can also produce sound by the alternative means of vibrating the syringeal membranes.

In all the species of this tribe the tracheal tube is of uniform diameter in both sexes, and females of all species have simple, goose-like syringeal structures. Males of the sheldgeese (*Cyanochen, Chloëphaga, Neochen* and *Alopochen*) all possess tracheal bullae which consists of a simple inflated and relatively spherical bony chamber on the left side of the syrinx (Fig. 1 and photo section). The size of the bulla varies considerably in different species, but in all it is thin and rather uniformly ossified. In some shelduck (*Tadorna*) species (the "casarcas") the male's tracheal bulla is very small and almost rudimentary (Fig. 1), but the Radjah Shelduck's (*T. radjah*) bulla is fairly large. In the Common Shelduck (*T. tadorna*) it is also large and is equally inflated on both sides (see illustration in Heinroth and Heinroth, 1928).

Male steamer ducks (*Tachyeres*) have tracheae with typically inflated bullae that do not differ markedly from those of the sheldgeese, but behavioural evidence (Moynihan, 1958) suggests that they should be removed from the shelduck tribe. The bronchi of both sexes of steamer ducks are greatly enlarged (see Fig. 1 and photo section). The Crested Duck ("*Lophonetta*" *specularioides*) is here considered a member of the typical genus (*Anas*) of surface-feeding ducks.

Tribe Cairinini

Males of all species in this tribe have voices distinctly different from those of the females, and the degree of tracheal dimorphism varies considerably. It is least in the pygmy geese (*Nettapus*), in which the bulla of the male is only slightly indicated (Fig. 1). In the Spur-winged Goose (*Plectropterus gambensis*) the bulla is rounded and very unevenly ossified. The same uneven ossification is present in the White-winged Wood Duck (*Cairina scutalata*), but the bulla is large and is strongly flattened dorso-ventrally (see Fig. 1 and photo section). In both sexes of this species the bronchi are also markedly ossified (as is true also of the Trumpeter Swan and its near relatives), and perhaps the loud, honking voices of both sexes are somehow related to this. The trachea of the nearly-mute Muscovy Duck (*C. moschata*) lacks these unusual features, and males have a simple, wholly ossified, rounded bulla. The equally silent male Comb Duck (*Sarkidiornis*

melanotos) exhibits a relatively rudimentary bulla. In the Hartlaub's Duck *Pteronetta* (" *Cairina* ") *hartlaubi,* the male's tracheal bulla takes a form more like that found in *Anas,* being thick-walled and possessing a triangular bony protuberance at the ventral surface.

The North American Wood Duck (*Aix sponsa*) (Fig. 1) and Mandarin Duck (*A. galericulata*) have relatively simpler male tracheae, with thinner and more spherical bullae than is found in the Hartlaub's Duck. The trachea of the Maned Goose (*Chenonetta jubata*) is similar (see photo section), and the Brazilian Teal (*Amazonetta brasiliensis*) also has a bulla which is relatively large and spherical (Phillips, 1924).

It is now fairly clear that the Ringed Teal, *Callonetta* (" *Anas* ") *leucophrys,* is a member of the perching duck tribe (Johnsgard, 1960b). This is also supported by its male tracheal structure, which is roughly intermediate between those of *Nettapus* and *Aix* (Fig. 1).

Tribe Anatini

Besides the large genus *Anas,* several aberrant genera are included in this tribe of surface-feeding ducks. Of these, the tracheal anatomy of the Pink-eared Duck (*Malacorhynchus membranaceous*) and Blue Duck (*Hymenolaimus malacorhynchus*) is still undescribed and a knowledge of these species' tracheae might assist in interpreting their evolutionary relationships. The male Pink-headed Duck (*Rhodonessa caryophyllacea*) has a trachea with a fenestrated bulla that is distinct from the typical *Anas* shape but approaches that of the pochards (illustration in Fig. 1 after Garrod, 1875) and certain aspects of the adult plumage pattern also indicate that this species might be placed in the pochard tribe.* Torrent Ducks (*Merganetta armata*) have male tracheal bullae that are distinctly *Anas*-like (Niethammer, 1952) and which especially resemble that of the Salvadori's Duck (*Anas waigiuensis*).

Males of the approximately 36 species of *Anas* have tracheal structures that are relatively uniform, but which vary enough sometimes to indicate evolutionary relationships. These variations can be used to divide the genus into several fairly distinct groups. The wigeons (*Anas sibilatrix, A. penelope* and *A. americana*) comprise one such group. In these species the male bulla tends towards a spherical shape as found in *Aix* and some other perching ducks (see photo section). From this condition the Falcated Duck (*A. falcata*) and Gadwall (*A. strepera*) grade to the more typical situation found in the groups of species known as the " green-winged " teal (*A. crecca* and *A. flavirostris*) and " austral " teal (*A. gibberifrons, A. bernieri, A. castanea* and *A. aucklandica*). In these species the tracheal bulla is relatively small, but is strongly and evenly ossified, and forms a triangular point at the right ventral extremity (see photo section). The Cape Teal (*A. capensis*) also has a trachea of this shape (Fig. 1) and certainly belongs with this group of species rather than with the " spotted " teal (see below). The Baikal Teal (*A. formosa*) also has a bulla of this shape, but it is of rudimentary size and the absence of a lateral sound chamber probably accounts for the fact that, unlike the species already mentioned, the male Baikal Teal lacks a whistling note.

*A complete specimen of this species' trachea has been located by the writer in the British Museum (Natural History). It differs from the specimen on which the illustration by Garrod is based, and is even more pochard-like (see Fig. 3, p. 69).

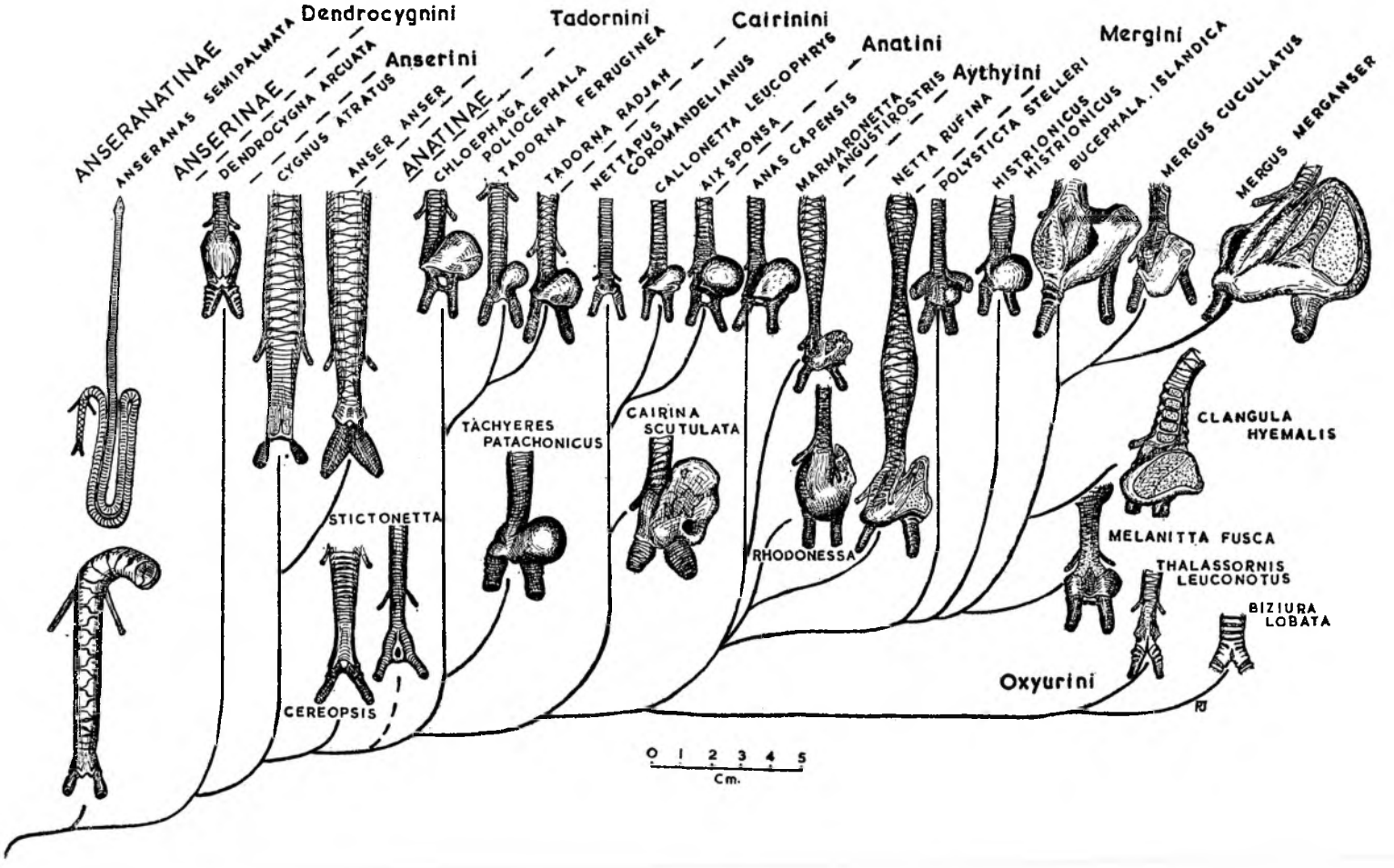
The " austral " teal in turn lead to the mallard-like and pintail-like ducks. On the basis of the shape of the tracheal bulla, the Salvadori's Duck (*Anas waigiuensis*) has been considered a near relative of the mallard group, but there is little in the species' behaviour which indicates it is a typical mallard and the bulla is also remarkably small. The African Black Duck (*A. sparsa*), which gives a stronger general appearance of being one of the mallard group, has a tracheal bulla which is relatively smaller than the typical mallard's. The Crested Duck (*Anas specularioides*) and Bronze-winged Duck (*Anas specularis*) have bullae of the same conformation as the mallard-like ducks (Phillips, 1924), but of decreased size and approaching the small bulla condition of the typical pintail-like ducks (*A. acuta* and *A. georgica*). Although the bullae are larger in the Bahama Pintail (*A. bahamensis*) and Red-billed " Teal " (*A. erythrorhyncha*), they are of the same shape as in the two preceding species and these four species comprise a homogenous evolutionary group.

The Silver Teal (*A. versicolor*) and Hottentot Teal (*A. punctata*) are unique among the species of *Anas* in that males possess a very marked enlargement of the trachea in the neck region. These two species are among the group termed " spotted " teal by Delacour (1954), but the other three species included by him in this group (Cape Teal, Red-billed Teal, and Marbled Teal) all appear to have closer relationships with other groups. The bulla shape of the Silver Teal (that of the Hottentot is unknown to me) is intermediate between the trangular shape of the pintail group and the rather globular shape of the blue-winged ducks (see photo section). This globular shape is found in the Garganey (*A. querquedula*), in which there is practically no asymmetry towards the left and the whistling voice typical of nearly all the preceding species is replaced by a low, wooden rattle. Most of the other blue-winged ducks also lack whistling voices (*A. discors* is the exception) and have small tracheal bullae situated more ventrally than towards the left (see photo section).

Behavioural evidence (Johnsgard, 1961) indicates that the Marbled Teal (" *Anas* " *angustirostris*) should be removed from the genus *Anas* and placed in a monotypic genus (*Marmaronetta*), adjacent to the pochard tribe. It possesses a male tracheal tube of gradually varying diameter such as occurs in male pochards (see photo section), and the bulla has several membranaceous fenestrae such as are typical of pochards and the Pink-headed Duck (Fig. 1).

Tribe Aythyini

The pochards exhibit an astonishing difference from the preceding tribe in the tracheal structure of males. Instead of a uniformly ossified and rounded bulla, there is a large, rather angular bulla on the left side which contains several membranaceous fenestrae, or " windows." As mentioned above, the Pink-headed Duck exhibits a transitional stage between the tracheal conditions of the Anatini and Aythyini, and has a crested and fenestrated bulla similar to those of male pochards (Fig. 1). In addition to this unusual bulla structure, the tracheal tubes in the males of most and perhaps all species of Aythyini are variable in diameter, with one or two enlargements (see photo section). The diameter of the tube in most species varies gradually, but in the Rosy-bill (*Netta peposaca*) the changes in diameter are abrupt. These diametric changes do not appear to have great taxonomic


ANSERANATINAE
ANSERANAS SEMIPALMATA
ANSERINAE
DENDROCYGNA ARCUATA
CYGNUS ATRATUS
Dendrocygnini
Anserini
ANSER ANSER
ANATINAE
Tadornini
CHLOEPHAGA POLIOCEPHALA
TADORNA FERRUGINEA
TADORNA RADJAH
NETTAPUS COROMANDELIANUS
Cairinini
CALLONETTA LEUCOPHRYS
AIX SPONSA
ANAS CAPENSIS
Anatini
MARMARONETTA ANGUSTIROSTRIS
NETTA RUFINA
POLYSTICTA STELLERI
Aythyini
HISTRIONICUS HISTRIONICUS
BUCEPHALA ISLANDICA
MERGUS CUCULLATUS
MERGUS MERGANSER
Mergini
TACHYERES PATACHONICUS
CAIRINA SCUTULATA
CLANGULA HYEMALIS
STICTONETTA
MELANITTA FUSCA
RHODONESSA
THALASSORNIS LEUCONOTUS
BIZIURA LOBATA
Oxyurini
CEREOPSIS
0 1 2 3 4 5
Cm.

significance, but there are some variations in the shape of the bulla itself which seem to suggest certain groupings. The genus *Netta* is relatively variable. The Red-crested Pochard (*N. rufina*) has two enlargements in the tracheal tube (Fig. 1) whereas the other two species of *Netta* have single enlargements. In the Rosy-bill, and also in the Tufted Duck (*Aythya fuligula*) and the scaup-like ducks the right side of the bulla is more inflated than in the other species.

Tribe Mergini

The sea ducks (here including the eiders, which have been placed by Delacour in a separate tribe) are the most variable in their tracheal anatomy of any single group of waterfowl. Partly because of this, Humphrey (1958) advocated the separation of the eiders from the other sea ducks and their placement near the Anatini. Indeed, the tracheae of eiders are remarkably like those of *Anas,* since the tracheal tubes are of uniform diameter and the bullae are completely and uniformly ossified and are of the same general configuration as those of some species of *Anas*. However, the Labrador Duck (*Camptorhynchus labradorius*) has an apparently similar tracheal bulla (Wilson, 1832), as does also the Harlequin Duck (*Histrionicus histrionicus*) (Fig. 1), although these two species otherwise appear to be relatives of the scoters (*Melanitta*) and the other sea ducks. The scoters are among the most aberrant of the ducks with regard to their tracheal anatomy, for in the Black Scoter (*M. nigra*) there is essentially no bulla, and in the Velvet (*M. fusca*) and Surf (*M. perspicillata*) Scoters the bulla is small and almost symmetrical (see Fig. 1 and photo section). In some species of scoters (especially *M. nigra*) and eiders (*Somateria*) the bronchi are greatly enlarged. The Steller's Eider (*Polysticta stelleri*) has a small bulla, but the associated muscles are highly developed, an unusual situation in view of the very silent nature of male Steller's Eiders (Fig. 1).

The Long-tailed Duck (*Clangula hyemalis*) possesses a trachea of relatively uniform diameter with a rather scoter-like bulla that is asymmetrically enlarged and fenestrated by one major and one minor " window " on the left side (Fig. 1). The Bufflehead (*Bucephala albeola*) has an undistinguished trachea which lacks swellings and has a small, simple bulla which is much like those of Velvet and Surf Scoters except that, as in the Long-tailed Duck, two membranaceous " windows " are present on the left side. In the goldeneyes (*Bucephala*) this basic form is more complex, but is certainly a modification of the type of bulla present in scoters and the Long-tailed Duck. In both species of goldeneyes the bulla is large and the two " windows " are placed more dorsally and anteriorly on the left side (Fig. 1). Unlike the Bufflehead and Long-tail, both species of goldeneyes have tracheae with distinct mid-tracheal swellings. In the Barrow's Goldeneye (*B. islandica*) this swelling is gradual and includes much of the tracheal tube, but in the Common Goldeneye (*B. clangula*) it is more abruptly restricted and is arranged in a cone-like

FIGURE 1. Ventral views of syrinxes of adult male Anatidae, arranged on a simplified evolutionary tree. The drawings of *Stictonetta, Tachyeres, Rhodonessa, Histrionicus* and *Biziura* are based on published illustrations and may not be to scale.

fashion that is " telescoped " normally but can be greatly extended (see photo section). This interesting adaptation no doubt is associated with the remarkable head-throw displays typical of the Common Goldeneye, which result in much greater neck-stretching than is the case during Barrow's Goldeneye display.

The mergansers (*Mergus*) exhibit a remarkable degree of variation in tracheal structure among the eight species. The Hooded Merganser (*M. cucullatus*) has a tracheal tube with one swelling near the bulla and a series of small " windows " just anterior to the bulla (Fig. 1). The bulla is shaped very much like those of the goldeneyes, with only a very small fenestra present on the side of the left chamber and a weakly ossified right chamber. The male Smew (*M. albellus*) has a tracheal tube rather uniformly enlarged over the female's, and the *sternotrachealis* muscles are also somewhat enlarged (see photo section), though not so markedly as in the Steller's Eider. The Smew's bulla is strongly enlarged towards the left, and the " windows " are much more noticeable than in the Hooded Merganser. The extremes of this tendency towards bulla inflation and development of large " windows " occur in the Red-breasted Merganser (*M. serrator*) and Goosander (*M. merganser*). In the male Red-breasted Merganser (see photo section) both the left and right chambers are greatly enlarged and contain fenestrae that are large and oval. The male Goosander has a tracheal tube with two enlargements and an asymmetrically inflated bulla with an extraordinarily large and fenestrated left chamber (Fig. 1). According to Humphrey (1955), the Brazilian Merganser (*M. octosetaceus*) has a trachea similar to that of the Red-breasted Merganser, whereas the Chinese (*M. squamatus*) and Auckland Island (*M. australis*) Mergansers agree more closely with the Goosander.

Tribe Oxyurini

The stiff-tail group is perhaps the most distinctive of all the tribes of waterfowl with respect to specializations for sound production. Although no species is known to have large or asymmetrical tracheal bullas, the auditory mechanisms are none the less of much interest. The Black-headed Duck (*Heteronetta atricapilla*), which appears to provide the most likely evolutionary " link " between the Oxyurini and the other waterfowl, has a simple male syrinx, a trachea which is enlarged near the middle of the tube, and lacks any tracheal air sacs. However, the oesophagus is enlarged and is probably inflatable and there is a large inflatable throat sac that connects with the mouth in males (Wetmore, 1926). Which of these structures is responsible for producing the various sounds which have been attributed to male Black-headed Ducks is uncertain.

Among the typical stiff-tails (*Oxyura*), the tracheal and oesophageal anatomy has been described for only a few species. The male North American Ruddy Duck (*O. j. jamaicensis*) has a simple trachea with a large air sac connecting with the dorsal side and which can be inflated at will. This sac serves as a " sounding board " for the bill-drumming, or " Bubble," display of the male, and is deflated to produce sound at the end of each display. The White-headed Stiff-tail (*O. leucocephala*) has a very similar display and so presumably has a similar tracheal air sac. In the Argentine Ruddy Duck (*O. vittata*) this sac is rudimentary, but the oesophagus of the male is enlarged and is apparently inflatable (Wetmore, 1926). In both this species and the

Australian Blue-billed Duck (*O. australis*) one of the common male displays is to inflate the neck, rear up in the water, and perform rapid preening-like movements of the bill against the breast which probably serve to deflate the oesophagus and produce sound. The Maccoa Duck (*O. maccoa*) male is reported to utter a loud " croaking " note without special head movements, and although it can inflate its neck it is not yet known whether this is the result of tracheal or oesophageal specializations. Likewise, the Masked Duck (*O. dominica*) male has a fairly loud voice, but the existence of inflatable neck structures has not been recorded.

The Musk Duck (*Biziura lobata*) has a trachea with a simple, bony syrinx that probably is the source of the male's whistling note (illustration in Fig. 1 after Beddard, 1898). Males also have an inflatable pouch (behind but not connected with the wattle) located below the tongue, which is possibly the origin of the male's well-known " plonk " call. The very aberrant White-backed Duck (*Thalassornis leuconotis*) seems to lack any form of inflatable air sacs or specialized oesophageal structure, but both sexes have loud, clear whistling voices that are reminiscent of whistling ducks or guinea pigs. The trachea of the male (Fig. 1 and photo section) is a simple tube with a rather long but not inflated bony bulla at the syrinx which is much like those of female whistling ducks. It seems most likely that this superficial similarity in the voice and trachea of the White-backed Duck to those of whistling ducks is the result of convergence, although this species also shows with the whistling ducks the previously undescribed feature of reticulated tarsi.

Discussion

As is true of many anatomical features, the value of the trachea for taxonomic purposes varies greatly in different groups. In the swans and true geese there is little inter-species variation in the basic structure of the trachea and syrinx, and accordingly the possibilities for taxonomic utilization appear to be reduced. In the shelducks (Tadornini), perching ducks (Cairinini) and dabbling ducks (Anatini) males of all species exhibit asymmetrical osseous tracheal bullas that often differ greatly within genera and sometimes provide strong clues as to relationships not otherwise evident (e.g., Cape Teal and Red-billed Teal). Tracheal evidence also points to distinctly different relationships in the case of the Pink-headed Duck and Freckled Duck from those which have heretofore been suggested.

The greatest degree of sexual dimorphism in tracheal structures occurs in the pochards (Aythyini) and especially the sea ducks (Mergini), in which the tracheal tubes and bronchi of males are often enlarged and the bullae are usually large and partially membranaceous. Here again the tracheal structure provides some interesting and valuable evidence for judging relationships (e.g.. Harlequin, Bufflehead, and Hooded Merganser), which are not always obvious from other evidence. Finally, in the stiff-tail group (Oxyurini) it seems likely that a combined study of the displays and the sound-producing structures of the various species of *Oxyura* would provide fascinating information on evolutionary relationships as well as on the inter-relationships between anatomy and behaviour.

As a final point, the evaluation of tracheal structures should be done with a full awareness of the actual vocalizations produced by the species being studied. For example, some species with outwardly similar male tracheal

structures (such as eiders and mallards) have extremely divergent vocalizations and thus the appearance of the trachea does not always indicate the type of vocalization produced. It is the latter which is of primary importance to the species, as well as to related species which live in the same region. Thus, simply because the trachea is an internal structure there is no reason to believe that it is less subject to convergent evolution than are certain external characteristics.

Opportunities for Future Studies

In spite of the fact that ornithologists have been interested in the tracheal anatomy of waterfowl for over a century, the tracheae of several species still remain to be described. The most important of these include the Pink-eared Duck and the Blue Duck, and the descriptions of male tracheae from such species as the Crested Duck, Bronze-winged Duck, Brazilian Teal, and numerous other species are inadequate and could be greatly improved with drawings or photographs. Likewise the male tracheal and oesophageal structures of the White-headed Stiff-tail, Maccoa Duck and Australian Blue-billed Duck should be examined and described. It is indeed fortunate that the tracheae of such now-extinct species as the Pink-headed Duck, Labrador Duck, and Auckland Island Merganser were described, for in each case important evidence for judging relationships has resulted which otherwise would have been entirely lost.

The means of preserving tracheae is exceedingly simple. The trachea is cut off at the base of the tongue and at the points where the bronchi enter the lungs. It can then be placed in an oxidizing solution such as hydrogen peroxide for bleaching and to loosen the excess connective tissues, and is finally dried and mounted. Submergence in a preservative such as formalin is a less satisfactory alternative procedure. The Wildfowl Trust would be pleased to receive tracheae from such species as are not usually represented in live collections.

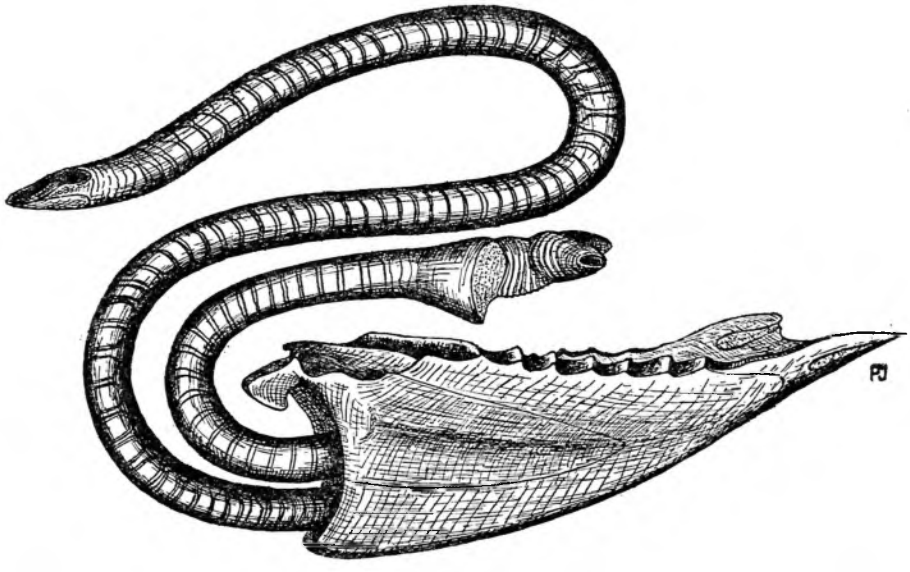


FIGURE 2. Lateral view of sternum and trachea of adult male Eastern Bewick's Swan (*Cygnus columbianus jankowskii*).

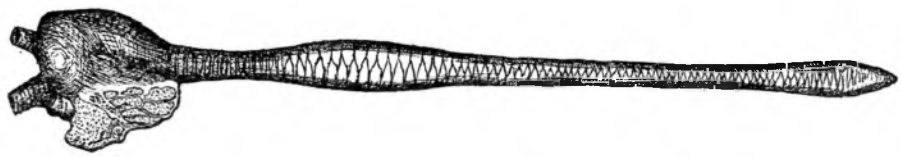


FIGURE 3. Trachea of male Pink-headed Duck, based on specimen of uncertain origin in the British Museum (N.H.). The view is a more directly ventral one than is the illustration on which the drawing in Fig. 1 was based and clearly shows the pochard-like bulla as well as the enlarged tracheal tube.

Acknowledgements

The information presented in this paper was obtained while the author was studying under National Science Foundation and U.S. Public Health Service postdoctoral fellowships. I would like to express my appreciation to both of these agencies for their support.

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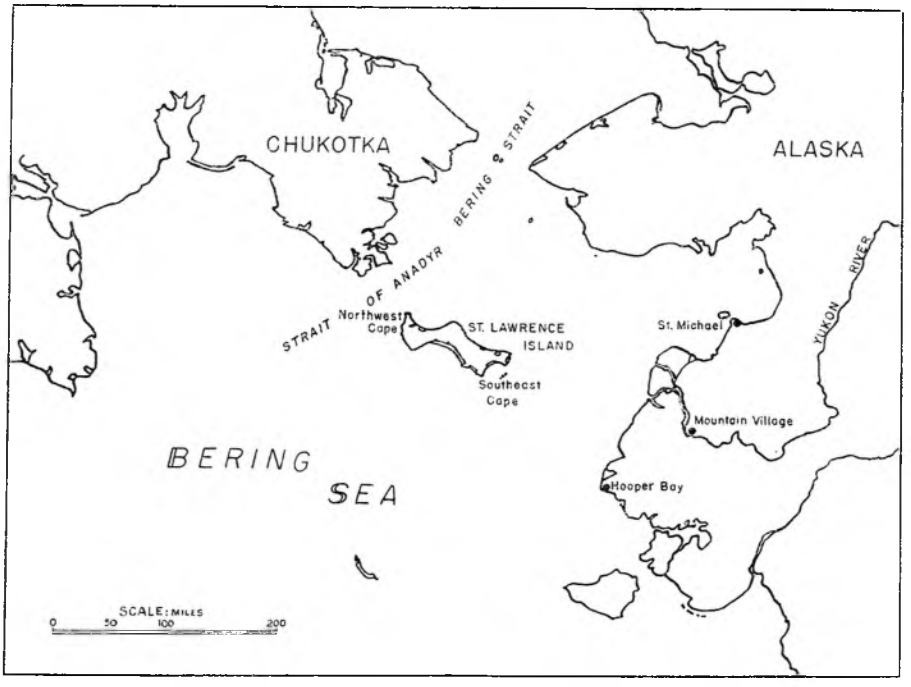

THE DISTRIBUTION OF WATERFOWL TO ST. LAWRENCE ISLAND, ALASKA

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Summary

TWENTY-TWO species of waterfowl are represented on St. Lawrence Island. Twelve of these breed on the island, and the rest occur irregularly or as migrants. The surrounding waters constitute a major wintering area for Long-tailed Ducks (*Clangula hyemalis*) and King Eiders (*Somateria spectabilis*), while in summer the island is an important breeding and moulting area for Emperor Geese (*Anser canagicus*), Pacific Eiders (*Somateria mollissima v-nigra*), Northern Pintails (*Anas acuta acuta*), and Long-tailed Ducks. Seasonal occurrence and some features of natural history of the more common species have been described.

The avifauna of St. Lawrence Island is more closely affiliated with that of North America than Asia. This may be a result of the island's relationship to the Bering Land Bridge, which probably had a strong influence on the intercontinental distribution of waterfowl. With gradual inundation of the land bridge during the last part of the Wisconsin (Würm) glacial epoch, the island's faunal tie to North America probably was weakened. A decrease in abundance of North American forms is indicated by a comparison of the Eskimo's waterfowl harvests of 1-2000 years ago with those of the present.

Introduction

St. Lawrence Island, a land mass of some two thousand square miles, is situated in the Bering Sea nearly midway between western Alaska and eastern Siberia (Fig. 1). The flora and fauna of this locality are typical of the low arctic and resemble those of the adjacent continents, to which the island evidently was connected quite recently in geologic time. Some ecologic and faunistic relationships of birds occurring on the island have been discussed

recently by Fay and Cade (1959), and material relating to the waterfowl is reviewed and enlarged upon in the present paper.

Some physical attributes of St. Lawrence Island that are of great importance to waterfowl are the 320-mile coastline and the extensive system of fresh and brackish water lagoons. The sand and gravel bars separating the lagoons from the sea comprise nearly one-third of the total coastline. About 60 per cent of the interior land area is low, rolling tundra dotted with lakes, while the remainder is mostly high, rocky upland. In summer, the shores and islands of the lakes and lagoons are nesting areas for about nine thousand ducks, geese, and swans, while the lagoons and coastal areas are resting, foraging, and moulting sites for these and more than twenty-five thousand non-breeding waterfowl. In winter, the surrounding ice-choked waters attract several hundred thousand sea ducks, which breed for the most part in higher arctic regions.

The vegetation of the island includes almost no arborescent forms; sedges, grasses, ericaceous shrubs, and cryptogams are abundant. The climate is low arctic maritime, with relatively milder winters and cooler summers than the adjacent continental areas. The average wind velocity is nearly 20 mph, and the prevailing wind direction is north-easterly (Weather Bureau, 1953). Storms with strong southerly winds are common from May through September, and precipitation occurs on approximately 300 days per year. Inclement weather predominates, and there are some indications that the climate is in large measure responsible for repelling some birds which might otherwise become established.

Ornithological investigations on the island have been intermittent and largely confined to the western half. Much of the information concerning the birds of the eastern half has come from the Eskimo, who formerly travelled widely over the island while herding reindeer. The earliest extensive account of the birds was published by E. W. Nelson (1883), and this was followed by a long series of notes and papers, especially by Herbert Friedmann and O. J. Murie. The earlier contributions were summarized by Friedmann (1932), and the more recent ones by Fay and Cade (1959). In the following description of the waterfowl, some information from previous accounts has been utilized, but I have drawn largely upon my own field notes made during 24 months of discontinuous observation from 1952 to 1960. The population figures included are approximations based upon casual observation and probably are accurate only within the limits of plus or minus 50 per cent.

The nomenclature and geographic ranges of the waterfowl considered in this paper are according to Delacour (1954-59).

The Seasonal Occurrence of Waterfowl

Winter

From December to May the island is surrounded by the ice pack, which extends from the polar sea to approximately the latitude 60°N. During the period 1st December to 30th April, the monthly mean temperatures range from 3° to 17°F, and snow squalls and blizzards are frequent. Prevailing winds pack the ice tightly against the northern coast and, at the same time, blow it away from the southern coast. Occasional contrary winds reverse this

pattern, and strong tidal currents along the shore modify it, especially at either end of the island, by alternatively dispersing and concentrating the ice about certain points and headlands. The result is an enormously complex, dynamic system of ice-free areas being created and obliterated continuously. Since openings are present somewhere around the island at all times, and since marine invertebrates abound, conditions are suitable for the over-wintering of a very large population of Long-tailed Ducks (*Clangula hyemalis*) and considerable numbers of King and Pacific Eiders (*Somateria spectabilis* and *S. mollissima v-nigra*).

The population of Long-tailed Ducks which winters annually about the island is conservatively estimated as five hundred thousand on the basis of aerial observations. These birds are constantly on the move, flying from one area of open water to another. With a reversal of wind and consequent packing of the ice on one coast, the entire population flies around and across to the opposite side of the island and alights again in the newly formed openings. During these flights in late winter and early spring, large numbers of Long-tailed Ducks are killed by the Eskimo for food.

The wintering Eiders may number upwards of fifty thousand but are much less evident than the Long-tailed Ducks because they tend to remain well offshore. In February, 1953, R. A. Ryder (*in litt.*) sighted one flock of King Eiders which he estimated contained fifteen thousand. He observed that the Pacific Eiders were present in much smaller numbers and were mixed with the large flocks of King Eiders. Both the Eiders and the Long-tailed Ducks are subject to predation by Snowy Owls (*Nyctea scandiaca*) and Gyrfalcons (*Falco rusticolus*) throughout the winter. The number of Gyrfalcons is small (certainly less than fifty), whereas several hundred Snowy Owls may be present in some years. Considering the large number of waterfowl present, it seems improbable that the predators have much effect on the populations, but I suppose that it may be as great as the mortality at the hands of the Eskimo. The latter usually take more than a thousand Long-tailed Ducks and less than two hundred Eiders during the winter months.

In most years, immigration of Long-tailed Ducks to the St. Lawrence Island region takes place in December when the first chunks of polar ice arrive from the north. They remain concentrated there at least until the middle or end of April, when milder weather and shifting winds begin to dissipate the ice pack. By 1st May, emigration is evident from the decrease in abundance, and toward the middle of the month, the Long-tailed Ducks that are present probably are those that will summer locally. The latter are nearly absent from the coast by the fourth week of May or first week of June, having moved inland to lakes and rivers from which the ice has begun to melt. The first courtship displays were noted on 25th April, and nesting probably commences in early June. Two nests found on 15th and 17th July contained four and six eggs, respectively, none of which had been incubated more than a week. Non-breeding birds seem to be about as numerous as the breeders, and flocks of from less than ten to more than a hundred are frequently seen along the lagoons and interior lakes from June to August. One flock sighted on 23rd August was flightless, and another flightless bird was seen on 2nd September. During September, these ducks disperse from the island and are rare or absent throughout October and November.

Spring

It is generally agreed by the St. Lawrence Islanders that winter ends in April with the arrival of the first whales and small groups of walrus. From this beginning until its end in early June, spring is a spectacular event in terms of vertebrate activity. The flight of birds to and from the island is continuous in the 24-hour daylight, and waterfowl comprise a large proportion of the total transient population.

The mean temperature during this period is about 30°F. Warm southerly winds are more frequent, and by the end of the season, most of the snow and ice is gone. Aside from the great population of Long-tailed Ducks, King Eiders are the earliest and most numerous migrants seen along the western coast[1]. These appear in abundance about 25th April and intermittently pass northward over the ice for about one month. Judging from the direction of flight, north of Northwest Cape, these birds are bound for both the Siberian and Alaskan coasts. Very few adults are present on the island in summer, but at least two thousand non-breeding birds remain in large flocks offshore and along the southern lagoons.

Pacific Eiders and Steller's Eiders (*Polysticta stelleri*) appear in force about 15th May, and a few Spectacled Eiders (*Somateria fischeri*) are also present at that time. Whistling Swans (*Cygnus columbianus columbianus*), Pacific Brent Goose (*Branta bernicla orientalis*), Emperor Geese (*Anser canagicus*), Lesser Snow Geese (*Anser cærulescens cærulescens*), and Northern Pintails (*Anas acuta acuta*) arrive somewhat later, usually between 20th and 29th May. The adult Steller's and Spectacled Eiders, like the King Eiders, mostly pass northward to their continental breeding grounds. Both of these species occasionally nest on the island, but for the most part their local summering populations consist of immature birds. The Swans, Geese, and Pintails pass in small numbers, and all proceed in a northwesterly direction, toward the Chukchi Peninsula. Breeding populations of each of these, except the Snow Geese, also remain on the island throughout the summer.

Of the Eiders seen on the western coast, the Pacific Eider is the most common throughout the spring and summer. A breeding population of, perhaps, thirty-five hundred occurs on the island in summer, and there is a smaller non-breeding group as well. The breeding birds move inland as the fresh water becomes ice-free in late May and early June, and incubation is under way by 15th June. In general, the nests are widely distributed over the island on nearly every type of terrain, but none has been found more than 500 yards from water. On several small islands in the southern lagoons, these ducks nest colonially, the maximum density being about a hundred pairs per acre. The average clutch size is approximately five eggs. Nests with fresh or slightly incubated eggs have been found frequently in the first two weeks of July, and females with downy young are a common sight after 15th July.

The Pacific Eider is taken by the Eskimo principally during the spring months, and eggs are collected from certain of the colonial nesting sites

[1]My observations of birds from mid-April to early June have been limited to a 20-mile segment of the western coast from Northwest Cape to the Moghoweyik River. Contrasting results of observations at Southeast Cape by a biologist (R. A. Ryder) and by the Eskimo indicate that avian activity on the western coast is by no means representative for the island as a whole. See " Delay in Migration." below.

nearly every year about the middle of June. The number of Pacific Eiders used annually by these people is less than five hundred, and the harvest of eggs may average more than a thousand.

During the height of the spring migration, several species of irregular or accidental occurrence have been recorded. These are the Thick-billed Bean Goose (*Anser fabalis serrirostris*), Pacific White-fronted Goose (*Anser albifrons frontalis*), Cackling Canada Goose (*Branta canadensis minima*), American Green-winged Teal (*Anas crecca carolinensis*), Baikal Teal (*Anas formosa*), European Wigeon (*Anas penelope*), and the Northern Shoveler (*Anas clypeata*).

Summer

In the long, cool days of summer, the skies are overcast more than 90 per cent of the time, and precipitation is frequent. The mean temperature during this period, mid-June to early September, is about 44°F, and winds are mostly from the south-west. Flocks of immature King and Steller's Eiders (up to two hundred per flock) are seen frequently offshore and along the lagoons, while Pacific Harlequins (*Histrionicus histrionicus pacificus*) occur along the southwestern cliffs and some other rocky points in aggregations of five to ten.

The nesting population of Whistling Swans on the western half of the island is less than ten pairs, and an approximately equal number of juvenile birds occupies this area. One pair of adults in courtship and defence of territory was seen on 24th and 25th May, and one empty nest was found on 29th July. Broods of two, three, four, and five downy young have been seen between 13th and 25th August. A group of seven flightless immatures was seen on 29th July, and the Eskimo report that the fledglings are incapable of flight until late September. Fledglings formerly were taken by the Eskimo for food, but this practice was discontinued at least fifteen years ago.

The density of the Northern Pintail population is highly variable, but in an average summer it may comprise more than a thousand breeders and about half as many non-breeders. The earliest nesting record is 15th June, and the latest 13th July. One hen with a brood was seen by P. E. Tovey (*in litt.*) on 15th August. The scarcity of brood records and the fluctuations in population density indicate that nesting is relatively unsuccessful in this locality.

Other ducks which occur irregularly but probably breed occasionally are the Pacific Scaup (*Aythya marila mariloides*) and the Red-breasted Merganser (*Mergus serrator serrator*). Both the White-winged and Black Scoters (*Melanitta fusca deglandi* and *M. nigra americana*) also have been recorded on several occasions, but none has been seen away from the littoral waters.

By far the most abundant and characteristic summering waterfowl on the island are the Emperor Geese. Between ten and twenty thousand non-breeding birds spend the summer along the southern coast and on some of the larger lagoons on the northern coast, congregating in large "herds" during the molt. I have seen the Eskimo capture flightless birds many times between 17th June and August 7th, and some apparently incapable of flight

were seen as late as 15th August. In an aggregation of approximately five thousand Emperor Geese along one of the southern lagoons on 21st July, 1960, not more than ten were capable of sustained flight.

It is difficult to estimate the size of the breeding population of Emperor Geese, but it is certainly no more than one-tenth as large as that of the immature birds. Clearly, the population of immatures is not entirely the product of local breeding. It seems probable, as Cade has suggested (Fay and Cade, 1959), that St. Lawrence Island is the principal summering area for the entire population of immatures produced in Alaska and Siberia.

According to the Eskimo, Emperor Geese nest extensively in the wet tundra of the central and eastern parts of the island. One nest with four partly incubated eggs was found by P. E. Tovey on 23rd June on the shore of a small lake in the central district (Fay and Cade, 1959, pl. 14, *b*). I have seen broods of two and three downy young on 15th and 29th July respectively, and one fledgling, fully feathered except for the head and neck, was taken on 22nd August. The latter was still unable to fly.

From about 10th to 22nd August there is a strong tendency for northward migration by the Emperor Geese and Eiders, both on the coasts and across the interior tundra and mountain ranges. The trend is reversed toward the end of August, and by 1st September nearly the entire population of immature Emperor Geese has departed from the western half of the island. Some Emperor Geese remain through September and early October, but these probably are all adults and young of the year. The Eskimo familiar with conditions on the eastern end of the island report that the southbound Emperor Geese congregate in the vicinity of Southeast Cape, and some remain there as late as December.

Fall

The interval between wet summer and icebound winter is long (September to December), severe storms are frequent, and birds are few. Winds are variable, though mostly from the north, and the temperature averages about 30°F. There is a strong, eastward migration of waterfowl along the coasts in September. Among the migrants are an estimated five thousand Lesser Snow Geese, which begin to arrive from Siberia about August 20 and pass intermittently for about a month. Most are in small flocks (ten to forty each), and the Eskimo state that these Geese depart directly from the eastern end of the island toward the Alaskan mainland. They are very shy, and no more than fifty are taken annually by the Eskimo.

Toward the end of September, waterfowl are relatively scarce on and near the island, and few are seen until the truly arctic species, *Clangula hyemalis* and *Somateria spectabilis,* return with the ice in December.

Delay in Migration

Whereas Ryder (*in litt.*) observed that Brent Geese were approaching the Southeast Cape of St. Lawrence Island on 1st May, 1954, none was seen at Northwest Cape until 28th May, that year. This discrepancy led to an examination of the arrival dates for other migrants and a comparison with arrivals on the Yukon Delta, a possible departure point for waterfowl flying to Siberia by way of the island. The comparison is shown in Table 1, in which the earliest dates for arrivals on the Delta have been drawn from the

compilation by Gabrielson and Lincoln (1959). Since the earliest arrival of Brent Geese on the Delta (5th May) corresponds closely to Ryder's record, it is assumed that the dates for other species are equally comparable. Waterfowl which occur around the island in winter and those for which comparative dates are not available have not been included in the table.

On the basis of the number of days between arrival dates for each species, the birds of Table 1 are divisible into two groups, *viz.* those which reach both localities within plus or minus ten days of the same date and those which reach Northwest Cape twenty to thirty days after their arrival

Table 1. Some comparative arrival dates of migrant waterfowl in spring on the Yukon Delta and at Northwest Cape, St. Lawrence Island.

Species	Date of earliest arrival	
	Yukon Delta*	Northwest Cape
Cygnus columbianus columbianus	" mid-April " (SM)	May 24
Anser cærulescens cærulescens	April 29 (MV)	May 21
Anser canagicus	May 15 (HB)	May 9
Branta bernicla orientalis	May 5 (SM)	May 28
Anas acuta acuta	April 28 (SM)	May 19
Aythya marila mariloides	May 18 (HB)	May 27
Polysticta stelleri	May 18 (HB)	May 16
Somateria fischeri	May 5 (HB)	May 13

*Localities: HB—Hooper Bay; MV—Mountain Village; SM—St. Michael

on the Delta. With one exception (*Aythya marila mariloides*), the birds of the first group winter primarily in the vicinity of the Aleutian Islands, while the second group winters mostly far to the south, in the western United States. The latter, having already completed the major portion of their migration, evidently tarry along the final segment of their route. On the other hand, the northern species have a relatively short distance to go and proceed more directly to their destination. The Brents, and possibly the others as well, evidently linger along the southern coast of the island.

In fall, the trend seems to be reversed, the northern species remaining longest and the southern group departing directly toward the mainland.

Recent History and Faunal Relationships

During the last part of the Wisconsin (=Würm) glacial epoch, St. Lawrence Island evidently remained connected to North America as a part of the Bering Land Bridge for more than a thousand years after the connection with Siberia had been severed (Hopkins, 1959). In consideration of this point and the position of the island relative to the probable form of the " bridge " (Hopkins, 1959, Fig. 5), one might expect the fauna to show slightly stronger affinity to North America than to Eurasia. For the birds, in general, this affinity has been demonstrated (Fay and Cade, 1959), and for the waterfowl, in particular, it is clearly shown by the status of species or races in the modern fauna (Table 2). Five of these are of North American origin, three are Asiatic, and the remainder are Circumpolar or Amphi-Pacific in distribution. Of the North American representatives, one breeds on the island, one occurs in large numbers as a migrant, and the others occur irregularly. Each of the Asiatic representatives, on the other hand, is known only from a single, extra-limital record.

The fourteen species and races of Circumpolar and Amphi-Pacific distribution comprise nearly 99 per cent of the total number of waterfowl utilizing the island and more than 99 per cent of the breeding population. For an island so near and so recently connected to Asia and North America, the representation of birds peculiar to these continents seems disproportionately small. It would seem, anyway, that the continental forms must have been more numerous during the periods when the land bridge was extant. Of course, there are no paleontological records available to compare with the present fauna in order to test this hypothesis, i.e., to determine what changes, if any, have taken place in, say, the last ten thousand years. Fortunately, there are some archeological records for the final quarter of that period, and these, cautiously interpreted, do suggest possible changes.

Table 2. Status of the recent waterfowl of St. Lawrence Island.

Faunal affinity	Species	Present status
NORTH AMERICAN		
	Cygnus columbianus columbianus	common; breeds
	Anser cærulescens cærulescens	abundant; migrant
	Branta canadensis minima	irregular
	Anas crecca carolinensis	irregular
	Melanitta fusca deglandi	irregular
ASIATIC		
	Anser fabalis serrirostris	accidental
	Anas formosa	accidental
	Anas penelope	accidental
AMPHI-PACIFIC		
	Anser albifrons frontalis	irregular
	Anser canagicus	abundant; breeds
	Branta bernicla orientalis	uncommon; breeds
	Polysticta stelleri	common; breeds
	Somateria mollissima v-nigra	abundant; breeds
	Somateria fischeri	uncommon; breeds
	Aythya marila mariloides	uncommon; breeds (?)
	Melanitta nigra americana	irregular
	Histrionicus histrionicus pacificus	common; breeds (?)
CIRCUMPOLAR		
	Anas acuta acuta	common; breeds
	Anas clypeata	accidental
	Somateria spectabilis	common; breeds (?)
	Clangula hyemalis	abundant; breeds
	Mergus serrator serrator	irregular; breeds (?)

In 1934, Friedmann published a note on the identification and distribution of several thousand bird bones from archeological sites on St. Lawrence Island. Much of the waterfowl material in this collection was excavated on the southeastern tip of the island from the lower levels of a large kitchen midden at Kialegak. This site was occupied intermittently from about two thousand to one thousand years ago and again in a more recent period (see Collins, 1937). The rest was obtained on the northwestern tip of the island, principally from three sites ranging in age from about a thousand to more than twenty-five hundred years old. Taken at face value, the proportion of these collections comprised by each species is not representative of the status

of the populations extant at the time, but relative abundance is certainly reflected in a general way. In order to interpret this, however, one must take into account the effects of preferential selection on the part of the Eskimo and the efficiency of their hunting methods. For example, today the Pacific Eider is taken in preference to any other duck because of its large size and the fine quality of its flesh. About half as many Pacific Eiders as Long-tailed Ducks are taken annually, although more than ten times as many of the latter are available during the year. The Long-tailed Ducks are among the least desired for food and are taken only when no other birds are available. On the other hand, Snow Geese are at present the most desired of the Anserinae, but they make up a very small proportion of the total harvest. Though abundant in migration, they are very shy and difficult to obtain, even with firearms. In the past, when the hunting equipment used for waterfowl consisted of spears, snares, and the bolas, Snow Geese would have been very rarely taken.

Having a rather complete understanding of the preferences and techniques utilized today and the sampling error introduced by them in the modern waterfowl harvest, it is possible to interpret the harvests of the past if one assumes that the preferences were similar but the equipment and techniques were less efficacious. With their primitive equipment, " it is obviously unlikely that the Eskimos would have been able to get numbers of birds that were rare at the time " (Friedmann, 1934, p. 84); hence, those species represented in the collections must have been relatively common.

In Tables 3 and 4 the waterfowl harvests of the past have been compared with those of the present, and to each species has been assigned a symbol indicating the direction of change of status. Only those species that were represented in the middens or are taken annually in the modern harvest have been included. The archeological data summarized in Table 3 are from the three oldest sites (2500-1000 B.P.) near Northwest Cape; Table 4 contains a summary of the Kialegak collection (mostly 2000-1000 B.P.). The difference in number and kind of species represented at Northwest Cape as compared to Southeast Cape is merely a reflection of the distribution of waterfowl on the island. Those present in Table 4 but not in Table 3 ordinarily do not occur in the northwestern district.

Table 3. Ancient and modern waterfowl harvests by Eskimo at Northwest Cape, St. Lawrence Island.

Species	Relative quantity (a) Past	Present	Change in status (b)	Faunal affinity
A. a. frontalis	x	—	—	Amphi-Pacific
A. c. cærulsecens ..	—	x	0	North American
A. canagicus	—	xx	+	Amphi-Pacific
B. b. orientails	—	x	0	Amphi-Pacific
A. a. acuta	—	x	0	Circumpolar
P. stelleri	x	x	0	Amphi-Pacific
S. m. v-nigra	xxx	xxx	0	Amphi-Pacific
S. fischeri	—	x	0	Amphi-Pacific
S. spectabilis	xx	xx	0	Circumpolar
A. m. mariloides ..	x	—	—	Amphi-Pacific
H. h. pacificus	xx	—	—	Amphi-Pacific
C. hyemalis	xx	xxx	0	Circumpolar

(a) xxx — common; xx — uncommon; x — rare; — — none.
(b) + — increased; 0 — no change; — — decreased.

Obviously, the result of weighting the harvest data is rather inexact, but the trend indicated is highly suggestive of a diminution in the North American and Amphi-Pacific elements during the last 2000 years. Of the North American species represented in the harvests, two have apparently remained unchanged while four have decreased in abundance. Of the Amphi-Pacific species, five are unchanged, three have decreased, and one evidently has increased. None of the Circumpolar species has undergone any changes detectable from this material.

Table 4. Ancient and modern waterfowl harvests by Eskimo on the southern coast, St. Lawrence Island.

Species	Relative quantity (a) Past	Present	Change in status (b)	Faunal affinity
C. c. columbianus ..	x	—	0	North American
A. a. frontalis	x	—	—	Amphi-Pacific
A. c. cærulsecens ..	—	x	0	North American
A. canagicus	xx	xxx	+	Amphi-Pacific
B. c. minima	x	—	—	North American
B. b. orientalis	x	x	0	Amphi-Pacific
A. a. acuta	x	x	0	Circumpolar
P. stelleri	xx	x	0	Amphi-Pacific
S. m. v-nigra	xxx	xxx	0	Amphi-Pacific
S. fischeri	xx	x	—	Amphi-Pacific
S. spectabilis	xxx	xx	0	Circumpolar
A. m. mariloides ..	—	x	0	Amphi-Pacific
M. f. deglandi	xx	—	—	North American
M. perspicillata	x	—	—	North American
M. n. americana ..	xx	—	—	Amphi-Pacific
H. h. pacificus	xx	x	0	Amphi-Pacific
C. hyemalis	xx	xxx	0	Circumpolar
M. s. serrator	x	x	0	Circumpolar
M. m. americanus (?) ..	xx	—	—	North American (?)

(a) xxx — common; xx — uncommon; x — rare; — — none.
(b) + — increased; 0 — no change; — — decreased.

Discussion

The physiography of the Bering Land Bridge during several stages of inundation toward the end of the Wisconsin glacial epoch has been broadly described by D. M. Hopkins (1959). For several thousand years St. Lawrence Island evidently was a part of the southern shore of this intercontinental link, and as such was situated on what probably was a major coastal migration route for aquatic birds. The general alignment of this coastline seems to have been northwest-southeast, diagonally across the, now, Bering Sea from Bristol Bay to southeastern Chukotka. Any waterfowl using this coastal route probably would have been species which wintered in western North America and spread northward in summer to breed in the non-glaciated regions of Alaska, eastern Siberia, and on the land bridge itself. The present movement of waterfowl between western Alaska and eastern Siberia by way of St. Lawrence Island may be a relict of that migration.

Judging from the bathymetry of the Bering-Chukchi Platform, with gradual inundation, the land bridge was bisected by a broad channel extending from the Strait of Anadyr north to Bering Strait (Hopkins, 1959). With further inundation, the channel evidently became wider and the southern coast of the defunct " bridge " receded northward and eastward, leaving St.

Lawrence Island first as the end of a peninsula and later as an isolated island. As the coastline changed, so also must the migration routes have changed, though at a much slower rate. In my opinion, the increasing overwater distance between western Alaska and St. Lawrence Island in the last 10,000 years, together with modifications of climate, must have been a deterrent to trans-Beringian migration, resulting in a very gradual diminution of the island's avifaunal tie to the continent. A comparison of the Eskimo's waterfowl harvests of 1-2000 years ago with those of the present indicates the kind of changes that have taken place in the final quarter of that period and gives some inkling of the rate at which they have occurred.

It is significant that those species, the status of which seems to have changed the least in the last 2000 years, are the same species that still migrate via the island to Siberia to breed. Those which evidently were abundant in the past but do not breed in Siberia at present, have decreased or are now absent from the insular fauna. It appears that the strength of the present avifaunal tie to North America is derived more from the use of the trans-Beringian migration route than from the suitability of the island, itself, as a habitat for continental birds.

Acknowledgements

For assistance in the field and for contributing information used in this paper, I am indebted to the following: Ronald A. Ryder, Robert L. Rausch, and the residents of St. Lawrence Island, especially Charles, Vernon, and Roger Slwooko, Clarence Pungawe, Nathaniel Iya, and the late Paul E. Tovey. The field notes on which much of the paper is based were by-products of other biological studies supported in part by the Arctic Institute of North America under an Office of Naval Research subcontract (ONR-77), the University of British Columbia, and the Public Health Service, United States Department of Health, Education, and Welfare.

I am grateful to Robert L. Rausch, Francis S. L. Williamson, Tom J. Cade, and Max C. Thompson for suggestions and criticisms of an earlier draft of the paper.

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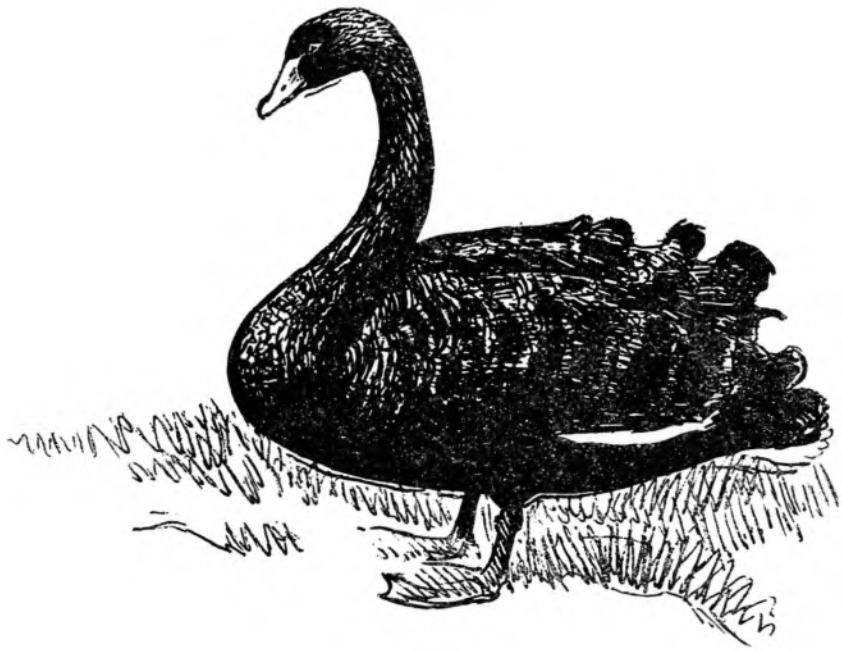

ECOLOGY OF WILD DUCKS IN INLAND AUSTRALIA*

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Summary

In inland Australia waterfowl habitats fluctuate greatly in extent from year to year. Small areas of permanent habitats occur but the most extensive habitats are those that are formed periodically and erratically by flooding of the rivers.

The movement patterns of the various species of wild ducks that inhabit the region vary according to the habitat occupied by the species and vary in regularity according to the permanence of the habitat. Species which are confined to the permanent swamps are very regular in movement, being either sedentary or regularly migratory, but those that utilize the more temporary habitats have developed nomadic habits to a very high degree.

The degree of mobility of the different species is related to their food requirements. The species having regular movements have regular food cycles. Some nomadic species have very adaptable food habits and can utilize a very wide variety of foods, thus being able to exploit all types of water as they occur. One nomadic species, however, is a food specialist and accordingly has developed an extreme type of nomadic wandering.

The species characteristic of permanent swamps have very regular breeding seasons but the nomadic species are able to breed at any time of the year whenever suitable conditions occur. The sexual cycle culminating in breeding is initiated by increasing water level in rivers. In this manner whenever flooding occurs the birds breed in the newly developed floodwater. The same factor, increasing water level, that initiates breeding in the birds initiates breeding in the animals forming the food of the ducklings so that abundant food is available.

*Reprinted from *Biogeography and Ecology in Australia* pp. 383-395, published by W. Junk, Den Haag, 1959, with the permission of the author, the publishers and the Officer-in-Charge, Wildlife Survey Section, C.S.I.R.O., Canberra.

Introduction

In many countries and in the coastal regions of Australia, where the seasons are reasonably regular, the movements, breeding and feeding patterns of waterbirds are well established. In the Northern Hemisphere it has been possible to accurately chart migration routes and breeding seasons and to forecast with some expectation of accuracy the numbers of birds liable to reach the extremities of their migration routes and the dates of their movements.

In inland Australia, however, the climate is arid and erratic. The depth and extent of water areas fluctuate widely from year to year. In some years, following flood, there may be hundreds of square miles of swamp in a region, but this may dry up and the land remain dry and parched for many years. Under conditions such as these it is apparent that waterbirds must develop adaptations to enable them to deal with the rapidly and erratically changing situations. This paper summarizes the results of studies on various aspects of the ecology of wild ducks in inland New South Wales and seeks to explain how wild ducks can exist in very large numbers in this semi-arid environment.

The Environment

The climate of inland Australia has been discussed in detail by many authors (e.g. Lawrence, 1937). The boundaries of the State of New South Wales enclose a typical cross section of all environmental conditions that are found on the continent ranging from the well watered coast to the semi-deserts in the far western parts of the State. The majority of the work on which this paper is based, was carried out in mid-western New South Wales between the 20-inch isohyet in the east and the 8-inch in the west; the rainfall is erratic and seldom approximates the annual average. In the north most of the rain falls in the summer and in the south most of it falls in the winter. Summer temperatures are high and the annual evaporation varies between 50 inches in the east and 100 inches in the west. The region is semi-arid with unreliable rainfall.

The land is flat and forms part of the flood plain of the Murray-Darling river system. The principal rivers, the Murray, Murrumbidgee, Lachlan, Macquarie, and Darling are sluggish and characterised by extensive systems of meanders, " billabongs " (ox-bows) and effluent streams. The levels of the rivers vary greatly; in times of flood the waters of the Murray, Murrumbidgee, and Lachlan may actually join across the plains but at other times the rivers may cease to flow and even dry up. The level of these rivers and flooding of the plains are mainly determined by conditions on the catchments hundreds of miles to the east and local rainfall is seldom sufficient to affect their level. They need have no relation to the local climate at the time and may occur at any time of the year.

Waterfowl Habitat

Streams

None of the rivers is entirely permanent but although they often cease to flow they seldom dry up entirely. Flooding is rather frequent and each 4 or 5 years on an average much of the region is inundated. The rivers in general have steep bare banks and under these conditions few aquatic plants

grow. Herbs, however, periodically flourish on exposed mud banks and beaches.

The effluent streams are normally dry but when the river reaches a sufficient level water flows into them and is carried far into the plains. The extent of the development of effluents and their type varies greatly between rivers and accordingly minor flooding gives different effects. In some cases a minor increase in water level merely leads to an increased rate of flow through the numerous streams, but in others quite a small rise in river level forces water to flow through the numerous effluents and sends shallow, temporary water across very large areas of swamps and reedbeds.

Irrigation areas, and Domestic Stock and Water Supply districts have been developed in the region. The channels carry water only periodically but, in some places, their banks support dense growths of *Eleocharis, Juncus, Polygonum,* and *Carex,* and provide thin strips of green herbage through otherwise dry plains.

Billabongs

For the present purpose three distinct types are recognised. The juvenile billabong is one which has apparently only recently been separated from the river. Its banks are tree lined, steep, deep, and bare of herbage. It has virtually no shallows. The inlet and outlet creeks are always present and almost as deep as the river itself. This means that a rise of a few feet in river level will cause water to flow through the billabong, but also a fall of a few feet will cause it to drain out again. Juvenile billabongs are usually dry or nearly so.

In more mature billabongs the banks are eroded to a gentle slope and the water course itself has partly filled with silt. The water is relatively shallow and supports perennial aquatic plants including *Potomogeton.* They usually have quite extensive shallow edges well colonised by *Carex* and *Eleocharis.* As the billabong silts up further it often loses its characteristic shape and the normal water level recedes further from the tree line which remains to mark flood level. Due to the relative shallowness of the water the whole area is usually colonised by aquatic plants. A lagoon usually has relatively wide shallow edges carrying *Juncas, Scirpus,* and *Polygonum,* and in the deeper centre may be *Azolla, Marsilea drummondii* and other aquatic plants.

Swamps

Swamps with dense emergent vegetation are formed in the more permanent water areas. Three distinct types are developed depending on the permanence of the water. Where the water is deep and permanent the dominant vegetation is cumbungi, *Typha angustifolia,* which forms dense pure stands. The deeper parts are occupied by *Azolla* and *Myriophyllum,* and the shallow edges usually carry stands of *Eleocharis, Carex, Marsilea drummondii, Agrostis avenaceae,* and *Paspalum distichum.*

In those depressions in which the water is less permanent and shallower, cane grass *Glyceria ramigera* is dominant forming a cane grass swamp. Normally *Marsilea drummondii* and *Azolla* do not occur and the more open parts of the swamp support heavy growth of *Eleocharis, Carex, Scirpus,* and other aquatic plants.

Lignum *Muehlenbeckia cunninghamii* is the dominant vegetation in areas subject to less frequent inundation, the more frequent the flooding the denser the lignum; few other aquatic plants occur in lignum swamps.

Temporary Water

On flooding of the rivers very large areas of the plain are covered by water to a shallow depth. These areas of residual floodwaters make available to the ducks an abundance of submerged dry-land plants and become colonised by large numbers of aquatic animals. They are sometimes sufficiently permanent for aquatic plants to develop.

Temporary water is also held in claypans, naturally occurring, circular depressed areas on the treeless plains. The bottoms are flat and composed of heavy clay, and support no plant growth. In times of heavy rain these collect water and form shallow temporary lakes but this water quickly evaporates and although claypans are often the source of some animal, particularly insect, life, they never support any plant growth.

Habitat Utilization

Twelve species of waterfowl, listed below, occur regularly and breed in the region.

Black Swan	*Cygnus atratus* (Latham)
Mountain Duck (Australian Shelduck)*	*Tadorna tadornoides* (Jardine & Selby)
Wood Duck (Maned Goose)	*Chenonetta jubata* (Latham)
(Australian) Black Duck	*Anas superciliosa* Gmelin
(Australian) Grey Teal	*Anas gibberifrons* Muller
Chestnut (-breasted) Teal	*Anas castanea* (Eyton)
(Australian) Blue-winged Shoveler	*Anas rhynchotis* Latham
Pink-eared Duck	*Malacorhynchus membranaceus* (Latham)
Freckled Duck	*Stictonetta naevosa* (Gould)
White-eyed Duck (Australian White-eye)	*Aythya australis* (Eyton)
Musk Duck	*Biziura lobata* (Shaw)
(Australian) Blue-billed Duck	*Oxyura australis* Gould

*names in parentheses are those used in *A Coloured Key to the Wildfowl of the World.* (P. Scott, 1957).

The Plumed Tree Duck *Dendrocygna eytoni* (Eyton) is an irregular visitor and may sometimes breed. Among these species some distinct habitat preferences exist.

Streams

The main stream of the rivers forms the principal Wood Duck and Mountain Duck habitat in the region. Both these species are almost exclusively grazing animals and feed on the banks. The rivers are used to a very limited extent by Black Duck and Grey Teal, but are completely avoided by the other species. Even in times of drought, when the main streams retain some water, few ducks are found on them. Presumably river water does not provide sufficient food for the wild ducks.

The effluent streams, which are not so deep nor as permanent as the rivers, provide important feeding habitat for all species except the swan and diving ducks. These are apparently excluded by lack of breeding sites and of suitable food. The species utilizing effluent streams vary according to the vegetation. Where the stream flows through living timber Wood Ducks, Black

Ducks, and Grey Teal are abundant; where the timber fringe is not continuous Wood Ducks and Black Ducks are less numerous and Grey Teal the commonest species. Where the stream crosses treeless plains Grey Teal and Pink-eared Ducks may be found in very large numbers but rarely are other species seen. Where the stream is deep and flows through lignum or cane grass the White-eyed Duck and Freckled Duck are the commonest species.

The larger storage dams are deep and usually contain few aquatic plants. They are not generally suitable for the breeding or feeding of waterfowl and few birds are found on them. In times of drought, however, they serve as temporary refuges for congregations of all species, when all other water has dried up. The irrigation channels provide some water habitat through large areas of otherwise dry country. They serve as focal points for Wood Duck flocks and frequently support small numbers of Black Duck and Grey Teal. In general, however, they are not an important waterfowl habitat.

Billabongs

Billabongs are the principal relatively permanent habitat for wild ducks in the region and are used for breeding, feeding, or refuge by all species. Immature billabongs seldom contain wild ducks apart from small numbers of Black Duck and Grey Teal, but the mature billabongs and lagoons form very important and extensive semi-permanent breeding places for many species and, after breeding, support very large numbers of all species except the diving ducks.

Swamps

The cumbungi swamps are the breeding and feeding habitat for Musk and Blue-billed Ducks and the usual habitat for Black Swans. A few Black Duck and Grey Teal may breed in them if some trees are available, but they are usually avoided by Wood Ducks. During the summer very large concentrations of Black Duck, Grey Teal, White-eyed and Freckled Ducks congregate in them but usually feed elsewhere (Frith, 1957a).

Lignum and cane grass swamps form almost the sole breeding and feeding habitat for Freckled Ducks and White-eyed Ducks, and sometimes support large numbers of non-breeding Grey Teal. Over the western part of the region studied lignum and cane grass swamps are almost the sole waterfowl habitat.

Temporary Water

When the rivers flood all vegetation associations are submerged and the waterfowl habitat in the region is increased many hundredfold. The utilization of the floodwater by waterfowl varies according to the type of country flooded and the birds' breeding and feeding requirements. On flooding, especially in the lightly timbered and treeless plains, vast areas of new waterfowl habitat are created and these areas are invaded by very great numbers of Grey Teal, Pink-eared Ducks, and Shovelers, and smaller numbers of Black Duck, and sometimes White-eyed Duck. Normally floodwaters are ignored by other species. The extensive breeding that may occur has been described (Frith, 1957b and unpublished).

Large and relatively deep claypans are an important site for opportunist breeding by Grey Teal and small numbers of Blue-winged Shovelers. They

are also important opportunist feeding places for Grey Teal and Pink-eared Duck. On the whole, however, their filling is infrequent and permanence slight.

Movements

It has frequently been observed that the numbers of wild ducks in different localities usually vary greatly from year to year (e.g. Morgan, 1954; Downes, 1955; Hobbs, 1957) and that, in the southern and coastal parts of the continent, a tendency exists for the numbers to increase during the summer. Banding returns and field observations, however, show that these movements cannot be explained as a simple migration. It is apparent that both migration and nomadic movements, dictated by climatic conditions, must be considered in the interpretation of waterfowl movements. Among the different species and, in some cases, within the one species, every movement pattern from completely sedentary through erratically nomadic to regularly migratory can be found. The movement patterns of the different species seem to be determined largely by their habitat requirements and alterations in the extent of this habitat.

Those species which inhabit the permanent swamps, exclusively, are quite regular in their movements. Thus the Musk Duck, which is confined to the heavily vegetated permanent swamps, is sedentary and is practically never seen beyond these swamps. The Blue-billed Duck which inhabits the same swamps has very regular seasonal movements. Both species can apparently afford to be regular in habit, in the one case sedentary and in the other migratory, because their habitats are permanent and " safe."

The White-eyed Duck, whilst mainly confined to the deep permanent swamps is also able to utilize deep semi-permanent floodwater. In accordance with these habitat requirements a regular north-south movement occurs in the permanent swamps, the species being more numerous in southern regions during the summer. In times of drought, when the permanent swamps decrease in area, this movement, however, decreases in volume or may not occur. In addition to this regular movement the birds are sufficiently adaptable to utilize deep floodwaters at any time of the year wherever they occur. Severe flooding is usually followed by an influx of White-eyed Ducks, but this influx when compared to the species discussed below is slight except into those areas where lignum and cane grass are flooded.

The Black Duck prefers deep, heavily-vegetated swamps but is more elastic in its habitat requirements than the White-eyed Duck and is able to utilize, to some extent, most other habitats for breeding and feeding. Each permanent swamp contains some Black Ducks always, but annually the number of birds in southern and coastal regions increases each summer and decreases each winter. The movements are, however, strongly affected by climatic conditions and, although dry seasons are characterized by an increased volume of movement to the coast, the majority of birds remain in the inland where great concentrations occur. In times of flood a movement to the flooded area occurs in any direction and at any time of the year. This movement however, in volume, is only a fraction of that of the Grey Teal.

The Grey Teal is a true nomad and may move over the whole continent in all directions and at all seasons in search of suitable living conditions. In

the inland each creek, swamp and billabong supports small numbers of birds and, as in the Black Duck, these numbers increase annually in the better watered areas of the south and on the coast; this movement superficially resembles true migration. However it has been shown by banding (Frith, unpublished data) that these movements are erratic. Birds from one breeding place may disperse over the whole continent in all directions. In time of flood immense numbers of Grey Teal arrive in that area within a few days. In time of drought virtually the whole population vacates the interior and concentrates on the coast or wherever rain has fallen. This is in contrast to the Black Duck which at these times has a tendency to concentrate in increasing numbers on the permanent waters inland.

The Pink-eared Duck is even more strongly nomadic that the Grey Teal. Whereas, in the Grey Teal, there are birds permanently in most areas and some semblance of regular movements, at times, in the Pink-eared Duck there is none. The whole population is nomadic and may appear in a district in very great numbers in one year but then disappear and not be seen again for many years. The birds require for their habitat expanses of shallow water, dirty, stagnant and dense with plankton. This type of water in the inland is only provided by flooding and under the conditions of high evaporation that exist is very temporary, and as it dries up the Pink-eared Ducks vacate the district completely. Extreme mobility is apparently essential for their survival.

Food Habits

In the period 1952-56 about 4,000 gizzards of the six common species of ducks in the inland were examined. From this study it was apparent that most of the movements of wild ducks could be explained by fluctuations in the food supply due to flooding or rainfall.

Among the nomadic species, the Grey Teal had a very variable diet. On the average the food consisted of 27% of plants usually growing on dry land, 40% aquatic plants and 33% aquatic animals, predominantly insects. The composition of the diet at any time, however, rarely approximated the average and varied greatly from place to place and from time to time according to the weather and the flooding of the rivers. There was no regular annual cycle of food but a cycle existed that depended on the stage of flooding in the area. Thus as the streams increased in level, or flooded, the birds fed almost entirely on dry-land plants and dry-land insects but as these were exhausted and the swamp plants (e.g. *Carex, Polygonum, Eleocharis*) were established the seeds of these swamp plants became the most important source of food. As the waters fell in level or evaporated the aquatic insects became more concentrated and these in turn became the most important source of food until ultimately the diet consisted entirely of them.

The Blue-winged Shoveler ate mainly aquatic animals, insects being most important, and was less dependent on vegetable food than the Teal. Of the vegetable food the majority was collected from the bottom of shallow water and negligible amounts only were derived from growing swamp plants. In conformity with this food preference the Shoveler occupies principally flood-waters at a rather later stage in their development arriving as the waters are receding and these foods are abundant.

The Pink-eared Duck fed almost exclusively on aquatic animals, including large quantities of microscopic forms collected by filtration of water and not from the bottom or edge as in other species. Accordingly Pink-eared Ducks do not compete with other species for food and at the same time the type of water in which they can live is limited. They are extremely mobile and arrive in an area as the floodwaters are receding and evaporating and can remain longer than most other species.

The diet of the less mobile Black Duck was similar to that of the Grey Teal but included greater quantities of swamp plants and aquatic animals. The Black Duck fed predominantly on the animals and seeds of larger size and characteristic of more permanent water. They were not adapted to collecting small submerged grass seeds and so were not able to exploit freshly flooded areas as efficiently as the Grey Teal; accordingly floodwaters were only used to a limited extent. Similarly the White-eyed Duck, Musk Duck, and Blue-billed Duck fed predominantly on the larger animals characteristic of deep permanent water. These species were unable to utilize temporary floodwater and their movements correspondingly restricted.

In inland Australia where the water areas fluctuate rapidly both in extent and depth, it is apparent that for a water bird to exist permanently in very great numbers it must be sufficiently adaptable, in its food habits, to deal with a food supply that may alter rapidly in both composition and abundance. The seeding swamp plants being used as food one day may be covered by several feet depth of clear water the next, whereas the dry grass seed far from the river may equally suddenly become available due to flooding.

The Grey Teal has evolved great adaptability in both the food eaten, the methods of collection and feeding habitat. This adaptability enables it to exploit most types of water and food as soon as they occur. There is no doubt that this adaptability to the food supply accounts, at least in part, for the Grey Teal being the commonest and most widespread and mobile species of wild duck in Australia.

The movements of the other highly nomadic species, the Pink-eared Duck, may also be explained on its food requirements. The birds are completely dependent on plankton and insects which are only common in drying waters. In order to secure this food regularly the birds must be prepared to move very widely and rapidly as water conditions alter.

The Black Duck and White-eyed Duck are adapted to utilize the foods produced by more permanent water than the other species. Their distribution and movements are controlled by the availability of this water, and as changes in its extent cannot be widespread nor rapid these species are accordingly comparatively local in distribution and relatively low in numbers in the inland.

Breeding

Breeding Seasons

The breeding of many species of wild ducks is strongly affected by rainfall and flooding. Among the common species every stage exists between those having regular annual breeding seasons and those that may breed at any time of the year when conditions are suitable; they may breed at a different time and in a different place in successive yeears. In the period

1950-1957 observations were made on the breeding of the common species of wild ducks in the Murrumbidgee and Lachlan regions, New South Wales. In this period conditions varied from extensive unprecedented flooding in 1951 and 1956 to droughts in 1954 and 1957. The volume of breeding also of many species varied directly with the seasonal conditions in each year.

Those species which inhabit the permanent stable water areas have regular breeding seasons. Thus the Musk Duck which is sedentary and confined to the cumbungi swamps where the water is deep and permanent with dense emergent growth of bulrushes has a regular breeding season beginning in late August and continuing until mid-October. Neither the extensive flooding that occurred in some years nor the droughts in others caused any significant departure from these dates or differences in the volume of breeding in different years. Similarly the Blue-billed Duck and Black Swan which occupy the same habitat are regular spring breeders and are not noticeably affected by flood or rain.

In the nomadic species the position is quite different and no regular breeding season exists. The birds breed wherever and whenever suitable conditions occur. Small numbers of Grey Teal are widely distributed throughout but they do not breed unless exceptionally heavy rainfall or, more usually, a fresh in the river causes an increase in water level. Such an increase in level is followed immediately by sexual display and, within a few days, by ovulation. In addition to the resident Grey Teal, however, very large nomadic flocks move about the inland from place to place as water areas change in extent. In 1955 for instance extensive breeding of these nomadic birds occurred in widely separated parts of the country throughout the whole year as floods or heavy rain occurred at different times. This breeding season began in February in southwestern Queensland, in March in northern New South Wales, in April in central New South Wales, in May on the Lachlan River (south-western N.S.W.), in July on the Murrumbidgee River, in August on the Murray River, and again in October on the Lachlan River. The movements and breeding of the Pink-eared Duck are completely dominated by the climate and there is no regular breeding season, they move and breed wherever and whenever the correct habitat is provided. When breeding is finished and the water dries up the whole population moves elsewhere and no residue remains.

The Black Duck is intermediate in habitat requirement; it is commonest in permanent swamps but is less regularly found in the temporary waters. Similarly the Black Duck is intermediate in its degree of nomadism and regularity of breediing season. The species tends to have a regular breeding season but apparently individuals differ greatly in the sensitivity of their response to the proximate factors initiating breeding. In unfavourable seasons, those with low rainfall and shrinking water levels, very few birds breed. In seasons of normal rainfall all the local birds breed and when floods occur the local birds are reinforced by newcomers who occupy and breed in the extra habitat created. In the Grey Teal unusually good conditions are utilized by a great influx of nomads and an extension of the length of the breeding season, but in the Black Duck there is no such extension of the breeding period but the good conditions are exploited by a greater proportion of the local birds breeding.

Effect of Water Level on Breeding

There have been several observations that, in inland Australia, breeding seasons of birds are closely associated with rainfall (Serventy & Whittell, 1948; Keast & Marshall, 1955). Serventy & Marshall (1957) concluded that in W.A. photoperiodicity was of little importance as a regulator of most birds, and that the critical stimuli to breeding were environmental conditions arising after rainfall in relatively high temperatures. In wild ducks where some species have completely erratic breeding seasons ranging from mid-winter to midsummer, clearly fixed annual factors such as daylength or air temperature could have little effect in determining the onset of breeding.

In studies of the sexual cycle of wild ducks (Frith, unpublished) it has been shown that in the Grey Teal every outburst of sexual activity followed an increase in water level and every increase in water level was followed by sexual activity whether rain had fallen or not. The response to a rise in water level is very rapid; sexual activity begins immediately and eggs may be laid 7—10 days later. There is little doubt that in the Grey Teal the breeding season is initated by an increase in water level.

The Pink-eared Duck carries the adaptation towards a breeding season initiated by a rise in water level one stage further. In the Grey Teal an increase in level sufficient to fill the lagoons is followed by ovulation. The Pink-eared Duck, even if already present in the district is not affected sexually by such a change in level. The sexual cycle leading to ovulation does not begin until actual flooding of low-lying land occurs—the species only breeds when these conditions occur.

In both the preceding species it has been shown that the rising water level which initiates the breeding season also initiates an increase in the amount of food available for the ducklings. Grey Teal ducklings feed entirely on animal food, principally Corixidae and Dytiscidae (Insecta). It has been shown that each increase in water level is followed by the sudden appearance of large numbers of juvenile forms and ultimately an increase in the number of insects available. Apparently the breeding season of the insects is also initiated by a rise in water level. The result is that a greatly increased food supply is available for the ducklings.

Similarly the ducklings of the Pink-eared Duck require large quantities of plankton. These organisms are only abundant in drying floodwater; the flooding of low-lying country, whilst initiating the sexual cycle of the ducks, at the same time provides conditions suitable for an increase in the duckling food supply. Synchrony of the ducklings and their food supply, which increases slowly, is achieved by a relatively slow development of the Pink-eared duck gonad following its initial stimulation.

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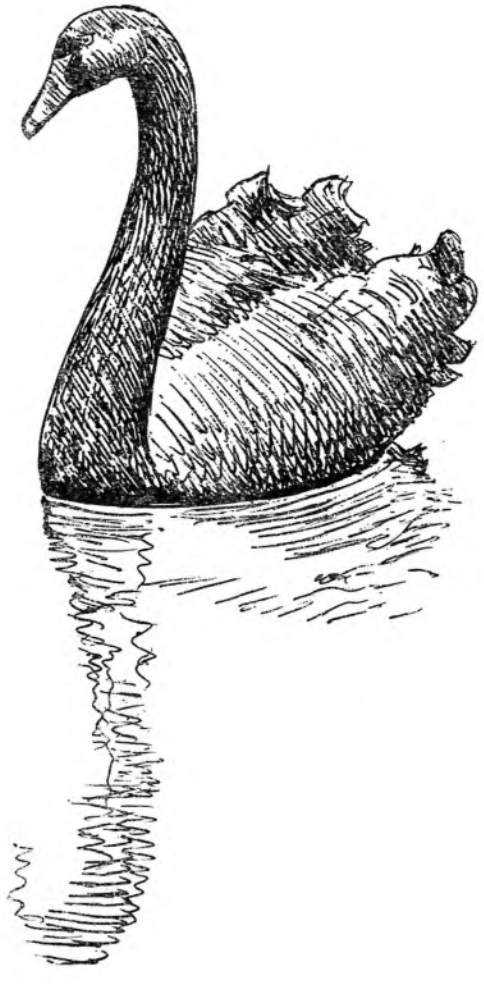

BREEDING BIOLOGY OF THE MAGPIE GOOSE

Paul A. Johnsgard

Summary

A BREEDING pair of Magpie Geese was studied at the Wildfowl Trust during one breeding season and part of a second. Nest-building was performed by both sexes and was done in the typical anatid fashion of passing material back over the shoulders. Nests were built on land of sticks and green vegetation. Two copulations were observed, both of which occurred on the nest, and precopulatory as well as postcopulatory behaviour appears to differ greatly from the typical anatid patterns. Eggs were laid at approximate day-and-a-half intervals, and the nest was guarded by both sexes. Incubation was also performed by both sexes, with the male normally sitting during the night. A simple nest-relief ceremony is present. The eggs hatched after 28 to 30 days, and the goslings left the nest the morning after hatching. Unlike all other Anatidae so far studied. the goslings, in addition to foraging independently, are fed directly by their parents and a special whistling begging call associated with a gaping posture is present. It is suggested that the bright bill colouration and unusual cinnamon-coloured heads of downy Magpie Geese are also related to this parental feeding. The parents constructed a " brood nest " of herbaceous vegetation that the goslings rested and slept on, which is also unique among the Anatidae. Family bonds are strong, and a rudimentary form of " triumph ceremony " is present. Development of the young and moulting sequences of downy, juvenal, and immature plumages are described; the presence of separate juvenal and immature plumages which are distinct from the adult plumage is apparently unique. It was also found that the juvenal rectrices are moulted shortly after fledging, which occurred on the 84th day, and the first remiges are moulted during the seventh and eighth months rather than at the end of the first year as is the usual anatid situation. A fully adult appearance, and presumably sexual maturity, is reached before the third year.

The Magpie, or Semipalmated, Goose *Anseranas semipalmata* (Latham) of Australia is unique among the wildfowl in that it constitutes individually one of the three currently recognized subfamilies of the family Anatidae, the Anseranatinae. In addition to this, the Magpie Goose is believed to represent the most generalized evolutionary condition of all the Anatidae and thus should provide the closest living " link " between the Anatidae and the other bird families. It is now generally held that the three species of South American screamers (Anhimidae), which together with the Anatidae comprise the order Anseriformes, do exhibit certain structural similarities with the Magpie Goose (Delacour, 1954), and it is of interest to compare the breeding behaviour and biology of the Magpie Goose with that of screamers as well as with the more typical wildfowl.

While the Magpie Goose may be rightly called the most generalized living species of the Anatidae, it is not altogether justifiable to refer to it as the most " primitive," since any species which is currently living has been subjected to natural selection for millions of years and is bound to be, in at least some respects, highly specialized. We may say, however, that the Magpie Goose has retained a greater number of primitive characteristics than has any other of the living species of wildfowl, and it is these characteristics which are of the greatest evolutionary interest. A rapid review of the structural peculiarities typical of the Magpie Goose that might be considered primitive may be mentioned here, before the biological peculiarities of the species are considered.

The semipalmated, or incompletely webbed, feet of *Anseranas* set it apart from the rest of the Anatidae (two other species of geese have slightly reduced webbing) and indicate a terrestrial or semi-aquatic habitat. Likewise the hind toe is long and is at the same level as the other toes, providing an

obvious perching adaptation. The screamers agree with *Anseranas* in both these respects. The second major feature of the Magpie Goose that sets it apart is the greatly elongated trachea, longer in males than in females, which loops between the pectoral muscle and the skin on the left (rarely the right) side of the sternum. Some swans have tracheae which convolute within the sternum, and male screamers have enlarged but not convoluted tracheae. However, males of some species of curassows (Cracidae), which are arboreal gallinaceous birds, have tracheae which are similarly convoluted between the skin and breast muscles. In addition, the structure of the syrinx and the associated musculature in the Anatidae, Anhimidae and the Cracidae are remarkably similar (Beddard, 1898), indicating that the nearest relatives of the Anseriformes are probably the Galliformes. Delacour (1954) has listed six skeletal features of *Anseranas* which deviate from the other Anatidae and agree with the Anhimidae, and Miller (1919) has mentioned several other anatomical features which set *Anseranas* apart from the typical wildfowl.

General Biology

The most striking single characteristic of flying Magpie Geese is their broad, rounded wings and associated ease of flight, conferring a stork-like or vulturine aspect on the birds when they are observed at any distance. Although many typical wildfowl perch frequently (particularly the perching ducks of the tribe Cairinini), Magpie Geese are superb perchers. Several observers of screamers have commented on their perching abilities as well as on their soaring flight. Magpie Geese do not swim often except when leading young, but can swim readily, floating high in the water. They have not been observed to dive. Screamers also swim well, no doubt partly because of their remarkable degree of skeletal pneumaticity and their subcutaneous air spaces. Magpie Geese are vegetarians. In captivity they consume practically any growing plant, from tree leaves (especially *Salix*) to rushes (*Juncus*) and even nettles (*Urtica*). They often dig up roots with their strong and pointed bills. In the wild they subsist primarily on swamp grasses (*Paspalum, Oryza* and *Echinochloa*) and the underground bulbs of certain sedges (*Eleocharis*), according to Frith and Davies (1958a). Where rice (*Oryza sativum*) is cultivated Magpie Geese have become a major agricultural problem. Screamers are likewise vegetarians and possess a bill that is somewhat similar in shape, but smaller and more pheasant-like than that of *Anseranas*.

Magpie Geese, in common with screamers and typical wildfowl, are gregarious and in the wild occur in flocks comprising up to tens of thousands of birds. Although they do not migrate as such, major flock movements do occur between the wet and dry seasons (Frith and Davies, 1958b). Observations on captive birds indicate that family bonds are strong, and it is likely that pair bonds are relatively permanent. Screamers likewise probably pair for life (Gibson, 1880). Frith and Davies (1958a) believe that there is no dominance hierarchy in Magpie Goose flocks, and that the basic social unit is the pair or family. As in geese, however, all birds react to danger signals and flight intention movements as a single unit. Lateral head-shaking, similar to the flight intention head-shaking of almost all Anatidae, is the primary pre-flight movement and is used in conjunction with mutual calling among the birds as they prepare to take flight. The sexes of birds eight months old or older may be readily judged by the pitch of the voice, that of the males

being lower than the female. In this respect Magpie Geese agree with screamers, which are most easily sexed by the lower-pitched voice of the male (Stonor, 1939). In the true geese the male has a higher-pitched voice than the female, and in only a few species of swans does the male have a distinctly lower-pitched voice.

Breeding Behaviour

Relatively little is known concerning the breeding of the Magpie Goose in the wild state. Frith and Davies (1958b) state that nesting occurs at the end of the wet season, in the deeper and more heavily vegetated parts of swamps. Nests are built over the water surface by trampling the swamp vegetation, followed by adding other plants to the heap of material. Thus nests tend to be bulky and according to Frith and Davies from four to 14 eggs may be found, indicating that two females often lay in the same nest. These authors (1958a) believe that sexual maturity is reached in the second or third year, possibly even later. There is a high mortality of eggs and goslings under wild conditions.

Although Magpie Geese have been kept in captivity for over a century, they have bred under captive conditions only a few times. The first case was in the San Diego Zoo, in 1945, and the same pair bred in 1946 (Delacour, 1954). However, little information on the breeding behaviour resulted from these nestings. Later, a pair of Magpie Geese bred at the Wildfowl Trust in 1956 (Johnstone, 1957). This pair has since bred each year, and is the pair I studied in 1960. The female was at least 20 years old at the time of her first nesting, and the male was at least ten years old.

Nest-building. Nest-building by Magpie Geese is done by both sexes, with the male probably doing the greater share. This is also the case among the true geese and swans. In 1955 the male constructed one nest, but nothing came of it, and in 1956 no less than seven nests were built on dry land in various parts of the pen (Johnstone, 1957). Each took about two days to complete, and all consisted of bulky piles of sticks and vegetation. Magpie Geese, in common with all other Anatidae, lack the instinctive ability to *carry* nesting material, and instead only stretch their necks forward, grab a bill-full of material, and pass it back over the shoulder and drop it. This is first done on the nest site, and later at various distances from the nest, so that eventually a considerable quantity of material is amassed at the nest. It is uncertain if screamers build their nests in the same manner. Gibson (1880) states that the nests of *Chauna chavaria* are of rushes, and situated in the water, suggesting that they are similar to those of Magpie Geese. In captivity, screamers have built large, bulky nests on dry land (Sclater, 1905). Both sexes of at least one species of screamer (*C. torquata*) help build the nest, beginning by " carrying about sticks in a rather aimless manner " (Stonor, 1939). This would suggest that screamers do actually carry nesting material when building nests. Although most gallinaceous birds do not carry material to the nest site, it is evident that the Cracidae, which nest in trees, must do so.

In recent years the Magpie Geese at the Wildfowl Trust have not built so many " dummy " nests, and in 1960 two piles of straw were placed in early spring near the previous nest sites. The birds did fashion both piles into heaps resembling nests, but only in one did they go so far as to develop

a cupped top. Work on the nest was done in a desultory fashion until after the middle of May, when one or the other bird was usually to be found near or on the nest site. A second female, which has shared the pen with the breeding pair for several years and has assisted in the care of the downy young in past years, was not observed to help with the nest-building. This female, a younger bird, could be identified by certain bill markings. When the nest was completed, it was approximately five feet in diameter, two feet high, and slightly cupped. The cup was lined with green vegetation and small twigs, but no down or feathers whatsoever were present.

Copulation. Previous to the present study no published accounts of copulatory behaviour in Magpie Geese were available, and indeed almost nothing had been recorded regarding sexual behaviour in this species. However, on 2nd April, Major L. T. C. Shakespear observed the Magpie Geese treading. This occurred in the early afternoon and the birds were at the rear of the pen near one of the piles of straw. His attention was attracted by the calling from the two birds, and upon investigating he observed that treading was taking place. This lasted about half a minute, with both birds calling loudly but remaining relatively motionless. After treading was completed both birds " bowed and scraped " to one another a good deal, but did not perform any wing-flapping or bathing.

On the afternoon of 23rd May I chanced upon a similar situation when checking on the progress of the nest-building. As I approached the nest which obviously was the " chosen " site, I saw both birds on the nest. The female was sitting very low in the nest with her neck and head hanging over the side, and the male was already mounted on her back. Both birds were so motionless and quiet that I was at first uncertain that I was actually witnessing a copulation and, unlike all other wildfowl copulations I have seen, the male was not grasping the female's nape. Upon seeing me the male dismounted and began to preen, and soon the female also got off the nest and began to preen as well. There was no calling during the entire time but I had obviously disrupted the copulation attempt before it could be completed.

The first egg was laid on 26th May, and one more observation of copulation was obtained on the morning of 27th May. I had arrived at 9.15 a.m., at which time the male was guarding the nest and its single egg, and the female was standing nearby. When I approached the nest both birds threatened me. After I left and hid behind a tree some ten yards from the nest site, the male remained standing on the nest, calling softly and repeatedly as he placed material on the nest at a rapid rate (about 20 building movements per minute). At 9.35 the male left the nest and joined the female, whereupon the two walked back to the nest together, both calling and shaking their wings occasionally, as well as rapidly opening and closing their bills in the familiar manner which is typical of Magpie Geese. The male climbed up on the nest immediately, but the female wandered off again and began to feed. At 9.40 the male again left the nest and returned with the female in exactly the same fashion. This time the female went directly up on the nest and settled down as the male " mandibulated " very rapidly. The male quickly climbed up the nest and immediately mounted the female without any more preliminaries. The male then remained motionless on her back except for tail adjustments for approximately two minutes. There was no calling, and in this case too the male did not appear to grasp the female's nape although my

view was partially obscured. The male then dismounted and began nest-building while the female remained on the nest. Finally she too began to work on the nest. There appeared to have been no post-copulatory display at all, so the copulation was probably unsuccessful. The post-copulatory nest-building of the male was vigorous (about 25 building movements per minute), while the female's behaviour consisted of re-arrangement of the nest cup itself. At 9.50 the male stopped building, stood " guard " a few minutes, then went to sleep in a standing position.

These observations, although incomplete, indicate that copulation takes place on the nest site. Pre-copulatory behaviour appears to consist of mutual calling, wing-shaking, and " mandibulating " (technically the raising and lowering of the maxilla). Post-copulatory behaviour seems to consist of the " bowing and scraping " by both birds that was observed by Major Shakespear. In only two other species of Anatidae known to me does copulation normally occur on land (the Ne-ne Goose *Branta sandvicensis,* and the Cape Barren Goose *Cereopsis novae-hollandiae*), and in both of these the pre-copulatory and post-copulatory displays are unlike those of the Magpie Goose and are closer to the behaviour of the typical geese. I know of no accounts of the corresponding behaviour in screamers, and it would be of interest to compare the copulatory (especially pre-copulatory) behaviour of screamers with these observations. Stonor (1939) does state that the courtship behaviour of the Common Screamer (*Chauna torquata*) consists of mutual preening around the neck region, but does not state whether this is related to copulation. Mutual preening in Magpie Geese is rare, and I have observed it only during nest-relief ceremonies.

Egg-laying and Incubation. The interval between the laying of each egg is, in most Anatidae, either one or two days. An interval of two days is the usual situation among the swans and geese, although the Ne-ne's interval appears to be closer to one and one half days (S. T. Johnstone, pers. comm.). The Common Screamer also lays every other day (Stonor, 1939). Benchley (in Delacour, 1954) indicates that the Magpie Goose at the San Deigo Zoo laid six eggs in six days, and Johnstone (1957) reports that in 1956 the female at the Wildfowl Trust laid eight eggs in 13 days. This latter would suggest an interval of roughly 36 hours between eggs. Such an interval between eggs also appears to have been the case in 1960. The first egg was laid during the afternoon of 26th May. The time of the second laying is uncertain, but probably occurred after 10 a.m. on 28th May. The third was probably laid in the early morning of 30th May. The fourth egg was apparently laid after 5 p.m. on 31st May, and the fifth egg was laid before 8.30 a.m. on 2nd June. The sixth egg was laid between 3.50 p.m. and 4.35 p.m. on 3rd June.

On 3rd June it became evident that both the females in the pen were spending time on the nest, and although I believe that the first five eggs were laid by the older female (which is thought to have laid all the eggs in earlier years), the younger bird apparently laid the sixth egg of the clutch. The seventh egg (laid presumably by the older female) was laid either late in the day of 3rd or on 4th June, and the eighth egg was laid before 9.00 a.m. on 5th June. These eight eggs were taken from the nest on the morning of 6th June and were replaced by seven wooden eggs. One last egg was laid on

the afternoon of 6th June, and I was fortunate enough to observe the act of oviposition.

The younger female had replaced the older bird on the nest at 2.40 p.m., when I noted that there were only the seven wooden eggs in the nest. At 3.40 the male replaced her for a short time when I again looked at the nest. However, she was back on at 4.30 and at 4.47, as I watched and waited for her to stand up so that I might count the eggs, she suddenly reared back sufficiently for her breast to be well free of the nest and almost immediately she deposited an egg on to the pile of wooden eggs below her. After this act, which appeared to have been performed without any evident strain, she settled back down on the eggs and was still in this position when I left at 5.15 p.m.

In the true geese and swans it is usual for the female to assume incubation duties, and only in the whistling ducks (*Dendrocygna*) and a few species of swans (*Cygnus atratus*, sometimes in *C. olor* and rarely in others) does the male assist in incubation. In the screamers both sexes incubate; Stonor (1939) found that in the Common Screamer the male usually incubated during the late morning and late afternoon. In both the Anatidae and the Anhimidae incubation does not normally begin before the laying of the last egg.

Although in previous years the breeding pair of Magpie Geese at the Wildfowl Trust has followed the usual pattern of leaving the eggs largely untended during the period of laying, in 1960 one or both of the birds were invariably on or beside the nest from the time the first egg was laid. Since no down is used in the nest, the eggs are exposed whenever the nest is left, and thus it is perhaps the usual situation for the nest to be closely guarded during the egg-laying period. The fact that no down is utilized for nest lining appears related to the fact that both sexes incubate, and therefore the eggs are never left uncovered from the time incubation commences. This same situation is true of whistling ducks, and Black Swan nests usually have only slight amounts of down present.

During the period of egg-laying there was no distinct daytime pattern of nest guarding by the birds, although the male apparently always sat on the nest from early evening until early morning. The male was also on the nest a good deal of time during the day, probably whenever the female was not in the process of laying. On 3rd June it became evident that both females were sitting on the nest, although the younger female may have previously spent some time on it unknown to me. Thereafter all three birds sat on the nest, but the older female did so less and less and the younger female tended to replace her.

Nest-relief ceremonies in the Anatidae other than the Magpie Goose are known to me only for the Black Swan and the Mute Swan (*Cygnus olor*), although it is possible that such ceremonies are also present in whistling ducks. Rayner (1948) has described these ceremonies for the Mute Swan, and my own observations on the Black Swan are in close agreement with his account. Briefly, the relieving bird swims or walks up to the nest while calling vigorously with the usual neck-stretching movements used in the " triumph ceremonies " of these species. The bird on the nest calls in a like manner, and the former bird walks up on the nest and gradually pushes the incubating bird off the eggs. This bird appears reluctant to leave the eggs, and before getting off the nest usually performs extensive nest-building

movements. Stonor's (1939) description of nest relief in the Common Screamer is very similar except that before the incubating bird leaves the nest both birds preen one another. Nest-relief in Magpie Geese did not appear to be highly ritualized, and often occurred when the nest was approached and the birds rushed to the nest to defend it. When " normal " nest relief did occur, it was preceded by mutual calling by both birds, and as the relieving bird approached the nest both would " mandibulate " rapidly. Sometimes this mandibulating developed into a preening or nibbling of the other's back and neck feathers, although this was certainly not the usual case. The sitting bird was eventually pushed off the nest, and both birds then usually performed nest-building movements.

It is not certain at what time incubation actually began, although the birds appeared to begin incubation with the first egg. It is more likely, however, that they simply covered the eggs, without actually settling over them. Since no down is used in the nest there is of course no brood patch present. On 1st June one of the females appeared to be definitely incubating, since she settled down low in the nest with ruffled body feathers.

Turning and prodding of the eggs by the bill occurred as soon as the first egg was laid, usually when one bird had replaced another on the nest. This was done in the same manner as in other species of wildfowl, by pulling upwards and backwards with the tip of the mandible. The eggs were not all systematically turned at one time, indeed egg-turning appeared to be rather haphazardly performed.

When the clutch was completed, there was much less shifting of birds on the nest. The male still appeared to incubate during the night while the younger female did most of the daytime incubation. After two weeks of incubation the wooden eggs and the single real egg were removed from the nest. Two of the eggs removed earlier hatched on 30th June and the last egg hatched on 4th July. This would indicate a 28 day incubation period for the last egg and an uncertain period for the other two. Only the last gosling that hatched survived from this clutch, and it seems likely that the poor hatching and survival of the other young resulted from the conflicting incubation and laying tendencies in the two females.

On 4th July the younger female was observed nest-building in a clump of nettles about 30 feet from the earlier nest site. On the next day I investigated the site and saw that three eggs were present in a rudimentary nest. All three birds defended the nest vigorously. Another egg was present on 5th July, and when the nest was again visited on 10th July it had been raised to a foot and a half, about three times as high as it was when I first noticed it. At this time eight eggs were present. Thus five eggs had been laid in six or seven days, apparently all by a single female. On 11th July the female definitely appeared to be incubating. Both females incubated this clutch during the daytime, while the male again sat on the nest at night. Four of the eggs from this clutch hatched on the morning of 9th August, indicating a probable incubation period of 30 days.

Nest Defence. The nest site was slightly defended even before it was completed, and on 25th May, the day before the laying of the first egg, both birds defended the nest fiercely as I approached. The male hissed at me (the first time I had ever heard a hissing noise uttered by Magpie Geese), erected

his scapulars and spread his tail somewhat. The female did not hiss, but assumed the same posture. Both birds " mandibulated " strongly.

After eggs were present in the nest the approach of a person would stimulate the guarding bird to honk excitedly. The other bird would then run to the nest and both would climb up on the nest and face the intruder with extended necks and bills ready to strike. Although the female often would spread her wings over the nest to cover the eggs, the wings were not used as the primary weapons as the case with swans and geese. The sharp and powerful bill is a much more effective weapon than the wings, and the concerted defence of the nest by both (or all three) birds was certainly effective. Stonor (1939) has described nest defence in the Common Screamer, and states that both birds defend the nest by standing on it in a similar fashion to that described for Magpie Geese. However, screamers utilize their wings primarily during defence, striking down with the nearer wing and attempting to slash the intruder with the sharp spur of the wrist.

Hatching and the Downy Plumage. Although the Magpie Geese hatched their clutch on 9th August, it was not until the following day that they were observed off the nest, by which time the goslings were strong and apparently hardy youngsters. On that morning all four goslings were actively feeding with their parents near the nest.

The downy plumage has already been described (Johnstone, 1957; Davies, 1957), but a short description might be desirable here. The body is an unspotted dark grey above, fading to light grey below. The head, neck and upper breast are a rather bright cinnamon red, and are almost the same colour as the orange facial skin, bill, and feet. The bill is not quite uniform in colour, since the large, terminal nail is a darker orange, although it fades towards the tip. The sum effect is as if the babies " had fallen into orange marmalade up to their shoulders " (L. T. C. Shakespear). This downy plumage is totally unlike that of any other waterfowl or the screamers, the latter having relatively unicoloured downies. Unlike the other Anatidae, the down feathers are not entirely out of their sheaths when the gosling hatches, but these sheaths are shed the first day.

Care and Feeding of the Young. Care of the young by both parents is the usual situation among the whistling ducks (Dendrocygnini), swans and true geese (Anserini), shelducks and sheldgeese (Tadornini), and a small proportion of the other true ducks (Anatinae). Likewise, both parents care for the young in screamers. This situation is equally true in Magpie Geese, in which family bonds are strongly developed.

The Magpie Goose does deviate from the other wildfowl in two important points concerning the care of the young. Foremost is the fact that adult Magpie Geese directly feed the goslings in a bill-to-bill fashion. This parental feeding was observed the first day that the downies were off the nest, although even by then a good deal of independent grazing and picking up of food particles was done. Frequently, however, one or more goslings would suddenly tilt its bill slightly upwards, gape, and utter a loud, sibilant whistle. This note, sometimes repeated once or twice, is much louder than the " conversational " chittering that is almost constantly emitted. The call usually had the effect of stimulating one of the adults to feed that particular gosling. Often one gosling's " begging " call would apparently stimulate one

or more of the others to utter the same call, and at times these goslings would bite one another. Parental feeding was most conspicuous during the first week after hatching, but was observed as late as five weeks after hatching. The parents took the goslings to water several times on the second day after hatching, and much material was brought to the surface by the adults and fed to the young. This included plant material as well as grain which was scattered for them, and the latter would be picked up by the adults and then gradually allowed to " dribble " out of their bills as the goslings gathered around the adults' bills. At times the adults would honk softly when they had food, and this call certainly had the effect of attracting the goslings. In view of the bright head and bill colouration of the downy young, unique in the Anatidae, it seems possible that this bright pattern serves as a " target " for parental feeding in an analogous manner to the coloured head and gape markings of newly-hatched young in other bird groups in which parental feeding occurs. I have not been able to discover if screamers feed their downy young in the same manner as do Magpie Geese, but since downy screamers lack any special head or bill markings it is possible that they do not.

Although the defence of the nest site ceased on the second day after hatching, the parents were very aggressive to other smaller waterfowl near the brood. After attacking such birds, the male would return to the family while calling with horizontally outstretched neck. Both females normally answered the male while facing him in the same posture, and all the adults would " mandibulate " rapidly. Usually they would vigorously shake their folded wings and ruffle their scapulars during this behaviour, which seems to function as a rudimentary form of " triumph ceremony " analogous to what Heinroth (1911) has described for true geese and swans. Since "mandibulating" and wing-shaking also occur in aggressive situations, this " triumph ceremony," in common with those of geese and swans, gave the impression of being " redirected " threat behaviour.

Whenever the newly-hatched downies stopped foraging to rest or sleep, the adults would begin to pull grass and, using typical nest-building movements, pile it around (and often on top of) the young. All the adults worked vigorously at this, the male often averaging over 30 such movements per minute and the females slightly under 30. As a result, a " brood nest " soon took shape on the grassy area which the birds adopted as a resting site. This " nest " was at first no more than a scattered pile of grass and a few herbs, and had no cup as would a true nest. The females would brood the family on this nest during the night-time as well, and to my knowledge did not return to the true nest after the second day following hatching. The brood was occasionally observed on the " brood nest " up to about two weeks after hatching, but it was gradually abandoned. It seems likely that such " brood nests " do function in keeping the downy young warm, and it would be of interest to learn if the building of such nests is also typical of wild Magpie Geese. I have not observed this behaviour in other wildfowl, although I have seen a female Black Swan drop bits of grass around her resting brood. Whether it occurs in screamers is unknown to me.

Plumage Changes and Development of the Young. As Davies (1957) has pointed out, the soft part colours of the downy Magpie Goose change rapidly, and the original orange to dull claret colour fades to a yellow in three to five days. The legs begin to turn grey near the end of the second week, and

the bill begins to turn grey at about the same time. The bill and legs are soon entirely a lead grey and remain thus for several months. The downy tail feathers are, surprisingly, replaced by juvenal tail feathers during the first week, these latter feathers reaching a length of one and a half inches by the end of the second week. In all other wildfowl the juvenal rectrices appear much later, after body feathering is apparent. By the time the bird is between six and eight weeks old the last trace of the downy plumage is gone. The head, throat and breast are a uniform greyish black, with slightly lighter feather tips. The underparts are white, the feathers being long, pointed, and practically lacking barbules. The upperparts are a rather uniform greyish black except for a few white feathers at the base of the tail and on the lower back. The bill is a lead grey, with a lighter nail. The juvenal rectrices are fully grown, and are four and a half inches long, pointed, and brownish black. The primaries and secondaries break through their sheaths when the bird is six weeks old, and fledging occurs at 84 days.

The juvenal plumage begins to be moulted during approximately the fourth month, and an immature plumage is assumed. The head, neck and breast feathers are moulted in a distinct " wave " down from the head during the fifth and sixth months, and the greyish-black feathers are replaced by uniformly black ones. The lower breast and underparts remain white, while the upper flanks remain greyish-brown. The scapulars of the immature plumage first appear at about four months, and are a mixture of white and black feathers. Moulting of the juvenal rectrices is begun at about the time of fledging, and these are replaced by long (five inch), broader, square-tipped tail feathers. The central rectrices are moulted first and, as the long juvenal rectrices are dropped, a curious " scissor-tailed " appearance is presented for a time before the rectrices of the immature plumage are fully grown. At the age of four months eight of the 14 rectrices of the immature plumage are fully grown. The fully grown wings are brownish above, with a few white feathers in the upper coverts. The under-wing coverts are white. The brownish-black primaries and secondaries are, strangely, moulted during the seventh and eighth months. The primaries are moulted in outward sequence, and the secondaries are moulted in outward sequence from the " elbow," with those nearest the wrist replaced somewhat after the outermost primaries have been replaced. This is the only species of Anatidae known to me in which the first flight feathers are moulted before the bird is a year old, and is one of the very few species (*Chloephaga rubidiceps* and perhaps two other species of that genus are the others) of Anatidae in which the flight feathers are moulted gradually rather than simultaneously, so that the power of flight is never lost. In *Chloephaga rubidiceps* the primaries and secondaries are moulted in outward sequence from the " elbow," with the outermost primaries dropped last, rather than in the sequence described for the Magpie Goose. Screamers also have a gradual wing moult, apparently similar to that of Magpie Geese.

At four months the birds still have the high-pitched peeping voice typical of the downy young, and the trachea of both sexes is still unconvoluted (that of the male exhibits a slight kink at this age and is 14 inches long as compared with 11 inches in females). At about six months the first real " honking " is apparent. A real difference in the voices of the sexes is first distinguishable at seven and a half months. By the time the males are eight months old they

are easily distinquished from females by their vocalizations, and a trachea of a male of this age is 28 inches in length. Three-year-old and older males have tracheae approximately 50 inches long.

The grey legs gradually turn to a pale yellow as the immature plumage is assumed, and the soft parts of the bill and the lores change from a grey to a greenish colour, which eventually (when the birds are about one year old) becomes yellowish and, finally, pink.

Following the moult undergone at the end of the first year, the plumage is of the adult type, differing from the immature plumage in that the mantle (scapulars and inner wing coverts) is pure white and the flanks are likewise white. The bill is a pale flesh pink at the base, as is the bare skin around the eyes. There is a black mark at the sides of the bill near the nail which seems to vary in size individually or with age. The surface of the bill also assumes a somewhat " pebbled " appearance. The bright yellow to orange legs are attained by the end of the first year.

The bony crown on the head of males is first noticeable in birds between the first and second years, and is almost fully developed in males two and a half years old. At about this same time the unfeathered facial patch begins to extend upwards to the front of the crown, forming an acute point which is yellowish in colour. I suspect that this enlarged crown of males between two and three years old is an indication of sexual maturity. Thereafter the only outward change in appearance is a slight additional enlargment of the bony crown. Females show no obvious change in appearance after the first year.

Conclusions

The Magpie Goose exhibits several characteristics in its breeding biology that show affinities with the other Anatidae, such as the manner of nest-building, flight-intention movements, strong family bonds, etc. It also shares some of the characteristics of the screamers (Anhimidae), such as the mutual preening during nest relief and similarities in anatomy, perching, and flying. Finally, in some of its characteristics, such as the behaviour during nest defence, the unusual moulting, the building of " brood nests," and perhaps in the direct feeding of the downy young, the Magpie Goose appears to correspond neither to the screamers not to the other Anatidae. Some authors (Miller, 1919; Boetticher, 1943) have recommended that the Magpie Goose be placed in a separate family (" Anseranatidae "), since it is at least as distinct as some of the families of the Galliformes. In any event, it may be concluded that *Anseranas* at least deserves subfamiliar distinction and seems to constitute a direct link between the Anatidae and the Anhimidae. This whole group, collectively termed the Anseriformes, probably was originally derived from a gallinaceous ancestor perhaps remotely related to the present day Cracidae.

Acknowledgements

This paper was written while the author was being supported by a U.S. Public Health Service Postdoctoral Fellowship. I would also like to express my appreciation to Major L. T. C. Shakespear, S. T. Johnstone, and K. M. Davy for their helpful observations.

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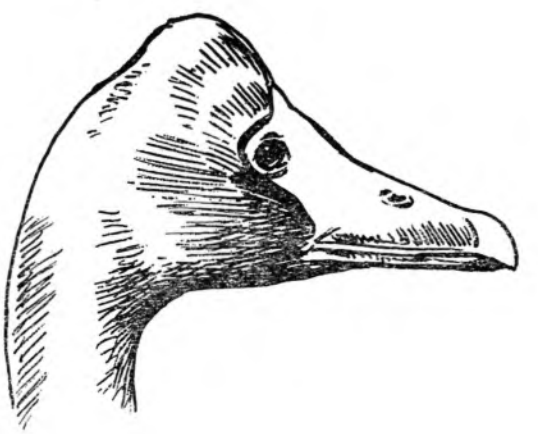
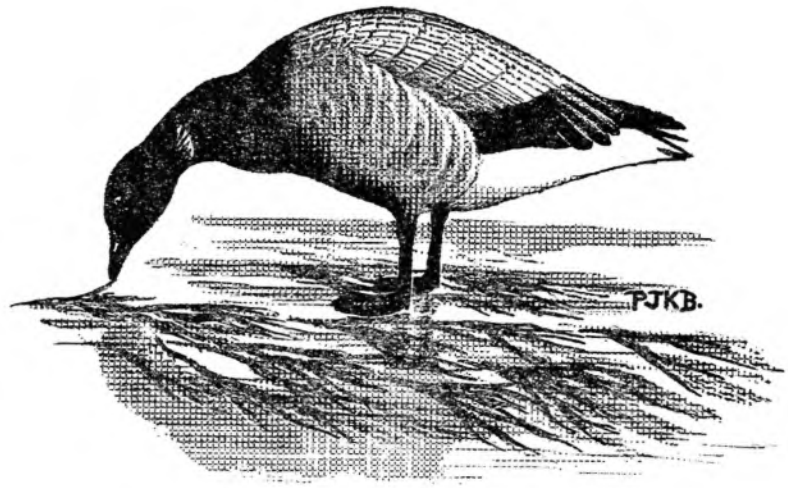




THE BRENT GOOSE AND ITS FOOD SUPPLY IN ESSEX

P. J. K. Burton

Summary

SURVEYS have been made of food supplies in the wintering areas of Brent Geese in Essex. The tidal distribution and productivity of the three species of *Zostera* is discussed, and results of surveys at Foulness and Osea Island are given. *Z. noltii* is the commonest species, and *Z. marina* is absent. Brent do not fully utilise all available supplies of *Zostera*. The behaviour of Brent in Essex is contrasted with areas where *Z. marina* is abundant.

Enteromorpha is the commonest algal food. Important supplies are found at Dengie, Ray Sands and Goldhanger. Results of surveys at Goldhanger are given. More Brent eat *Enteromorpha* later in the winter; and in some areas Brent move between *Enteromorpha* and *Zostera* beds with the tide. Higher plants and animal foods are sometimes taken, and the ingestion of sand is discussed.

Calculations of feeding rate based on measurement of grazing at Foulness suggest that food supplies in the main wintering haunts are more than adequate for the numbers of Brent recorded up to 1959-60. A reserve of food exists in other areas, and in theory could support considerably more; in practice, competition and the need for space to move about in would limit numbers. It is suggested that the highest winter average which would be comfortably maintained would be about 6000.

Introduction

The relationship between the Brent Goose *Branta bernicla* (L) and its food supply has attracted attention since the 1930's, when one of its most important food plants, *Zostera marina,* died out over large areas of the North Atlantic seaboard. The decline in numbers which followed aroused a conservational interest in the species which still persists. At the time of writing, the Brent Goose is given total legal protection in Great Britain and several other European Countries.

One of the chief wintering haunts of the Dark-bellied race of this species (*B. b. bernicla*) is the Essex coast. This paper sets out the results of surveys of food supply made in the county during the past four years, and an attempt is made to assess the value of food as a limiting factor on Brent numbers in this region.

Methods

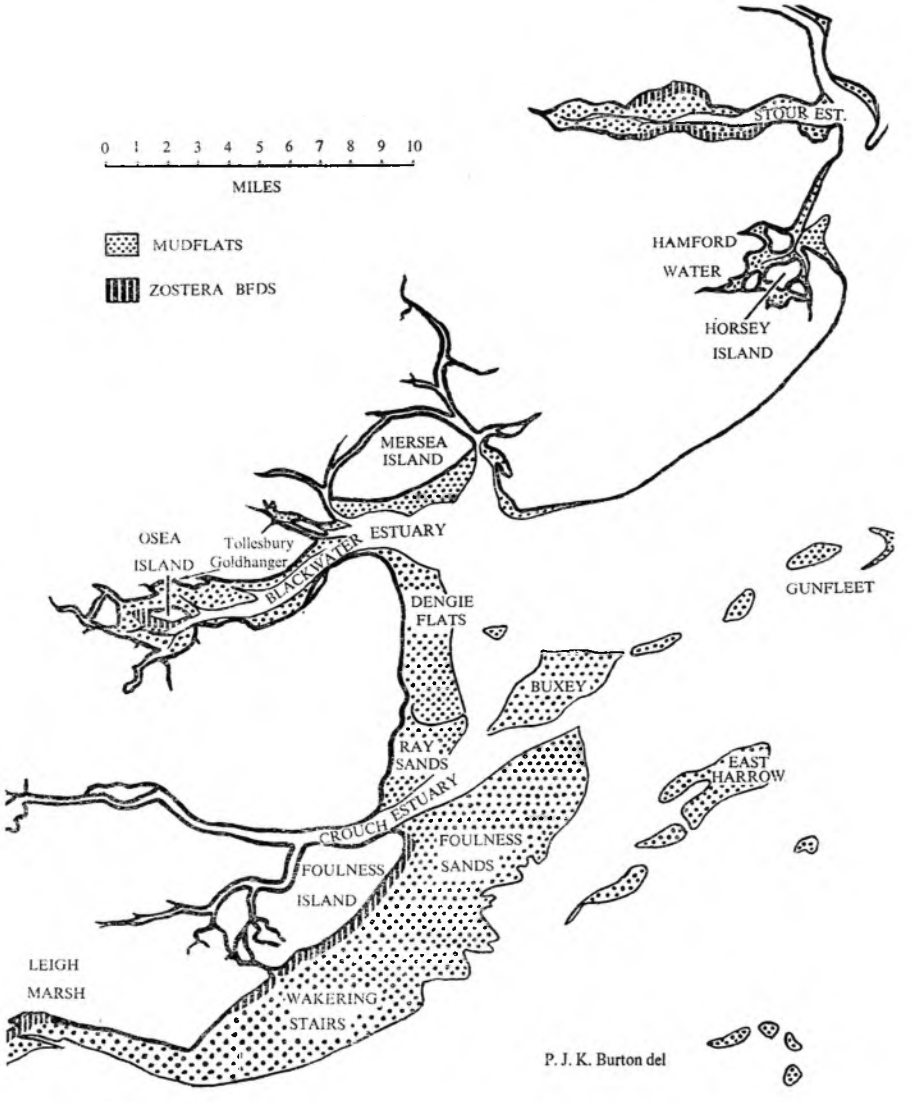
The methods employed for assessing the productivity of plants growing on mudflats are essentially the same as those described by Ranwell and Downing (1959). A large number of quadrat throws are made on the mud, and for each, an estimate of percentage cover is made by eye. These estimates are then related to weight by collecting and weighing a number of samples of the amount enclosed by a quadrat at the different estimated percentages. From these data, a reasonable figure can be arrived at for weight per unit area, and given the area covered by the food plant, the total weight of the crop can be calculated. Areas have been estimated by surveying tidal ranges with a home-made theodolite, and plotting the results on 2½″ Ordnance Survey maps. The areas most thoroughly surveyed have been Foulness Flats, Wakering Stairs and the Goldhanger-Osea Island area of the Blackwater estuary. Many other parts of the coast have been visited and the extent of cover estimated by pacing. Assessments of crop density have been made by examining the thickness of the growth, and estimating visually the percentage cover, drawing on the experience of surveying Foulness and Osea. The account which follows gives the results of surveys for different types of food, and aspects of Brent behaviour which affect the amount taken are mentioned.

Zostera

Dandy (1958) recognizes three species of *Zostera*. *Zostera marina* is the largest form, with leaves up to 1 cm. broad and 120 cm. long. *Z. angustifolia* (=*Z. hornemanniana* (Tutin)) is smaller, with leaves up to 4 mm. broad, and 30 cm. long. *Z. noltii* (=*Z. nana* (Roth.)) is a very small species, only 1-2 mm. broad and up to 20 cm. long.

The distribution of these plants in relation to tidal levels is not clear, and probably varies according to local conditions of shelter, substratum, salinity, etc., where these are such as to affect the nutritional balance (Butcher, 1935). However, true *Z. marina* appears to be most abundant at low tide levels and in sublittoral regions, while the two narrow-leaved species occur higher up the shore. *Z. noltii* seems characteristic of high levels; in Essex it does not extend below about mid-tide level, and in North Norfolk (Ranwell & Downing, *loc. cit.*) it may remain exposed during high water neap tides. *Z. angustifolia* growing in Essex occurs almost entirely in pools of standing water formed in depressions; at Osea Island, such depressions are only found high up the shore, and *Z. angustifolia* is therefore limited to high levels. At Leigh-on-Sea, pools are plentiful about mid-tide level, and *Z. angustifolia* is therefore found at the seaward end of the *Z. noltii*.

Productivity figures are available for the various forms of *Zostera*. Ranwell & Downing (*loc. cit.*) estimated the yield of *Z. nana* green parts in autumn at Scolt Head, North Norfolk as 2800 kg./ha., and using the same methods in Essex, the writer obtained exactly the same figure. Mörzer Bruijns and Tanis (1955) record a productivity at Terschelling, Holland, of 8000 kg./ha.; this includes both the autumn and the heavier spring crops, together with the rhizomes, and indicates a somewhat greater yield than in Essex. In Norfolk and Essex *Z. angustifolia* has a patchy distribution: though it is a larger plant than *Z. noltii*, Ranwell & Downing obtained a figure for it of only 1260 kg./ha. For *Z. marina*, Boysen-Jensen (1915) gives


0 1 2 3 4 5 6 7 8 9 10
MILES
MUDFLATS
ZOSTERA BEDS
STOUR EST.
HAMFORD WATER
HORSEY ISLAND
MERSEA ISLAND
OSEA ISLAND
Tollesbury
Goldhanger
BLACKWATER ESTUARY
DENGIE FLATS
GUNFLEET
BUXEY
RAY SANDS
EAST HARROW
CROUCH ESTUARY
FOULNESS SANDS
FOULNESS ISLAND
LEIGH MARSH
WAKERING STAIRS
P. J. K. Burton del

a yield of between 1700 and 6000 gm./sq.m., commonly about 3500 gm./sq.m. This corresponds to 35,000 kg./ha. Such a high figure is evidently due to the fact that the samples were sublittoral ones; where continually submerged *Z. marina* forms a dense uniform cover, the buoyant leaves standing upright in the water.

The present distribution of *Zostera* in Essex is shown in Fig. 1. The greatest amount is at Foulness and Wakering, where *Z. noltii* extends for more than 6½ miles down the coast in a zone 300 to 350 yards wide. The total area is some 800 acres or 320 hectares, and the total crop of *Zostera* shoots in autumn some 900 metric tons. A few *Z. angustifolia* plants have been found at Wakering.

The *Zostera* at Osea Island, including a good deal of *Z. angustifolia* at high levels, is of much smaller extent. It extends 50 to 150 yards out for 1½ miles along the south shore, covering about 25-30 hectares. The crop weight is about 70 metric tons. The total crop for both Foulness and Osea is thus of the order of 1000 metric tons. In addition there are extensive beds of *Z. noltii* on the Stour estuary (with a little *Z. angustifolia*) and at Leigh-on-Sea (where *Z. angustifolia* is plentiful, though patchy); comparatively few Brent winter in these two areas. Traces of *Z. noltii* have recently been found in the Dengie area and at Tollesbury, perhaps indicating the start of recolonisation. *Z. marina* is apparently extinct on the Essex coast, though at one time recorded from Osea and Mersea Islands, and on the Dengie coastline.

All three species of *Zostera* were found on Hamford Water, south of Horsey Island, in the 1930's (Butcher 1934). *Spartina townsendii* was introduced around the island about this time and has spread rapidly; returning in 1955, Butcher (pers. comm.) only found drift *Zostera* debris here, and on a visit in September 1958, the writer saw none at all. Evidently the *Spartina* has increased silt deposition in this landlocked bay, making it unsuitable for *Zostera.*

Brent Geese most often feed close to the tide edge; hence, where *Z. angustifolia* grows mainly at high tide levels as at Osea and Norfolk, it only forms a small proportion of the birds' diet. In Norfolk, Ranwell & Downing (*loc. cit.*) found no evidence that any was taken, though birds at Osea are sometimes seen feeding close inshore, and a stomach from this area contained 70% *Z. angustifolia* (analysis by D. S. Ranwell). Also, the densest part of the *Z. noltii* is concentrated at a high level, and is therefore not fully utilised by the geese.

At Foulness, the Brent do not feed uniformly along the whole coastline, but congregate largely in one area throughout the winter. A different area is chosen each winter. This is fortunate since, while the region in use is subjected to heavy grazing pressure, in other regions the spread of rhizomes can continue with little hindrance.

The habits of Brent in Essex and other areas where *Z. noltii* is the dominant form differ from those in areas where *Z. marina* is more abundant. *Z. marina* produces large quantities of drift, especially in autumn when disturbance by seasonal gales detaches leaves. At this time of year, Brent often spend much time offshore eating this floating débris (Russell 1890). During the winter, leaves loosened from the mud by feeding geese replenish this driftweed "larder." Such drift is negligible where *Z. noltii* is the dominant plant, as it is insufficiently dense, and its short leaves do not bind

together so tightly, so that the floating masses are easily broken up by the sea. Owing to this, and to the higher zonation of *Z. noltii,* Brent in areas where it is the common form spend much less time offshore than in areas where *Z. marina* abounds.

Where *Z. marina* is available, it constitutes the major part of the diet throughout the winter—Cottam *et al* (*loc. cit.*) estimated 85%. In areas where the geese subsist on *Z. noltii* there is characteristically a shift later in the year to other foods, especially green algae.

Algae

Second in importance to *Zostera* as a food are the green algae, notably *Enteromorpha* and *Ulva. Enteromorpha* is more abundant in most regions and hence is taken in greater quantity. There seem to be no preferences for particular species of either genus. The species of Ulva most often recorded are *U. lactuca* and *U. latissima,* evidently because they are most common. Campbell (1946) found that *Enteromorphae* from Brent stomachs were all of fine species; however, this too may be merely because they were the more abundant in the areas studied. Brent in Essex have been recorded as taking *Enteromorphae* of widely varying growth form—species identified have been *E. clathrata, intestinalis, prolifera* and *ramulosa.*

Enteromorpha and *Ulva* occur on a variety of substrata. They are least dense on pure sand. Rocks and boulders may be thickly covered, often with red algae associated. *Ulva* thrives on rocks, while *Enteromorpha* reaches maximum density on mud. They occupy the area down to about mid-tide level, and are densest at high levels. This distribution is simi'ar to that of *Z. noltii* and the habits of Brent are similar in both *Z. noltii* and *Enteromorpha* regions. *Enteromorpha* however has a somewhat wider range, and in Essex a sparse growth is found for about 50-100 yards seaward of the *Z. noltii.* Landward of the *Zostera* at Foulness is a zone occupied by the green alga *Cladophora. Enteromorpha* is found on all parts of the Essex coast, especially where *Zostera* is absent, and has colonised areas from which *Zostera* has disappeared. It is better able than *Zostera* to exist on an unstable surface or in regions of rapid silt deposition as at Hamford Water.

Important stretches of green algae in Essex are at Dengie, the Ray Sands, Goldhanger and the Tollesbury-Mersea area. The beds of algae in the Goldhanger area are probably the most dense in the county. A cover of up to 80% extends 50-100 yards out from the saltings, and a band of about 20% cover continues for another 50 yards to about mid-tide level. The predominant species are *E. prolifera* and *ramulosa,* which form a mat some 3″ thick in autumn. The mean productivity is about 8500 kg./ha. and the total mass in the area on the north shore of the Blackwater estuary between Heybridge Basin and Gore Saltings is estimated at 3-400 metric tons. Elsewhere in the estuary, and on Hamford Water, the crop is very sparse indeed, with a productivity of probably not more than 1000 kg./ha. At Dengie, a density of 2000 kg./ha. is estimated; this would be greater were the surface of the mud not broken up extensively by runnels.

Mörzer Bruijns & Tanis (*loc. cit.*) observed that Brent at Terschelling fed mainly on *Z. noltii* up to November or December, but after this, moved increasingly to the *Enteromorpha* beds. In Norfolk, *Zostera* and *Enteromorpha* are eaten in the first half of the winter and *Enteromorpha* alone later in the

season. The majority of Essex Brent change during the winter from a diet of pure *Z. nana* to a mixed diet of *Zostera* and algae, but many subsist throughout the winter on *Zostera* alone. When a mixed diet is taken, the birds move with the tide between different feeding areas, usually taking *Zostera* on the flood and *Enteromorpha* on the ebb. Such an alternation is well seen in the Osea Island area and also at the mouth of the Crouch and on the Stour.

There is evidence that algae are less nutritious than *Zostera;* Ranwell and Downing (*loc. cit.*) give analyses suggesting that fresh *Z. noltii* leaves are about three times as rich in protein as fresh *Enteromorpha* thalli, and also contain a good deal more carbohydrate. Cottam *et al* (*loc. cit.*) found that American Brant which had been feeding on algae were unusually thin, and reasoned that this was due to nutritional inadequacy of the algae. However, another explanation may be that this was because the large population of Brant had been thrown suddenly upon a less abundant food source, and had quickly exhausted it. Brent certainly seem to support themselves on algae in other areas, and observations in Essex show no difference in the time spent feeding on the two types of food. Many factors, such as the size of mouthfuls taken, the amount of energy spent in grazing the two types of food, the greater fibre content of *Zostera* and so on, may obscure the effects of the differences in composition of the two foods. It is not thought unduly inaccurate to regard *Zostera* as equivalent to *Enteromorpha* in the assessment of food resources in Essex, since the figures available are in any case only rough approximations.

Green algae other than *Enteromorpha* and *Ulva* are usually only recorded in trace amounts from stomach or dropping samples, though colonial diatoms sometimes appear in quantity. *Cladophora* is fairly abundant in Essex, but occurs at high tide levels not much frequented by the geese, and little is therefore taken. Brown and red algae are eaten at times in small amounts. Sixteen genera of algae have so far been identified in Brent food samples.

Other plants

Higher plants other than *Zostera* spp. are at times taken in considerable quantities. Two especially favoured are the glasswort, *Salicornia,* growing at the seaward edge of the saltings, and the grass *Puccinellia,* found abundantly on the saltings. Others often eaten are *Spartina, Festuca rubra, Triglochin maritima* and *Aster tripolium.* In Essex these plants may be taken at any spring tide, when high water floods the saltings, but in many areas a seasonal factor also plays a clear part. Thus Mörzer Bruijns and Tanis (*loc. cit.*) found that Brent in the Terschelling area foraged on the saltings to some extent during the early part of the winter, and again in the spring. A tendency to visit the higher marsh late in the winter was also noted in Norfolk (Ranwell and Downing, *loc. cit.*).

Foraging on saltings or inland meadows has in the past been correlated with Zostera scarcity; such behaviour was noted after the disappearance of *Z. marina* in the 1930's, both in Europe and North America. It is possible that a tendency towards land feeding late in the winter is a normal feature which may become emphasised when *Zostera* is scarce. Bolin and Webbe (unpublished) quote a report that before the 1914-18 war so many used to come ashore in spring to feed on the island of Föhr that they could be heard

all over the island on a calm evening. Factors other than food scarcity on the mudflats that could play a part are the renewed growth of land and salting plants, producing new tender shoots, and the impending change to a land habitat for the breeding season. As a direct cause of land foraging at Tipperne, Denmark, Lind (1956) has suggested that strong spring winds may result in overland flights by the geese revealing the foraging possibilities to them.

Animal Food

Small quantities of animal matter are regularly found in stomach and dropping samples, which must be ingested with other food. *Zostera* is particularly rich in animal associates, and samples of *Z. noltii* collected at Foulness contained about 2% by weight of animal matter (excluding *Littorina* spp.). Most of this material consisted of the amphipod *Corophium,* which was abundant among the leaves of *Zostera* and must be taken with them by feeding Brent. Hydroids occur quite often in food samples. Many other animals including molluscs, crustaceans, annelids, fish fry, protozoans and even insects, are recorded.

Brent are occasionally recorded taking animal food deliberately, and at Foulness, Essex, Brent Geese have quite often been observed pattering on the mud with their feet like gulls to bring up lugworms *Arenicola marina* which were then eaten.

Sand and Mud

A good deal of sand and mud is ingested by Brent, both deliberately and with food plants. More mud and sand is mixed up with *Enteromorpha* than *Zostera,* and this may be a reason why Cottam *et al* (*loc. cit.*) found more gravel in the stomachs of birds which had been feeding on green algae, though hunger may have played a part. In Essex, at low tide, the geese commonly resort to stretches of mud distant from the sea wall. In these areas they may be seen feeding on what appears to be mud, since nothing grows at these low levels, and the only abundant animal is the gastropod *Hydrobia ulvae,* which is only occasionally found in stomach and dropping analyses.

Discussion

There has been much speculation in the past regarding the extent to which *Zostera* supply limits the population of Dark-bellied Brent in Northern Europe. Recent opinion has tended to suggest that its importance has been exaggerated. For Essex at least it is possible to give some indication of an answer to this problem.

It is necessary first to attempt an assessment of the amount of food taken by a Brent in a day. Some clue is given by data for other birds. Drinnan (1958) estimated that Oystercatchers *Haematopus ostralegus* took 17.5% of their body weight per day in dry weight of food, and quotes figures for other animal feeders in the range 12-25%, varying inversely with the size of the bird. At Foulness, surveys indicated that some 650 metric tons of *Z. noltii* were removed during the winter of 1957-58. The Brent is the only species abundant at Foulness which eats *Zostera,* and an estimate of feeding rate

was made by dividing this quantity by the average number of birds counted throughout the winter—some 2300. This gives a figure of about 350-400 gm. dry weight of *Zostera* per day, equivalent to about 20-25% of the body weight per day. This seems high compared to the figures mentioned, but since these all concerned animal foods, different results might be expected. Also, some *Zostera* may have been removed by storms, frosts, etc. However, an underestimate of *Zostera* supply is to be preferred to an overestimate, and the figure of 375 gm. dry weight (=approx. 2400 gm. fresh weight) is therefore used in the calculations which follow.

From the surveys made of Foulness, Wakering, Osea Island and Goldhanger, it is possible to make cautious assessments of the bulk of food present in other areas of Essex, based on relative extent and density of cover. The estimated figures are shown in Table 1 below:—

Table 1: Estimates of the annual crop of Brent food plants at the less important haunts on the Essex coast.

Locality	Area (Hectares)	Plant	Density estimated (in kg./ha.)	Total crop estimated (metric tons)
Stour	150	*Zostera*	2500	400
Leigh-on-Sea	60	*Zostera*	3000	200
Dengie	350	*Enteromorpha*	2000	700
North Blackwater (other than Goldhanger) ..	100	*Enteromorpha*	500-1000	50-100
South Blackwater	100	*Enteromorpha*	500-1000	50-100
Hamford Water	200	*Enteromorpha*	500-1000	100-200

Adding these figures to those for the area surveyed, a figure for the whole county is arrived at of some 3000-3500 metric tons. This would be sufficient for about 12,000 Brent throughout the winter. Wildfowl counts show that the average number present throughout the past six winters has been 3300.

The figure of 12,000 would be impossible to maintain in practice for various reasons. In the first place, a considerable amount of the available food must be taken by other birds, of which Wigeon *Anas penelope* and Mute Swan *Cygnus olor* are the most important. Both species are abundant on the Stour, and Wigeon are numerous in the Blackwater and on the Dengie coastline, though scarce at Foulness and Wakering. Furthermore, Brent need a good deal of space to move about in, and it is characteristic that they should not make use of all the available feeding grounds. Thus, at Foulness, only part of the expanse of *Zostera* is usually grazed during any one winter.

It seems improbable, then, that a very high proportion of the coastline could be fully used without in effect overcrowding the birds, and it is suggested that the highest winter average which could be comfortably maintained would be in the region of 6000. Even during the last century the comparable figure may not have been so much more, for considerations of space would still have been important; although further large numbers may have been maintained at sea by the drift then available from *Z. marina*. During exceptionally hard winters in the past, very large numbers indeed seem

to have collected for a time in some areas, and would temporarily have overcrowded them. This may occur again, but need not affect the general conclusion that Brent numbers in Essex are not far below the maximum possible, the ultimate limit being imposed by space, competition and food supply.

Acknowledgements

My sincere thanks are due to all those who have advised, assisted and encouraged me throughout this study and the preparation of this paper. I am especially grateful to the following:-

H. Boyd, Dr. R. W. Butcher, Mrs. Y. M. Butler, M. R. Cheffleburgh, J. E. Dandy, R. Larner, Dr. G. V. T. Matthews, P. J. S. Olney and Dr. D. S. Ranwell.

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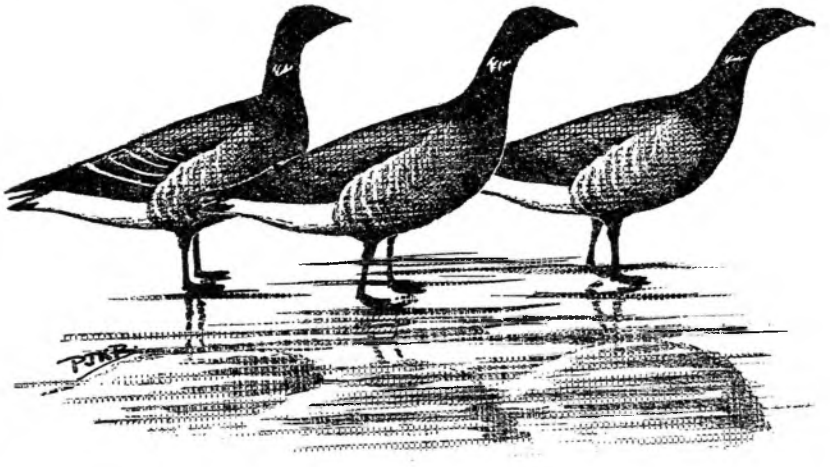

BRENT GOOSE AGE-GROUP COUNTS 1959-60

P. J. K. Burton

ACCOUNTS of studies on age-group ratios in Dark-bellied Brent Geese *Branta bernicla bernicla* (L.) in Essex and elsewhere have appeared in the three previous Annual Reports (Burton 1958-1960). In 1958-59, the counts were extended by the collection of data from observers in other areas and this has been continued. Counts during 1959-60 came from Essex and North Norfolk, and also from Holland and France. In addition, some counts of Pale-bellied Brent *B. bernicla hrota* (O. F. Müller) have been received from Northumberland. The results for the various areas are given below.

Essex

Counts were made at Foulness, the Ray Sands, Dengie, Goldhanger and Hamford Water. The total examined was 1664, of which 379 (23%) were first-winter birds. 29 samples of 50 were obtained from the following areas:-

Foulness	15 samples
Dengie	5 samples
Ray Sands	2 samples
Goldhanger	7 samples

The mean number of first-winter birds per sample was 11.69, with the high standard error of 1.31. Counts from different parts of the county varied quite widely, and at Foulness the proportion of first-winter birds noted in November, 1959 was unusually high in relation to the results obtained there and elsewhere during succeeding months.

Other Areas

Counts from areas other than Essex totalled 621, of which 115 (19%) were first-winter birds. 11 samples of 50 were obtained, 8 from Norfolk and 3 from Holland.

Norfolk

Counts were made on 4th and 5th January, 1960 at Scolt Head Island by the writer and R. Chestney, Warden of the Reserve. The 8 samples of 50 obtained included 67 first-winter birds (17%). All the birds observed were Dark-bellied.

Holland

Information on the Brent in the Kattendijke area of the Ooster Schelde in South Holland were again received from T. Lebret. 3 samples were provided by a count made on 13th December, 1959 which totalled 158, including 25 first-winters (16%). A late count on 8th May, 1960, which gave only 6 young out of 124, has not been included in the totals, as it is very likely that at such a late date, many young had already moulted into their summer plumage, which is indistinguishable from the adult. However, the count is valuable, as it shows that at least some first-winter birds can still be identified in late spring. This was implied by Moffitt (1932) stating that the latest lingerers in May among Black Brant *B. bernicla nigricans* Lawrence in California are mainly immature, and also by Phillips (1932) who noted

that immatures were in less hurry to leave the Monomoy area of Massachusetts on spring migration. This evidence supports the belief that the observed absence of young in West Jutland in spring 1959 was further evidence of breeding failure in 1958 (Burton 1960). It is interesting to note that young Black Brent hatched at Slimbridge in 1959 had moulted out of first-winter plumage by the end of January. Age-group counts in Essex have shown no sign of such an early moult on any noticeable scale, and it seems there may be some physiological difference in this respect between collection birds and wild ones.

France

Two small counts have been received. On 31st January, 1960, 8 young were found in a party of 34 at the Baie de l'Aiguillon (Vendée), where some 200 were present (F. Spitz). On 9th March, 1960, 15 first-winters out of 29 were counted at Anse du Pô, Golfe du Morbihan, by l'Abbé R. Bozec.

Total Count

40 samples were obtained in all, giving a total of 429 first-winter birds. The mean number per sample was 10.72, with standard deviation 6.44 and standard error of the mean 1.02. The results of counts since 1954-55 are summarised in Table 1.

Table 1: Proportions of first-winter birds in sample counts of Dark-bellied Brent in England, 1954-55 to 1959-60.

Season	Total count	Number of 1st winter birds	Mean No. per sample of 50	S.D.	S.E. of mean	Number of samples
1954-55 ..	776	314 (40%)	—	—	—	—
1955-56 ..	2020	522 (26%)	13.26	6.40	1.19	29
1956-57 ..	1484	97 (7%)	3.52	3.90	0.78	25
1957-58 ..	1810	955 (53%)	26.32	5.53	0.95	34
1958-59*	Hardly any young in most areas, except Wash and N. Norfolk.					
1959-60* ..	2285	494 (22%)	10.72	6.44	1.02	40

*Essex observations supplemented by counts from other areas.

Family Size Counts

In previous seasons it has not been found possible to collect sufficient brood size counts to give a statistically reliable figure, owing to the difficulty of picking out families among the dense jostling flocks of Brent at the tideline. During 1959-60, an attempt was made to remedy this by collecting counts of small parties seen in flight, on the assumption that these would be families. Boyd (unpublished) applied this method successfully to Barnacle Geese on the Caerlaverock Reserve in 1958-59. Parties of more than 8 were ignored, as previous experience has shown that broods of 7 are very rare indeed among Brent. Assuming that each party consisted of two parents with their brood, the distribution of brood sizes obtained is shown in the second row of Table 2. In addition, a few families were positively identified by watching by the writer and by T. Lebret, and their distribution is shown in the first row. The two means do not differ significantly, and the total distribution and mean is shown in the third row.

Table 2: Mean brood-size and frequency distribution of brood-sizes among Dark-bellied Brent in England and Holland, 1959-60.

	Number of young in brood						Total No. of broods	Mean	S.E. of mean
	1	2	3	4	5	6			
Identified families	3	1	3	**4**	3	1	15	3.40	0.58
Flying Parties	7	12	16	11	6	**4**	56	3.16	0.20
Total	10	13	19	15	9	**5**	71	3.21	0.17

Pale-bellied Brent in Northumberland

A count at Holy Island in February, 1960 gave the unusually high proportion of 165 young out of 226 (73%) (R. Marriss). This could scarcely be typical of the whole population, but a good breeding season is indicated.

Discussion

The breeding season of 1959 must be regarded as having been rather a poor one for the Dark-bellied Brent populations studied, especially since there can have been few immature birds in adult plumage following the bad year of 1958. The weather records from the breeding areas (extracted from British Daily Weather Reports) show no sign of exceptionally poor conditions, reaffirming the conclusion (Burton 1960) that only wholesale breeding failures such as those of 1958 and 1956 are likely to be detected from meteorological records. Other species breeding within or near the same range—Bewick's Swans and White-fronted (see p. 17) and Barnacle Geese (Boyd, 1961)—seem to have been fairly successful. Conversely, counts from Solway suggest a poor year for Barnacle from Spitsbergen (Boyd, 1961) while Brent there apparently did well (see Holy Island count, above). Probably correlations between Brent and other species are also only to be expected in a very bad year.

In view of the figures for the last two seasons, it does not seem very likely that the increase in Brent numbers noted up to 1957-58 can have been maintained. It is evident from this that although the original period of trial protection for Brent is now over, considerable caution must be exercised in deciding finally when shooting shall be resumed.

Acknowledgements

The help of the following observers in submitting counts in the past season is most gratefully acknowledged:—

M. l'Abbé R. Bozec, R. Chestney, T. Lebret, R. Marriss and F. Spitz.

In addition, my sincere thanks are due to all those who have helped with information of various kinds and by finding other observers. I am particularly grateful to M. Françis Roux for his valiant efforts to obtain counts from France. Finally, for their patient help in the field, I am greatly indebted to M. R. Chettleburgh and R. Larner.

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THE NUMBER OF BARNACLE GEESE IN EUROPE IN 1959-1960

Hugh Boyd

Summary

A CO-OPERATIVE international inquiry in the winter of 1959-1960 resulted in an estimate of about 30,000 for the world population of *Branta leucopsis*. At 1st December, 1959 there were about 11,100 in the Netherlands, 8,600 in Germany, 7,100 in Scotland and 2,800 in Eire. No other country is likely to have held more than a few stragglers at that date. Evidence from ringing and from observations on the proportions of first-winter birds in different flocks suggests that the geese in the Netherlands and Germany are those breeding in Novaya Zemlya and Vaigach Island, off the Siberian coast. Scottish birds include some from Spitzbergen, and more from east Greenland. The Irish geese probably come only from Greenland. The stocks from Siberia and Spitzbergen have apparently recovered in recent years from the dangerously low levels they reached in 1945-1950, although aerial surveys in Sweden show that numbers stopping there in spring have decreased greatly in the last few years. Barnacle geese breeding in Greenland are faring less well than the other two stocks.

Introduction

In 1957 the writer began, on behalf of the Trust, an investigation into the distribution and population dynamics of the Barnacle Goose *Branta leucopsis* in the British Isles. This study must be continued for several more years before a satisfactory understanding of the behaviour of the British population is achieved. The main purpose of this short paper is to report the results of an international inquiry in the winter of 1959-1960 which produced for the first time details of the numbers of Barnacle Geese present in all the important wintering places at one time, namely 1st December, 1959.

The arrangement of counts in Germany, the Netherlands and Sweden was carried out by national organisers at the request of the International Wildfowl Research Bureau. The results were transmitted to the writer, who embodied them in a report approved by the Bureau at a meeting in Wilhelmshaven in October, 1960. That report forms the basis of the present paper.

In addition to summarising the results of the winter census, the paper also presents evidence from recoveries of ringed geese and from observations on changes in numbers and on the proportion of first-winter birds present in flocks in different areas which helps to explain some problems in the distribution of the species.

The number of Barnacle Geese at 1st December, 1959

From counts and estimates made in Germany, the Netherlands, Scotland and Ireland in November and December, 1959, it appears that the total number of Barnacle Geese at 1st December, 1959 was most probably about 30,000, with extreme limits of 24,600 and 37,500.

It is unlikely that any other country held more than a few vagrants at this date.

The geese were distributed in the following way:-

GERMANY:	Schleswig-Holstein	8400		
	Nieder-Sachsen	170		
			8,600	(5,400– 9,500)
NETHERLANDS:	Friesland	11000		
	Delta area	100		
			11,100	(9,000–13,300)
SCOTLAND:	Outer Hebrides	1430		
	Inner Hebrides	3300		
	N.W. Highlands	550		
	Solway area	1800		
			7,100	(6,500–11,500)
IRELAND (Eire):			2,800	(2,700– 3,200)
	GRAND TOTAL		29,600	(24,600–37,500)

The surveys in each country varied in technique and completeness so that some account should be given of how the above figures were arrived at.

Germany. Counts organised by Dr. F. Goethe and Dr. H. Requate, of Vogelwarte Helgoland, supplemented by observations submitted to the British Services Wildfowl Sub-Committee, reported by Mr. J. A. V. Davies. Observers: Sqn. Ldr. R. S. T. Buchanan, W. Fuhrman, Dr. jnr. R. Heldt, P. Petschendorffer, P. Rabe, Dr. Rassow.

Schleswig-Holstein. Two major flocks. At Hamburger Hallig, near Bredstedt, about 5000 geese estimated to be present on 1st December. There were about 5000 in the same area on 18th November and about 6000 on 6th December.

2,500 to 3,000 geese were seen in the Friedrichskoog area on 15th November. No observations were made around 1st December. On 13th December, only 80 were seen on Dieksanderkoog, part of the Friedrichskoog area. Since it seems clear that the Hamburger Hallig flocks were not affected by the movements of the Friedrichskoog birds, the compiler has assumed that 2,700 were present in the latter group on 1st December. In view of the rapid build-up in Friesland (see below) in the last few days of November this assumption may well exaggerate the size of the continental population, by including in the German total some birds that had already moved from Friedrichskoog to Friesland.

100 Barnacles were present on the island of Föhr at the time of the survey.

Nieder-Sachsen. All the known resorts of the species except Greetsiel seem to have been visited in November and December, but the only positive records were of 100 on the west side of the River Weser, opposite Bremerhaven and of 70 on the east side of the Jade Busen, both on 29th November. There were about 50 at Carolinensiel in mid-November and about 30 on Langeoog for a few days in mid-November, but none in either haunt on 1st December. The compiler has put the regional total at 170. About 1500 were seen at

Balje, on the River Elbe, on 31st October. They had been there for about a week, but flew off westwards that day. It seems unlikely that any substantial number was still in the area at the beginning of December.

Netherlands. Counts made and collected by A. Timmerman and communicated by Dr. M. F. Mörzer Bruijns, of the State Institute for Nature Conservation Research—R.I.V.O.N. Full details are held by that Institute. A series of counts and estimates of the numbers in the two important wintering areas in the Netherlands were made from October to the end of March. All the regular haunts (6 in Friesland, 5 in the delta area) were counted each month. Only the counts on 30th November are used in Table 1.

Scotland. The Solway area was counted from the ground by E. L. Roberts (Warden, Caerlaverock Wildfowl Refuge), J. Powell and R. Stokoe. The counts were complicated by the frequent shifting of the geese between two localities about 16 miles apart during the census period, but the error is unlikely to have exceeded ± 200 in 1800.

All other areas were inspected from the air by H. Boyd. There are about 100 haunts known to be frequented more or less regularly at the present time. All were examined except Eilean nan Roan, Sutherland and Staffin Island, off Skye, Inverness. Neither haunt is a large one and the total missed there has been put at 150 ± 150. Errors in counting or estimating numbers from the air are likely to have been of the order of 5% in flocks of less than 100, 10% in flocks of 100 to 250 and up to 20% in larger groups. Since most of the flocks seen contained less than 150 birds, counting errors are thought to have been small (± 500 in all). Failure to find geese is likely to have been an important source of error only on the island of Islay, the main wintering place, where 2,800 were seen on 2nd December. This total was smaller than had been expected and larger numbers were seen later in the winter (see below). It is rather unlikely that large numbers were missed in December, since the observer is familiar with the distribution of geese on the island and since some geese were in fact seen on all the major feeding areas except one.

Ireland. All the known haunts and a number of other possible islands were inspected from the air by H. Boyd. Since most of the birds were in small groups the limits of error are believed to have been small.

A full account of the survey in Scotland and Ireland is in the files of the Wildfowl Trust. Though no complete census had been made in the previous winter, 1958-59, data from the Solway, Islay and Ireland suggest that the British mid-winter population in that season was substantially bigger than in 1959-60, probably about 13,000.

Mixing of breeding stocks in winter

A second task of the 1959 inquiry was to find out to what extent geese from the three breeding areas (E. Greenland, Spitzbergen and Novaya Zemlya) may mix in the wintering places. There were two ways in which field observations might help : (1) by the comparison of counts in different places at intervals through the winter, and (2) by the comparison of age-group ratio counts from different areas.

Numbers at other times during the winter of 1959-60

The series of counts obtained in the Netherlands is of great interest. There were only 500 on 23rd October, 600 on 29th October and 13th

November, at least 4,500 on 24th and 11,000 by 27th November. The number present in early December, 1959 (11-12,000) increased to over 16,000 at the beginning of January, 1960 and reached a peak of 19,200 on 17th January, dropping slightly to 18,260 on 22nd, to 17,515 on 31st January, 17,325 on 8th February and 17,020 on 14th February. Later in February far fewer were present and the most seen in March was 3,000. Perhaps the most important feature of these counts is that the maximum (19,200) lies close to the estimate of 19,700 present in the Netherlands and Germany together at the beginning of December, 1959. Though in the absence of a complete series of observations from Germany it is not possible to be sure that the number of Barnacle Geese on the North German coasts on 17th January, 1960 was negligible, the resemblance between the December and January figures fits the hypothesis that the geese of Germany and the Netherlands form a single group. Where most of these geese went in late February and March and where they were in October and the first half of November are questions that still have to be answered.

Because of the widely scattered occurrence of Barnacle Geese in Scotland and Ireland it was financially impossible to repeat the November-December survey later in the winter. But some records from the principal haunts—the island of Islay, Argyll, and the Caerlaverock Wildfowl Refuge on the Dumfriesshire coast of the Solway estuary—show that substantial fluctuations in numbers took place during the winter. In mid-February, 1960 Dr. J. Morton Boyd found 7,200 $\pm$ 20% (5,800-8,600) on Islay, and Professor M. F. M. Meiklejohn reported about 8,000 there shortly afterwards. The numbers on the Caerlaverock Refuge in the second half of February, 1960 varied : 1,600 from 12th-19th; 1,000 on 20th and 21st; and 1,650 from 22nd to 28th, but it is very probable that the temporary drop was due to a shift to another part of the Solway, rather than further afield. Thus these two localities alone seem to have held 8,800 Barnacle Geese, compared with the total of 9,900 found in all the Scottish and Irish haunts together at the beginning of December, 1959. If the geese wintering in Scotland and Ireland are isolated from those in the Netherlands and Germany, it seems necessary to suppose either that the December census on Islay was incomplete or that most of the other haunts in the islands were deserted or greatly depleted in the middle of February. Alternatively, it is possible that in late February and March some Barnacle Geese from the Netherlands moved to Scotland. Further information on seasonal changes in numbers on the smaller Scottish islands, particularly in the Outer Hebrides, is badly needed.

Age-group ratio counts

In the appeal for help in this inquiry sent out in September 1959 it was suggested, on the basis of weather records, that " few young birds will have been reared in Spitzbergen and Greenland but that the population of Novaya Zemlya may have had a successful breeding season." These predictions seem to have been correct.

On the Caerlaverock Reserve, Dumfries, Scotland, where a flock of about 1600 Barnacle Geese was examined on 20th and 21st October 1959, 146 in a sample of 1000 were identified as juveniles (14.6%). This flock was seen to include at least four geese ringed in Spitzbergen in July, 1954 (which carried white plastic rings as well as numbered aluminium ones).

On Islay, Argyll, Scotland on 26th to 28th October, 1959, 102 juveniles were identified in groups totalling 721 (14.1% juveniles). The only ringed goose so far recovered in Islay (in December, 1956) was marked in Greenland in 1955.

Precise counts of juveniles cannot be made from an aircraft, but in favourable conditions it is possible to distinguish between flocks containing many or only a few young birds, because the wings of juveniles look darker than those of adults when seen in flight from above. None of the flocks seen in Ireland in December, 1959 contained a large proportion of young birds.

Opportunities for close study of Barnacle Geese in the Netherlands are less favourable than in the two Scottish localities where large samples were scrutinised, but four groups studied at close range in widely scattered localities included 86 juveniles in 345 (25.0%). 46 caught in nets at Joure, Friesland, in January and February, 1960 included 17 juveniles (37%). A flock of 800 at Sondel, Friesland, on 21st January, 1960 appeared to contain 30-50% young birds and another flock of 300 seen on 1st March, 1960 near Lemsterland, Friesland had 20-30%. (Full details of these Dutch observations have appeared in a paper by Dr. M. F. Mörzer Bruijns in *Limosa* 34 : 29-33.

It is planned to extend these age-group observations in the Netherlands and in Britain in future winters.

The distribution of recoveries of ringed geese.

An important step forward in our knowledge of distribution has been made by Mr. J. A. Eygenraam, of the Institute for Biological Field Research, Arnhem (I.T.B.O.N.). He has persuaded nearly all the remaining professional goose-netters in Holland to ring geese for the Institute. Most of the geese caught are White-fronted *Anser a. albifrons* and Bean *A.f. fabalis*, but since 1956 increasing numbers of *B. leucopsis* have been marked and have so far yielded 11 recoveries. From this recent Dutch ringing, and earlier work by expeditions to Spitzbergen in 1954 and Greenland in 1955, both led by Mr. Russell Marris, the following picture of distribution has emerged:

Recovered in	Ringed in Spitzbergen	Ringed in E. Greenland	Ringed in Holland
Siberia			4
Germany			3
Holland			4
Iceland		1	
Scotland			
Hebrides		17	
Solway	6		
Ireland		4	
Spain		1	

This evidence from ringing supports the hypothesis that the Continental population is distinct from those of Scotland and Ireland, although movements in late February and March, such as those which may have occurred in 1960, are unlikely to be demonstrated by recoveries, since only in Germany can Barnacle Geese legally be shot at that time.

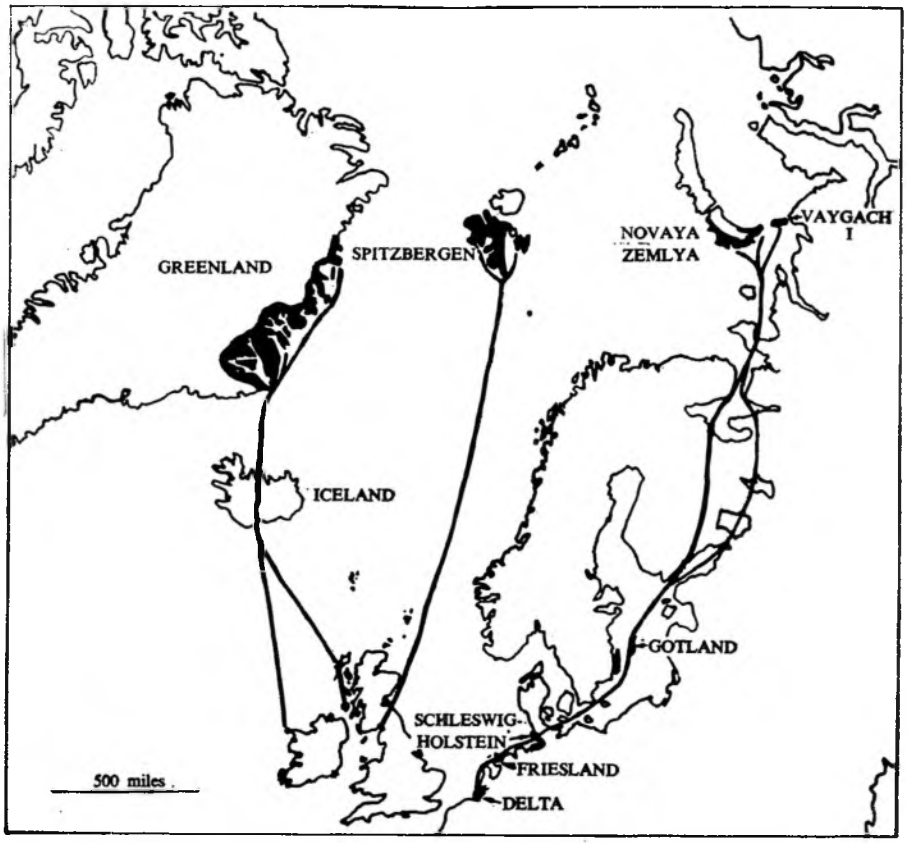


Figure 1. Breeding and wintering areas of the Barnacle Goose

Numbers of Barnacle Geese in Sweden in the spring of 1960

As part of the international inquiry Dr. K. Curry-Lindahl, of Nordiska museet and Skansen, Stockholm, organised an aerial survey of Barnacle Geese in Gotland on 29th April, 1960. The census was arranged in collaboration with the Royal Swedish Air Force and the Swedish Association of Hunters, who provided two observers, Mr. Nils Höglund and Mr. R. Beinert. Two small aircraft were used, one following the other around the coast of Gotland, providing independent estimates of the numbers of geese present. In addition, photographs were taken to check the visual estimates.

Seven different areas on the south-western and eastern coasts of the island are used by Barnacles. The total number found on 29th April, 1960 was about 3,500 geese, a slight increase on the numbers estimated visually (3350 from aircraft A and 3250 from B) because the photographs showed a tendency to underestimate numbers.

This number was much lower than expected. The spring of 1960 was exceptionally early in northern Scandinavia and possibly the geese continued their migration earlier than usual. But other factors were probably involved, since numbers in recent years are known to have declined from the 10,000 geese reported in the early 1940's. There have been marked changes in the

abundance and distribution of Barnacles in Sweden in spring at other times during the last hundred years, which are discussed fully by Curry-Lindahl in *Vara Faglar i Norden,* pt. 1, (p. 353, 1959).

For the immediate purpose of this inquiry the important point is that the number seen in Sweden is only a small fraction of the total population and less than one-fifth of the number present in Germany and the Netherlands from November to February so that Swedish observations seem unlikely to be useful as a check on midwinter numbers.

Breeding distribution of the Barnacle Goose in the U.S.S.R.

A recent paper by S. M. Uspenski (Some species of birds in the north-east of the European part of the U.S.S.R., *Uchen. Zap. Moscow Univ.* 197 : pp. 35-47, at pp. 40-1, 1959) reviews the present distribution of Barnacle Geese on

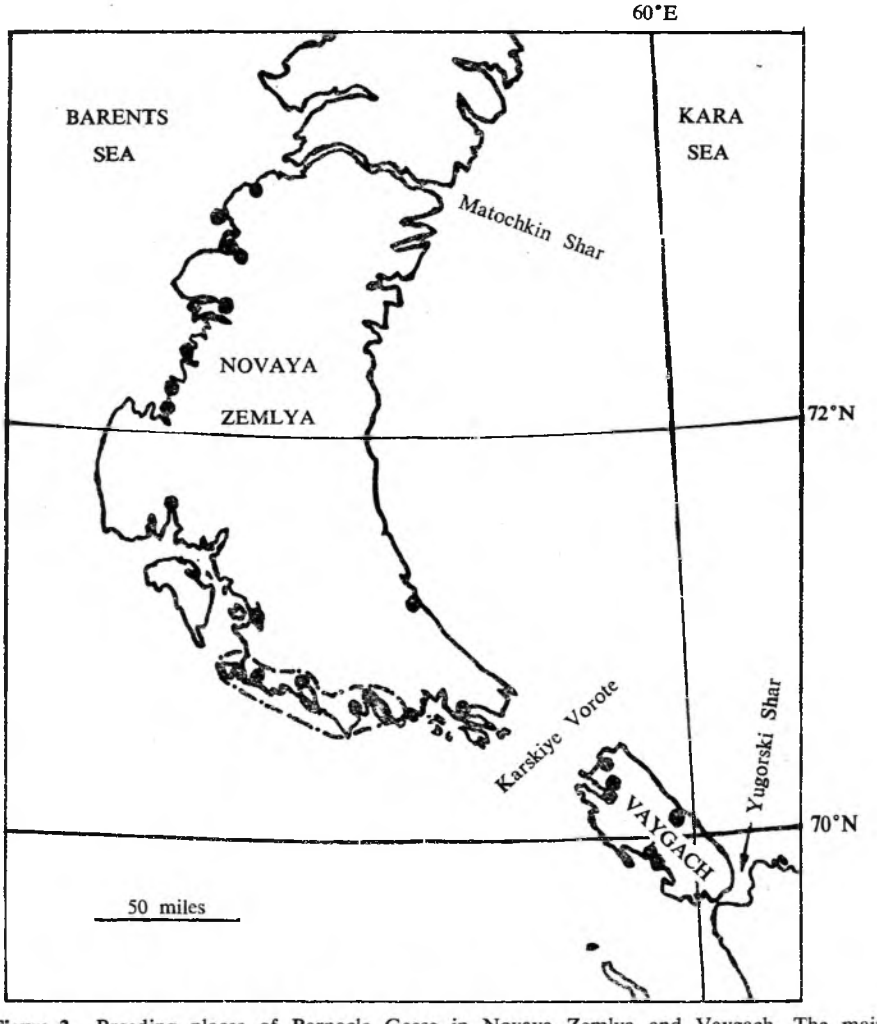


Figure 2. Breeding places of Barnacle Geese in Novaya Zemlya and Vaygach. The main concentration is in the area enclosed by a broken line. (After Uspenski, 1959).

the southern island of Novaya Zemlya and reports the discovery in 1957 of breeding on the island of Vaigach, between Novaya Zemlya and the Kara peninsula. The buoyant tone of this paper is in contrast to the gloom of the account of *B. leucopsis* in *The Birds of the Soviet Union* (1952) which said that in recent years the species had declined catastrophically on Novaya Zemlya. It seems possible that the earlier decline has been checked, or even reversed.

The accompanying map, redrawn from one given by Uspenski, shows the distribution of the known breeding places of Barnacles on the two islands.

Discussion

The present inquiry was intended to provide a starting-point for future research rather than to be complete in itself. The lack of detailed and complete counts in earlier years effectively prevents thorough discussion of changes in the abundance of Barnacle Geese, but it seems proper to indicate briefly how the findings of 1959-60 compare with what was known before.

The population wintering in Germany and Holland seems to be larger now that it has been since the 1939-45 war. The large numbers found in the Netherlands in January and February, 1960 and at the same period in 1959 were substantially greater than had been recorded previously. In the early 1950's the wintering population was thought to be about 10,000. There are some indications that recent gains in Holland are due to reductions in the numbers staying in Germany in mid-winter, although there are too few numerical records from German haunts to make this certain. In any event the numbers in Germany in autumn seem to have increased over the last twenty years. In 1952 J. G. Harrison remarked that " there seems every reason to associate the increase of the Barnacle Goose with the extensive reclamation schemes that are being developed," since these have provided additional areas of turf-forming grass, the preferred food of the species. It is also likely that the improved status of this continental population is due in part to the complete protection afforded by law to the species in the Netherlands since 1946.

In the British Isles the situation appears more complicated. As has been noted above, there were probably substantially more Barnacles wintering in 1958-59 than in 1959-60, but the difference could be due solely to a poor breeding season in 1959. On the Solway the 1,800 or so present in 1959-60 were the largest number recorded for about twenty-five years (though the total rose again in the autumn of 1960 to 2,500). There has been an encouraging growth in the numbers wintering in the Solway since 1953-54 when the stock was as low as 300. The resurgence followed immediately upon the full legal protection afforded by the Protection of Birds Act, 1954, and has been especially marked since the creation of the Caerlaverock Nature Reserve, on the Dumfriesshire shore, in April, 1957.

Numerically, the most important British resort is Islay, where from 6,000 to 10,000 have been found nearly every winter since 1954-55, the numbers having increased to that level over the last thirty years and having probably reached somewhere near the " carrying capacity " of the island. Here, as on all the island resorts of the species in Scotland except three, the

total legal protection afforded from 1st December, 1954, was removed by an Order taking effect on 18th November, 1955, permitting Barnacles to be shot on the islands in the months of December and January. On Islay this Order has had no serious effects, because the geese are exceptionally well looked after by interested landowners, but elsewhere the situation is less happy and there is some evidence that the numbers frequenting the Outer Hebrides have continued to decline in the last four years.

In Ireland the numbers of Barnacles found in 1959 seem to have been of the same order as at any time in the last ten years. There has been a big decrease at what was formerly the largest haunt on the mainland, in Co. Sligo, which held about a thousand from the early years of this century until about four years ago and where now less than 250 occur : and a decrease in numbers and in regularity of occurrence at the only other important mainland locality, in Co. Wexford. But on the islands off Mayo, Donegal and Galway the numbers do not yet seem to have fallen to a similar extent, despite increased disturbance of some of the larger flocks by indiscriminate shooting. In Eire, Barnacle Geese may be shot from 1st September to 25th February. In Northern Ireland the Barnacle has been wholly protected since 1951, but unfortunately it nowhere occurs in quantity.

In sum, the Barnacle Goose is not a very rare bird and its present status does not seem especially perilous, but the species is scarce enough to justify a continuing careful watch and restraint on factors liable to be harmful, as well as further research on several aspects of its biology. There is a particular need for information about the places frequented on passage in autumn and spring.

Acknowledgements

I am grateful for the generous co-operation of Dr. M. F. Mörzer Bruijns, Mr. J. A. Eygenraam, Dr. K. Curry-Lindahl and Dr. H. Requate not only in organising counts but in supplying other information and correcting earlier drafts. My thanks are also due to the other participants in the counts named in the paper; to Dr. Edward Hindle and Miss Phyllis Barclay-Smith, Hon. Director and Secretary of the International Wildfowl Research Bureau for encouraging and assisting the inquiry; to Mr. Arthur Wignall, the pilot of the aircraft used in the British surveys, and other members of the staff of Skycraft Services Ltd., for their efficiency and enthusiam; and to other correspondents and helpers, particularly Mr. Kevin Murray and Major R. F. Ruttledge.

THE DISTRIBUTION OF MALLARD RINGED IN SOUTHERN ENGLAND

H. Boyd and M. A. Ogilvie

Summary

RECOVERIES of Mallard ringed at six stations in the south of England from 1947 to 1960 are used to study the homogeneity of the population. A large majority of the ducks were ringed in the months August-November and very few in the breeding season. Little emigration of autumn-marked Mallard occurs during the winter, though some move to France. Within Britain dispersal is usually over quite short distances. Circles of 10 miles radius around the three major stations (Abberton, Essex; Borough Fen, Northants; and Slimbridge, Glos.) include 81 (63%), 99 (22%) and 43 (22%) direct recoveries (in the same season). The "winter dispersion areas" of the three stations, defined as the areas containing the nearest 90% of direct recoveries, cover about 2,200, 13,800 and 10,500 sq. miles, with comparatively little overlapping. Recoveries in the breeding season (February to July in England) are much less plentiful than those in the shooting season, but they show a pattern of distribution similar to the "winter dispersion areas." The proportions of recoveries in England in later winters which are within the dispersion areas are very high : 86%, 86% and 85%. Smaller-scale ringing in Norfolk and Dorset confirms that most surviving Mallard remain in, or return to, their winter homes.

The winter population of Mallard in southern England includes immigrants drawn from a large area around the Baltic and from west Germany, Holland and northern France. The proportion of visitors from abroad seems to vary considerably from place to place. Precise estimates are impossible from the available data but it seems that about half the Mallard sampled in Essex which survive the winter emigrate the next spring. The corresponding fractions for Borough Fen and Slimbridge, though uncertain, are substantially less. No differences in the summer distribution of recoveries abroad are apparent. In the autumn after ringing the proportion of Essex-ringed Mallard taken in Holland is higher, and that of Borough Fen and Norfolk-ringed birds lower, than the average, suggesting that in the later stages of autumn migration some differentiation of routes occurs. No differences in the summer ranges of males and females are apparent.

Introduction

Ringing prior to 1939 in the British Isles and elsewhere enabled Landsborough Thomson (Results of Ringing Duck. *Factors affecting the general status of Wild Geese and Wild Duck,* pp. 84-105. Cambridge. 1941) to give a general picture of Mallard migration in Europe. Recently C.S.P. van Dam, on behalf of the International Wildfowl Research Bureau, has re-investigated the situation with the aid of a relatively large volume of ringing and recoveries from many countries since 1945. His analysis, not yet published, has provided a much more detailed picture, without substantially altering the earlier outline. Van Dam made extensive use of the data on which the present paper is based, but this insular inquiry is made with a different object : to see whether an intensive study of the movements of ducks within a small segment of the winter range can throw light on some general problems of migration and distribution.

Over 20,000 Mallard ringed at six stations in southern England since 1947 have provided the material used. Two of the ringing stations are operated by the Wildfowl Trust : Berkeley New Decoy, Slimbridge, Glos. and Borough Fen Decoy, Peakirk, Northants. Major General C. B. Wainwright operates a large number of cage-traps at Abberton Reservoir, Essex, with financial assistance from the Trust. M. R. and C. A. Boardman have caught ducks in cage-traps at Ludham, Norfolk for many years and P. L. Wayre used a cage-trap at Mileham, Norfolk, from 1951 to 1955. Small numbers of Mallard have also been caught for ringing in the decoy at Abbotsbury,

Dorset, by F. Lexster for the Earl of Ilchester since 1937. In this paper particular attention is paid to ringing at Abberton, Borough Fen and Slimbridge, where most ducks have been marked. Table 1 provides a summary of the numbers ringed at the major stations and recovered up to the end of July, 1960.

Table 1. Numbers of Mallard ringed at three major trapping stations in England, 1947-60 and recoveries reported to July, 1960. Figures in italics in last three columns express recoveries as percentages of numbers ringed.

Station	Period of ringing	Number ringed	Numbers so far recovered in Britain	%	overseas	%	Total	%
Abberton, Essex ..	1949-60	4618	943	*20*	272	*6*	1215	*26*
Borough Fen, Northants	1954-60	7033	682	*10*	166	*2*	848	*12*
Slimbridge, Glos. ..	1947-59	6698	755	*11*	189	*3*	944	*14*
total		18349	2380	*13*	627	*3*	3007	*16*

Quantitative interpretation of recoveries is beset with difficulties, many of them insoluable without additional information, most of which cannot be collected. For example, the intensity of shooting at different times in different

FIGURE 1. Direct winter recoveries of Mallard ringed at Abberton, Essex, August 1949 to February 1960. 81 recoveries at or within 10 miles of Abberton shown by circle not marked individually.

countries, the chances of rings being reported when found, the proportion of deaths not due to shooting, and so on. The following account is restricted to topics not likely to be undetectably biassed in an important way by reporting troubles.

Direct Recoveries

The most abundant and readily interpretable evidence from recoveries of ducks ringed in the autumn and winter consists of reports during the same season, here referred to as *direct* recoveries. Figures 1 to 3 show the distribution of direct recoveries in England and Wales of Mallard ringed at Abberton, Borough Fen and Slimbridge. Three recoveries further north are not mapped nor are one in Ireland and 34 in France. The pattern of dispersion is a familiar one, with the density of recoveries high near the ringing station and falling off rapidly with increasing distance. Circles of 10 miles radius around Abberton, Borough Fen and Slimbridge include 63%, 22% and 22% respectively of all the direct recoveries. Recoveries beyond this distance, though widely scattered, are clearly not randomly distributed throughout England. This is shown plainly in Figure 4 on which " winter dispersion areas " for the three stations are plotted. These areas are drawn so as to omit the outer 10% of the direct recoveries from each. The approximate sizes of the areas are 2,200, 13,800 and 10,500 sq. miles respectively (the

FIGURE 2. Direct winter recoveries of Mallard ringed at Borough Fen, Northants, August 1954 to February 1960. 99 recoveries at or within 10 miles of Borough Fen not shown individually.

FIGURE 3. Direct winter recoveries of Mallard ringed at Slimbridge, Gloucestershire, November 1947 to February 1959. 43 recoveries at or within 10 miles of Slimbridge not shown individually. (Mallard caught at Slimbridge in 1959-60 were used in transportation experiments and so have been ignored here).

total area of England bring 50,300 sq. miles). The only overlap between the areas is in the central midlands where ducks from Slimbridge and Borough Fen mix. The small size of the Abberton area is the more striking because the recovery rate for Abberton birds is high. London appears to form a barrier between the Abberton and Slimbridge areas. The Mallard population of the city is quite large and is not wholly sedentary, so that the lack of recoveries from London may reflect the absence of shooting there rather than the non-occurrence of marked ducks.

Table 2. Numbers of direct winter recoveries of Mallard ringed at Abberton, Borough Fen and Slimbridge. One Borough Fen bird recovered in Ireland is not included.

	recoveries reported in		recoveries per 1000 marked	
	England and Wales	France	England and Wales	France
Abberton	307	15	66	3
Borough Fen ..	458	9	65	1
Slimbridge	192	10	29	2
total	957	34	52	2

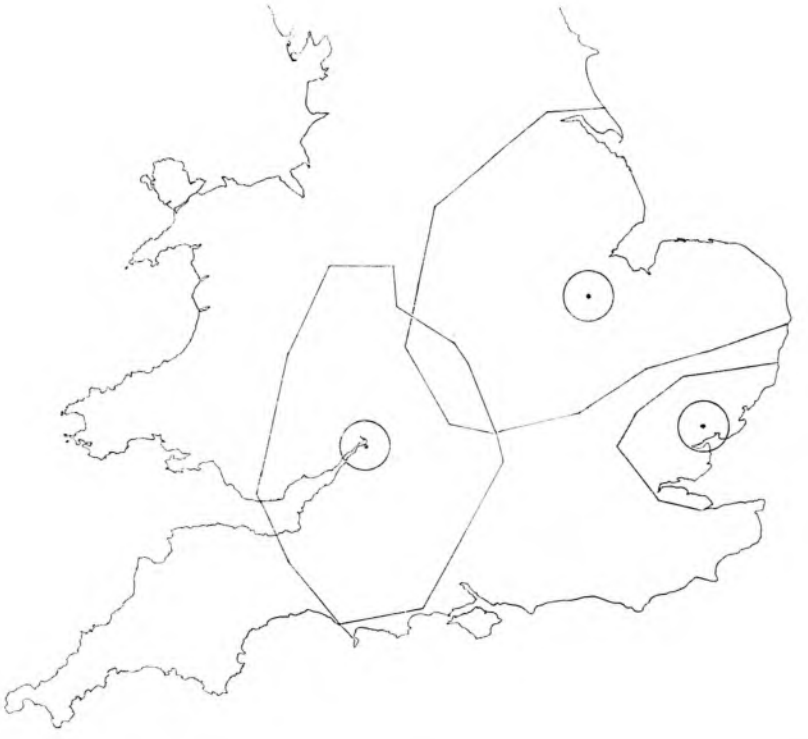


FIGURE 4. The " winter dispersion areas " of Mallard ringed at Abberton, Borough Fen and Slimbridge. Each area is drawn to exclude the 10% of the direct recoveries furthest from the ringing station.

Emigration to France during the winter (October-February) seems to be on a comparatively small scale (Table 2). With no means of determining whether the probability of reporting differs greatly between France and England the apparent proportion of emigrants to winter residents (about 4%) cannot be taken as reliable, but in view of French enthusiasm for *la chasse* it seems unlikely that a substantially greater fraction of the stock emigrates. The suggestion that more Abberton-caught Mallard move to France than do those from Slimbridge and Borough Fen has some bearing on the discussion of autumn movements from the Baltic to England in a later section. The virtual absence of movements to Ireland is in strong contrast to the behaviour of Teal and nearly all other ducks that have been ringed in England.

There have been no major variations in the pattern of dispersion between different seasons. Nor are significant differences apparent between ducks ringed early in the season and those ringed later.

Recoveries in Spring and Summer

Because shooting in spring is illegal in Britain and in most other countries of north-west Europe the numbers of recoveries from March to July are small and their interpretation difficult. In August shooting is resumed in most places, though not in Britain (since 1955) : but by then Mallard may

have moved far from their nesting places, before or after the flightless period of the moult, so that recoveries in July and August do not necessarily record breeding distribution.

Figure 5 shows the spring and summer distribution of recoveries in Great Britain. No distinction between five recoveries in July and August and those earlier is made, because they are not markedly different in scatter. The "summer dispersion areas," determined like the winter ones in Figure 4 by the exclusion of the outer 10% from each station, show considerable resemblance to those winter areas, though there is a substantial overlap

FIGURE 5. Recoveries in the British Isles in March-August of Mallard ringed at Abberton, Borough Fen and Slimbridge. "Summer dispersion areas," excluding the outer 10% of recoveries.

between the Abberton and Borough Fen regions. The number of Mallard found dead where ringed is high at Slimbridge, where many nest and where bodies of dead ducks are more likely to be found. There have been none at Borough Fen, where no ducks nest. From Figures 1 to 5 it seem unlikely that large-scale shifts of British-breeding Mallard take place, at least to or from southern England (a conclusion reached by Landsborough Thomson long ago).

The breeding season recoveries overseas (Figure 6) give no indication of segregation according to the place of marking. The chance of recovery in summer is so small that any differences in distribution which might exist are perhaps liable to be masked by chance effects. The few recoveries in England of Mallard marked at their breeding places in Finland and Sweden have been widely scattered and offer no support for the hypothesis of segregation.

Indirect recoveries abroad in late summer, autumn and winter

Recoveries in the Baltic area in the months August-October of English-ringed Mallard are mapped in Figure 7. This does not differentiate between ducks ringed at the various stations because, as in the April-July recoveries, no differences in distribution are evident. The main features of the map show, first, how Mallard from the eastern part of the breeding range become confused with those further west and, second, that the evacuation of the Baltic is apparently a very gradual process.

FIGURE 6. Recoveries overseas in March-July of Mallard ringed at Abberton, Borough Fen, Slimbridge, Abbotsbury (Dorset) and in Norfolk.

FIGURE 7. Recoveries *in the Baltic area* in August (solid circles), September (open circles) and October (crosses) of Mallard ringed in England. Recoveries in Denmark, Germany and Holland, too numerous to be shown here, are tabulated in Table 3.

Early autumn recoveries in Denmark, Germany and Holland are too numerous to be shown individually on a map. They are summarised in Table 3. Close scrutiny reveals few differences in the cell entries from the numbers expected from the row and column totals. The only clearly significant departures from expectation refer to Abberton-ringed birds. There are half as many again in Holland and only half as many in France as would be anticipated. Other less striking discrepancies suggest a reversal of this result for Borough Fen birds (fewer in Holland, more in France); Norfolk-ringed birds provide relatively many Danish and German and few Dutch recoveries. It is easy to explain the high proportion of Abberton-ringed birds taken in Holland in terms of a difference in the journeys of Essex-bound and Wash-

Table 3. Recoveries of English-ringed Mallard from August to October in Denmark, N.W. Germany, Holland and northern France.

where recovered	where ringed				
	Abberton	Borough Fen	Slimbridge	Norfolk	total
Denmark	11	16	16	6	49
N.W. Germany ..	7	8	13	6	34
Holland	41	18	28	2	89
France	6	14	14	2	36
total	65	56	71	16	208

bound stocks, but the occurrence of recoveries in France in autumn is less readily accounted for, especially in view of the direct recovery rates (Table 2) which show Abberton birds more frequently moving to France in winter than those from elsewhere.

Table 4. Recoveries overseas in November-February of English-ringed Mallard. 32 same-season recoveries in France (shown in parentheses), the remainder in later winters.

where recovered	where ringed: Abberton	Borough Fen	Slimbridge	Norfolk	Dorset	total
Baltic area ..	3	4	2	1	0	10
Denmark ..	10	5	7	7	1	30
N.W. Germany	3	5	5	3	1	17
Central Europe	2	1	4	0	0	7
Holland ..	17	13	8	8	6	52
France ..	(14+)10	(9+) 5	(9+)16	1	2	34(+32)
total	45	33	42	20	10	150

Indirect recoveries overseas in the months November-February (Table 4) throw no further light on the problem. The only departures from expectation are in the Slimbridge-ringed column, with too few Dutch and too many French, and in the Norfolk sample with unexpectedly many in Denmark and few in France. The latter discrepancies are as likely to be associated with date of ringing as with place, since nearly all Mallard ringing in Norfolk has been done in January and February, so that the sample is especially liable to include late immigrants.

Indirect recoveries in Britain in autumn and winter

Table 5 summarises the occurrence of recoveries in Britain in the second season after marking for Mallard ringed at the three major stations. The most striking and important point that emerges is brought out by the second column of figures. It will be recalled that the winter dispersion areas were defined to contain 90% of the direct recoveries from each station. Column two shows that these areas also contain 86% of the second-season recoveries in Britain. This suggests not only that most of the English-resident Mallard are nearly sedentary but also that immigrants tend to return to the same wintering area. Recoveries in later seasons, though relatively few, show very similar results.

Table 5. Recoveries of English-ringed Mallard in Britain in the second season after marking (September-February) in the years 1955 to 1960. Italic figures in the second column show recoveries in the winter dispersion area as a percentage of the total recoveries in Britain during the second season.

where ringed	recoveries: dispersion area		outside	total	recoveries per 1000 marked: in area	outside	total
Abberton	101	*86%*	16	117	52	8	60
Borough Fen ..	150	*86%*	24	174	30	5	35
Slimbridge	82	*85%*	14	96	19	3	23
total	333	*86%*	54	387	31	5	36

Another obvious feature of Table 5 is the difference in the second-season recovery rates for each sample, which are high for Abberton and low for Slimbridge, especially within the winter dispersion areas but also beyond them. If attention is concentrated on recoveries within 10 miles of the ringing station the second-season recoveries show even greater differences: Abberton 76 (3.9% of those marked), Borough Fen 38 (0.9%) and Slimbridge 24 (0.6%). The simplest explanation would seem to be that either shooting pressure or the reporting-rate is greatest in the Abberton area : although the first-season recovery-rates for Abberton and Borough Fen are very similar to each other (Table 2).

Table 6. Recoveries, other than by shooting, in the months March to August inclusive of Mallard ringed at Abberton, Borough Fen and Slimbridge. Records from all years, 1948 to 1960.

where found	ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	16	38	57	111
overseas	15	10	20	45
total	31	48	77	156
% overseas	*48*	*21*	*26*	*29*
where found	recoveries per 1000 ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	3	5	9	6
overseas	3	1	3	2
total	7	7	11	8

The proportion of migrants

It is of practical importance as well as theoretical interest to find out what proportion of the stock of Mallard in England in autumn and winter is of foreign origin since this bears directly on sound 'harvesting' practice. Unfortunately sampling difficulties prevent a satisfactory solution of the question, though some approximate answers can be given from the recovery data. The most direct approach is by a comparison of the numbers of recoveries in the breeding season at home and abroad (Table 6). Because of differences between countries in the legality of summer shooting it is desirable to consider only recoveries not due to deliberate killing by man. Since summer shooting is much more common abroad than in Britain, recoveries due to shooting falsely suggest that most Mallard breed overseas. But restriction to reports of accidental deaths reduces the number of recoveries to a very low level (a rate of 8 per 1000 marked, against 54 for first-winter and 60 for second season): and the chances of dead ducks being found vary widely from place to place. For example, at Slimbridge where many Mallard attempt to breed in an area searched intensively for nests the chances of dead ducks being found are unusually high, as Table 6 shows. No generalisations about the conditions overseas can be other than guesses. The ratios found abroad : all found suggest that about 3/10 of English-ringed

Mallard may have been of foreign origin, nearly half those marked at Abberton but only a fifth of those at Borough Fen coming from abroad. The recovery-rates also indicate a lower proportion of 'foreigners' in the Borough Fen sample than the Abberton one.

A second method of approach is to compare the numbers of second-season recoveries at home and abroad (Table 7). Because of possible differences in 'shooting pressure' there is no reason to expect that the ratio foreign : all reported will be close to the ratio breeding abroad : breeding in England, though in fact this ratio for the total sample (32%) resembles the ratio of summer recoveries (29%). The ratios for the different stations are particularly liable to be affected by differences in reporting in England, already mentioned, since British recoveries exceed those abroad, and the indication that Slimbridge-ringed Mallard include a higher proportion of foreigners than the others is particularly suspect. The recovery rates (lower part of Table 7) suggest, in agreement with the approach in Table 6, that the Abberton sample includes more immigrants than those of Borough Fen and Slimbridge. This result is emphasised by Table 8, in which attention is concentrated on the relative numbers shot in early autumn in the Scandinavian and Russian breeding areas. (Most of the data of Table 8 are included in those of Table 7, so that the two are not independent).

Table 7. Recoveries from all sources in the second season (September-February) of Mallard ringed at Abberton, Borough Fen and Slimbridge, 1954 to 1959.

where found	recoveries			
	Abberton	Borough Fen	Slimbridge	total
in Britain	117	174	96	387
overseas	48	71	63	182
total	165	245	159	569
% overseas	*29*	*29*	*40*	*32*

where found	recoveries per 1000 ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	60	39	22	36
overseas	25	16	15	17
total	85	55	37	53

Though there is a definite impression from Tables 6-8 that Abberton Mallard include the greatest proportion of migrants, it does not seem possible to decide on this evidence whether Borough Fen has more migrants than Slimbridge.

Table 8. Recoveries in Scandinavia and Russia in August-October of Mallard ringed at Abberton, Borough Fen (1954-59) and Slimbridge (1947-59).

	recovered				per 1000 marked
	August	September	October	total	
Abberton	15	16	6	37	19
Borough Fen ..	32	15	13	60	9
Slimbridge	26	15	5	46	7

While it is not proposed to discuss the survival of ringed Mallard here, it is relevant to note that, though the Abberton recovery-rates in autumn and winter are high, there is evidence that the annual mortality rate of Abberton-ringed Mallard is no higher than that for ducks ringed at the other major stations (Boyd, unpublished report).

Distribution of the sexes

No distinction has been drawn in earlier parts of this paper between the distribution of males and females. This is because few differences seem to exist. There is no evidence of segregation in summer either in Britain or abroad and the apparent ranges overseas are as nearly identical as could be expected from the rather small number and wide scatter of recoveries. Nor do the same-season winter emigrants to France consist predominantly of one sex. There are some indications that in autumn immigrant males tend to move ahead of females, a finding consistent with those of other studies (e.g. E. Bezzel, *Anzeiger Orn. Ges. Bayern*, 5 : 269-355, 1959) but the exploration of these differences needs evidence from observations as well as from ringing and will not be pursued here.

Investigation of possible differences in the behaviour of young and old birds has been greatly hampered by difficulty in identifying first-winter birds caught later than September and it is necessary to accumulate more material before reporting definitely. Present indications are that no major differences will be found.

Some practical implications

This investigation has two results of some importance to effective conservation of the Mallard in Britain. First, the concept of " dispersion areas " shows that even within an area as small as the southern half of England there exist different stocks of Mallard which behave independently. Second, foreign-bred Mallard seem to be in a minority in southern England, though the proportion varies from stock to stock. It follows that effective conservation of Mallard stocks, by provision of refuges or feeding areas, by control of shooting or in other ways, will best be tackled by regional rather than by national management plans. Since this is a consequence of the relative importance of home-bred birds in the Mallard population it does not necessarily apply to other species, such as Teal and Wigeon, in which home-bred birds make up only a tiny proportion of the wintering stock. The evidence of sedentariness is particularly encouraging also to the proponents of the release of hand-reared Mallard as a means of increasing local stocks because it shows that the effectiveness of such schemes should be apparent on a local level.

ORIENTATION EXPERIMENTS WITH MALLARD

G. V. T. Matthews[1]

By 1959, after twelve years plentiful food and freedom from shooting, there were far too many Mallard at Slimbridge. Various suggestions for their reduction were made, some of which, though momentarily attractive, were scarcely consonant with our functions as a Wildfowl Trust. It was decided to remove any Mallard caught and release them at a distance. Previous ringing recoveries (p. 00) had shown that Slimbridge Mallard are mostly rather sedentary and it was hoped that they would show little homing ability. The surplus stock would then be spread over the countryside, to everyone's benefit, including the wildfowlers. Further, observation of their behaviour at release promised to throw light on some problems of animal behaviour. In particular it was desired to check a report by Frank A. Bellrose that migratory Mallard he released in Illinois all turned northwards, as if towards the prairies where they had been bred.

Organised drives in the pens at the end of June 1959 resulted in the capture of 284 moulting, flightless Mallard. 150 not already carrying rings were forthwith moved to a reservoir in Somerset and to another suitable place in Hampshire. The rest, previously ringed and hence of known history, were kept in a large covered aviary, 27 by 10 yards by 7 feet high, until they had regained the power of flight. Two other large aviaries each 20 x 7 yards were later constructed. These served to store birds as they were caught until sufficient (about 30) were available to make a trip and release worthwhile, and also to provide a stock of birds long after the main catching season was over. Careful checks on the condition, weight and behaviour of these temporary captives showed that they were not to be distinguished from fresh caught birds, and that results obtained with them could be accepted with confidence.

Releases took place at sixteen different points from 24 to 158 miles away and in various directions from Slimbridge. The release sites were carefully selected. They had to be flat with a good all round view since Mallard often fly off low for the first hundred yards or so before mounting up to present a silhouette against the sky; and there had to be no large body of water nearby since the birds alight on it. Deserted airfields were ideal. The ducks were released individually, thrown up into the air, the liberator facing successively round the compass. Each bird was followed through powerful binoculars (x 16) until out of sight. Only then was the next bird released. The bearing of this vanishing point was determined, an assistant taking intermediate bearings every half minute. Only bearings of birds in full flight were used for analysis. A proportion of birds landed not because they were incapable of flight (they were often recovered later many miles away) but presumably because they had found some puddle or rivulet too great an attraction.

In all, between 30th July, 1959 and 10th June, 1960, 1042 Slimbridge Mallard were released in this way in the course of 35 separate experiments. It soon became clear that in conditions when the sun was clearly to be

[1]This is a short version of a paper entitled " 'Nonsense' orientation in Mallard and its relation to experiments on bird navigation " which appeared in *Ibis* 103a : 211-30 (1961).

located, more than three quarters of the birds were lost to sight between north and west of the release point. This was quite regardless of the direction of home in relation to the release point; birds released in Wales headed directly away from home. Nor did the distance of release have any effect, the N.W. orientation being shown in areas with which the birds might have been familiar, as well as those which were certainly unknown to them. Experiments spaced throughout the season showed that there was no difference in the orientation, certainly no seasonal reversal of direction as might be expected if the orientation had anything to do with migration. Nor was there any difference between birds caught at different times of the year, nor between males and females. The age of the bird had apparently negligible effect. If anything, the older birds gave a rather wider spread of vanishing points. This argues against the north-west orientation being a learned reaction to local topography, such as the lie of the river at Slimbridge relative to the Decoy. If learning were involved we would expect the orientation to become sharper with increasing experience.

The very multiplicity of release points puts out of count any suggestion that the N.W. orientation was imposed by their topography. Indeed pains were taken to select some release points where lowlands, river valleys or the coast lay to the south and east, while rising ground lay to the north and west. Again and again the Mallard headed off into the looming hills and away from the type of country that one would think they would seek on release.

A marked feature of the orientation was the extreme rapidity with which it was adopted. Bearings taken only thirty seconds after release were already clustered about north-west—even at fifteen seconds the pattern was beginning to emerge. It is clear that this is a form of astronomical orientation since if the sky is really heavily clouded the birds fly off in all directions. Overcast which is not wholly uniform still seems to give sufficient indication of the sun position for the birds to pick up, rather more crudely, their usual direction. But the exact limits of cloud density and uniformity require further experimental probing. The birds must have an appreciation of time, for the N.W. orientation is adopted swiftly at any hour between sunrise and sunset, i.e. the birds fly at different angles to the sun position.

The effect of wind on the initial orientation seems to be purely mechanical. A moderate wind sweeps the birds before it for some seconds then, if it is from the north-west, they beat back determinedly. The subsequent scatter of vanishing points is then wider because birds come back to right and left of the release point rather than heading directly away.

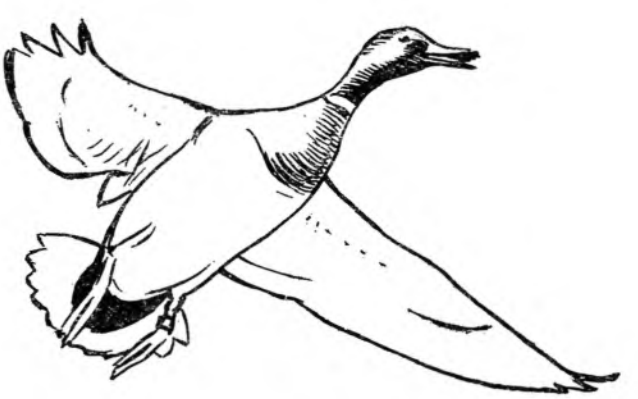
Although orientation continues to improve up to about two minutes from release, in the sense that the bearings close more tightly about the north-west median, thereafter orientation deteriorates the longer the bird is in sight. It may be that the north-west orientation is essentially short-lived. We certainly know that it does not continue indefinitely. The recovery points of sixty birds were scattered at random as regards the release point, the great majority being within 30 miles. A lack of homing ability is also demonstrated by a low proportion of recaptures at Slimbridge as compared with those from 279 birds released locally through the season.

We are still trying to find an explanation for this extraordinary behaviour—flying off to the north-west in all circumstances, and then apparently wandering around in all directions. It may be that to fly in one

direction and then alight on the first body of water over which it passes (this has been observed) will increase the chances of a bird rejoining its companions when a flock has been scattered. But this would still leave the question why the north-west was 'selected.' Young ducks, like other birds, show a tendency to wander northwards immediately after fledging and before commencing the normal southerly or westerly autumn migration. This may well be advantageous to the species in extending the range. So possibly the immediate reaction on escaping from duress is a reversion to juvenile behaviour. All this is pure speculation and any suggestions will be gratefully entertained. But we can eliminate any suggestion that the north-west orientation is achieved by the detection of the earth's magnetic pole—if it were, cloudy skies would have no effect.

Apart from its intrinsic interest the demonstration of "nonsense" orientation at release, unrelated to the direction of home, has important repercussions on general problems of bird navigation. It would appear that similar orientation is found in pigeons and can overlay true orientation towards home. Many of the conflicts of evidence that have arisen can be resolved now. Thus claims of pigeons showing a near-immediate orientation towards home (which would preclude any detailed observation of the sun's path) are now thought to refer to orientation northwards. These and other clarifications of thought are set out in detail in the 'Ibis' paper.

The experiments are being continued to investigate the effect of cloud in full detail, to examine night orientation and its basis, to test Mallard from other points of capture (e.g. Borough Fen) and to test other species.



THE FLIGHTLESS PERIOD OF THE MALLARD IN ENGLAND

Hugh Boyd

Summary

CAPTURES of flying and flightless Mallard in cage-traps at Abberton, Essex and of flightless Mallard at Slimbridge confirm that the timing of the wing-moult in males and females in England is similar to that found in Holland. Flightless males are found from early June to mid-August, females from late June to September and occasionally October. The spread of the female moult is due to variation in individual breeding success, females normally not moulting until their young are fledged. From records of ringed males of known age it appears that males one and two years old tend to become flightless ahead of the majority of older birds.

It is well known that adult Mallard *Anas platyrhynchos* are rendered incapable of flight for a period each year as a consequence of the simultaneous moult of the primaries and secondaries. But because ducks are hard to find when in this condition there is little precise knowledge of the timing of the wing-moult or its duration, though Hochbaum (1944) has provided a valuable account of the behaviour of ducks moulting in Manitoba and more recently several investigations in the Netherlands (Lebret 1949, Timmermann and Lebret 1951, Eygenraam 1957) have yielded a detailed picture of the sequence of events in the Dutch Mallard population. Millais (1902) gives an account of the behaviour of Mallard based on material collected by him in Scotland and in the London area which differs considerably from that of the authors just mentioned, so that it seems worthwhile to record data obtained in the last six years at two English ringing stations which bear on the apparent differences.

According to Hochbaum some captive Mallard completely renew the wing within $2\frac{1}{2}$ weeks after the old flight feathers are dropped, but in most individuals the interval is between three and four weeks. Timmermann and Lebret estimated that Dutch Mallard could fly again after 23-24 days, before the growth of the new primaries was complete. No Mallard males with primaries longer than 14 cm. could be caught in the nets used by them for catching moulters. Observations on captive Mallard at Slimbridge indicate a flightless period of 24-26 days. Occasional captures of wild birds can scarcely be expected to give much information on this point, and the only record of real value is of a male first caught at Slimbridge on 3rd June, 1959 (an early date), which was still not able to fly on its new flight feathers 26 days later.

Millais made no clear statement on the length of the flightless period, but he made several about the times at which the flight feathers are shed. He regarded the first fortnight in August as the peak period of flightlessness in males, in the middle of the period of eclipse, given as 15th June to 10th October. One of the specimens he illustrates had shed all its old flight feathers on 6th July, although it retained much of the spring body plumage. Millais evidently regarded this as exceptional : and three of the four specimens he illustrates, which had been collected (method unknown; presumably shot) from 6th to 9th August, appear to have wings incapable of flight. The recent investigators have found flightless males much earlier. Hochbaum noted some flightless before the middle of June, the peak of the flightless period in mid-July and many flying again by the first week in August. Counts by

Timmermann and Lebret in the Netherlands gave a similar picture, the first males without flight feathers being seen on 5th June, the peak period being around 8th July and most males flying again by 1st August.

According to Millais the occurrence of the female wing-moult is phased so that successful females regain the power of flight at the time their offspring begin to fly. Females compelled to re-nest delay their moult by the appropriate interval, so that " adult females moulting and sometimes incapable of flight (may be found) at any time between the months of June and September." Later authors agree that flightless females may be found at any time in this long period and even in October, but their observations make clear that Millais was wrong in suggesting that females normally moult while still in charge of their broods. According to Timmermann and Lebret females with very late, repeat, broods are the only ones which sometimes show wing moult.

The capture of ducks in cage-traps at Abberton Reservoir, Essex, provides the bulk of the new evidence presented here on the timing of the flightless period in England. The traps are operated throughout the year. The numbers of ducks caught in the summer are relatively small and from 1953 to 1957 included only two flightless birds in a total of 275 adult Mallard caught in the months June to September. In the summers of 1958 to 1960 the situation changed greatly, flightless birds comprising two-fifths of the catch of 198 adult Mallard in the period 11th June to 30th September. Why the proportion of flightless ducks in the catch has increased so greatly is not known, since the trapping technique has not been altered and no clear change in the behaviour of the summering population is known to have occurred. The catches of adult Mallard in summer in the years 1958 to 1960 are shown in Table 1, grouped by sex and into the categories 'flightless' and 'flying.' The captures of flightless birds show a pattern like that reported from Manitoba and from the Netherlands, males tending to moult earlier than females and doing so more nearly simultaneously.

An early August peak of flightlessness among males, as reported by Millais, is not apparent in the Abberton catches, but they do show signs of a double peak, early and late in July. The females also show a double peak, around 10th August and again early in September.

Table 1. Adult Mallard trapped at Abberton, Essex, in the period 11th June—30th September, in the years 1958 to 1960. Grouped by 10- or 11-day periods in each month : I = 1st-10th; II = 11th-20th; III = 21st-30th or 31st.

	June II	June III	July I	July II	July III	Aug. I	Aug. II	Aug. III	Sept. I	Sept. II	Sept. III	Total
Males												
flightless	0	13	16	7	6	4	2	0	0	0	0	48
flying	16	17	10	10	1	3	8	4	3	0	3	75
	16	30	26	17	7	7	10	4	3	0	3	123
Females												
flightless	0	1	3	2	2	8	9	3	9	2	0	39
flying	2	4	1	4	2	11	7	11	4	1	7	54
	2	5	4	6	4	19	16	14	13	3	7	93

Among the males the latest flying on old feathers was caught on 10th July. The first flying on new feathers was not caught until 3rd August although some should have been free-flying at least two weeks earlier. The first female with complete new feathers was taken on the same date, 3rd August. The latest female retaining all old flights was taken on 19th September : if recaptured later, this must have provided an example of a flightless female in October.

Millais made the remarkable assertions that the female " should she commence to moult (as she occasionally does) before the young can take care of themselves, she does not generally moult all her quills simultaneously, as the males do, but casts them unevenly or alternately, retaining a sufficiency of intermixed new and old primaries to support her in her flight " and " . . . as a rule, many females can fly throughout their moult." These statements have not been confirmed by later workers. In 1960 care was taken to record whether ' flying ' birds caught at Abberton had new or old flight feathers. No females with a mixture of new and old were found.

At Slimbridge ducks are usually caught for ringing in the decoy, which is not operated in June and July and is in any case unsuitable for catching birds unable to fly. But in several years attempts have been made to round-up flightless birds living in the pens surrounding the decoy, among the captive collection. Because such round-ups disturb the captives, few have been attempted and only in two years, 1955 and 1959, was much success achieved. The drives were arranged at times when the numbers of flightless Mallard were thought to be high, in late June and the first half of July, and yield nothing on the spread of the moulting period, but the results are of some interest, since the numbers of ducks caught are relatively large.

Table 2: Sex-ratio in flightless adult Mallard rounded up at Slimbridge, Gloucestershire, in June and July, 1955, 1957 and 1959.

	Slimbridge			
	June III	July I	July II	
males	135	64	31	230
females	9	11	13	33
	144	75	44	263
males : 1 female ..	15.0	5.8	2.4	
(Abberton	13.0	5.3	3.5)	

Table 2 shows that the sex-ratio in catches in each of the three relevant time-units correspond quite closely to those in the Abberton catches at the same times. The larger numbers caught in June III compared with July I and July II may be a consequence of differences in the numbers of ducks present, or in driving success, from year to year, rather than an indication that the onset of flightlessness is earlier at Slimbridge than at Abberton.

The most useful contribution of the Slimbridge round-ups to knowledge of the moult results from the fact that a high proportion of the birds caught had been ringed previously. Some of them had been identifiable as birds of the year when first marked and the captures include enough males of known age to test the hypothesis that males of different ages become flightless at different times (Table 3). Small though the numbers in each category are,

it is possible to assert with some confidence that they show males of one and two years old to be proportionately more frequent in the June catches, suggesting that they had tended to become flightless ahead of the majority of older birds.

Table 3: Numbers of flightless male Mallard of different ages caught at Slimbridge in June and July.

Age	Caught			
	June III	July I	July II	Total
1 year old	11	4	2	17
2 years old	9	1	3	13
3 years old and more	11	12	14	37
Total	31	17	19	67

There is no evidence of a difference between one-year-olds and two-year-olds; larger samples, and means of correcting the numbers found to allow for differences in the numbers available from each year-class would probably be needed to show whether any difference really exists. Explanation of earlier moulting by younger birds must at present be speculation. It may be guessed that it is not simply a function of age. In the unusual circumstances of Slimbridge, where from about 1955 to 1959 the population attempting to breed was at a very high density by British standards and probably too great for the capacity of the place, it may have been that a high proportion of the younger males were unsuccessful in breeding and so went into wing moult ahead of older more successful individuals. But local conditions may not have been important, and further studies of the situation are desirable.

It is unfortunate that females of known age that were caught (12 yearlings and 10 two years old or more) were so few that no age-difference could be established. Experimental study of the relation of the onset of the wing-moult to breeding success and to age seems to offer the best prospects for advance in this and in the related field of the timing and duration of the male eclipse plumage.

Acknowledgements

I am very grateful to Major General C. B. Wainwright and his assistant R. King for providing the Abberton data and for helpful comments; to colleagues at Slimbridge, particularly S. T. Johnstone and Dr. G. V. T. Matthews, for catching flightless ducks; and especially to T. Lebret for translating his papers on this subject, providing additional information and criticising a draft of this paper.

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REPORTED CASUALTIES TO RINGED DUCKS IN THE SPRING AND SUMMER

Hugh Boyd

How important are predators, diseases and accidents in their effects on the numbers of ducks? This is a crucial question in population dynamics, yet it is quite unanswerable at present, because so little is known about causes of death other than man. The purpose of this short note is to summarize what can be learned in this field from the recoveries of British-ringed ducks. Attention is concentrated on the months March to August for three reasons. First because this period covers the breeding season, a time when in Britain and some other countries shooting is both illegal and little practised so that ducks found dead are relatively unlikely to be shooting casualties not retrieved by the shooters. Second, because it is known from a variety of other studies that losses to predators and some diseases are commoner in the breeding season than in winter. Third, because losses suffered immediately prior to breeding, or in the course of incubating eggs or rearing young have relatively larger effects on the output of any population than losses at other times of year.

Over 60,000 ducks, including 27,000 Mallard *Anas platyrhynchos* and 28,000 Teal *Anas crecca,* have been ringed in Britain, of which at least 8,000 have been recovered. Yet the number of spring and summer recoveries which include some indication of how the bird died amounts to only 881 and at least 629 of these records are of birds killed by man, mostly in August. The other 252 recoveries comprise no more than 0.4% of the ducks marked and less than 1 in 50,000 of the total British-visiting duck population at risk in the last twelve years (in which most of the ringing has been done). A sample as small as this is unlikely to be adequately representative.

A further difficulty is that most people finding dead ringed ducks are in no position to carry out thorough examinations to establish the cause of death, so that only the most obvious causes are likely to be recorded, and even these may sometimes be guessed wrongly. In Table 1 the reported non-shooting casualties are assembled in three main classes. Mallard and Teal provide nearly the same number of records. But whereas the 115 Mallard recoveries comprise 36% of all those reported for the months March to August, the 114 Teal represent only 26% of the spring and summer reports for that species. This difference might reflect greater susceptibility to ' natural death ' in the Mallard, but it is much more likely to be due to the difference in the breeding distribution of the two species. Many ringed Mallard stay in England to breed and so are more likely to be found and reported than are Teal breeding abroad in countries with much less dense human populations. The ten records in the " other dabbling ducks " column are made up of six Wigeon *Anas penelope,* two Pintail *A. acuta,* one Shoveler *A. clypeata* and one Garganey *A. querquedula.* They represent only 12.5% of the known spring and summer deaths of ringed birds of these four species. Why this proportion should be so low is not clear. The 13 diving ducks comprise 32% of the total recoveries in March-August.

Table 1: Reported causes of death of British-ringed ducks recovered from March to August, excluding those deliberately killed by man.

	Mallard	Teal	Other dabbling ducks	Pochard & Tufted Duck	Total
predators	18	21	2	0	41
accidents	29	52	0	6	87
'found dead' ..	68	41	8	7	124
Total	115	114	10	13	252

An interesting feature of Table 1 is that there are specific differences in the proportion of deaths assigned to predators or accidents as against birds found dead from no obvious cause. In particular the proportion of casualties attributed to accidents is much higher among Teal and the diving ducks than it is for Mallard and the other dabblers. This difference, unlike that in the kill by man, is not to be explained by the relative abundance of British recoveries of Mallard, since the ratio of apparent accidents to other causes of death, excluding the kill by man, is very nearly the same in Britain as abroad. Casualties classed as accidental include birds caught in fishing-nets, fish-traps, or musk-rat traps, colliding with overhead wires, killed on or near their nest by mowing-machines and some other odd ones—such as collision with cars and trains.

Table 2 sets out the records in these categories, differentiated by sex as well as by species. The most striking sex difference is in casualties due to mowing machines which, not surprisingly, appear to be confined to females. In some parts of North America losses of ducks and their nests from this cause have assumed serious proportions, so that efforts have been made to reduce them by fitting 'flushing bars' on the machines in front of the cutters, but such casualties have attracted little attention in Europe. This is perhaps because nesting in open grass fields is not very common in Mallard and Teal. Pintail and Shoveler, which favour open sites, are only sparsely distributed as breeding birds in north-west Europe. It is worth noting that all six cases in the Mallard were British. Even though the samples are small, the proportion of mowing machine casualties in female Teal (1 in 19 accidents) is significantly smaller than in Mallard (6 in 16). This may reflect differences in agricultural practices between Scandinavia and England, or in choice of nest sites by the two species.

Table 2: Identified causes of accidental deaths of ringed birds. The 'Total records' column includes six ducks not sexed when ringed and six of species other than Mallard and Teal.

	Mallard	Teal	Males	Females	Total records
overhead wires ..	11	4	12	3	17
nets and traps ..	6	38	23	21	50
mowing machines	6	1	0	7	7
others	6	3	5	4	13
	29	46	40	35	87

Two recoveries have resulted from mowing machines cutting the ringed leg off a bird which flew away otherwise unharmed. Two instances of unringed ducks losing legs in this way have been found at Slimbridge.

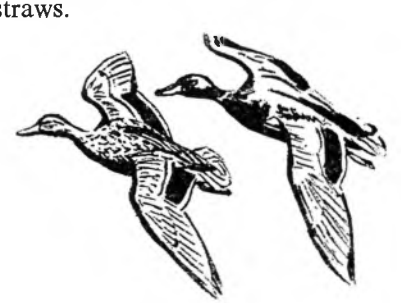
Males and females seem to be equally liable to be caught in fishing-nets, fish-traps or musk-rat traps. All the casualties in these devices were reported from overseas, mostly from Finland and Sweden. None has been noted in Russia, but it is possible that they occur there too, because many Russian recoveries lack any details of the manner of finding or say 'caught' without further qualification. (Such records have been omitted from Table 2). Ducks caught in fish- and musk-rat traps are sometimes released again.

The evidence that males are more likely to be killed than females by collision with overhead telephone or power lines, though suggestive, is not statistically conclusive. This hazard accounts for a higher proportion of reported deaths in Britain than overseas. But are any other countries so cluttered with wires?

Deaths attributed to predators amount to one-sixth of the reported losses not known to be due to man. Whether it is really the case that predators are only half as important as accidents due to human constructions and machines cannot be decided on the available evidence, though it seems possible in England, where predators are few. Of 41 predator records, 20 were attributed to mammals and 18 to birds. The mammals included 9 foxes, 7 cats and 3 dogs. The birds identified were 6 Eagle Owls *Bubo bubo,* 4 Peregrines *Falco peregrinus,* 1 Goshawk *Accipiter gentilis,* 1 Sparrowhawk *A. nisus,* and 4 'hawks.' Nearly all the records of birds-of-prey came from Sweden. There is some indication that females are more vulnerable to mammalian predators than males, which is to be expected since females alone incubate. More remarkably, 13 of the 17 ducks of known sex reported taken by birds-of-prey were males.

The relatively large class of ducks 'found dead' is the most frustrating. Presumably some were unretrieved shooting casualties and others may have been dead too long to make a guess at the cause of death possible. Yet if some of these birds could have been submitted to expert examination they must surely have included more cases of disease than the three English Mallard so labelled.

It seems unlikely that ringing, however massive in scale, can make a major contribution to our knowledge of the causes and incidence of wildfowl mortality, other than the consequences of human activities. But practicable alternative methods of approach are little more promising and it still seems necessary to clutch at straws.



VOICE RECORDINGS OF THE ANATIDAE

Jeffery Boswall

BBC Natural History Unit

THE purpose of this paper is to provide a systematic list of all the forms of Anatidae whose recorded voices are available on gramophone records: it is cross referenced to a list of the discs concerned.

A world catalogue of published bird voice discs (Boswall, in press) shows that since the issue of the very first one in 1910 (Koch 1910), at least ninety-six individual records or sets have appeared giving examples of sound production by approximately 963 species of bird.

The analysis which forms the basis of this paper reveals that seventeen of the items in this catalogue include the voices of ducks, geese or swans. In addition, the BBC's Library of Natural History Recordings gives some voices of wildfowl; duplicate sets of the discs in this library are available in Oxford and Cambridge, and a part set in the U.S.A. (See table 2).

The family Anatidae comprises 247 forms of 147 full species (Scott 1957). Of these, 61 forms of 55 species appear in the list below of recorded voices which are available. In other words, recordings of rather less than one-third of the total number of species have been made; the emphasis is on swans and geese.

Seventeen of the 61 forms have been recorded only in captivity and 34 only in the wild state; the remaining 10 have been recorded both wild and captive.

It must be emphasised that the same individual recording can appear on more than one disc. For example against the Barnacle Goose we find the numbers *1*, 12 and 13, but the last figures both refer to a recording made of a wild flock in Sweden which North and Simms (1958) copied for their *Sound-Guide* from the set of Palmér (1958-60). The two major sources of overlap are (a) between North and Simms (*loc. cit.*) and the BBC's library; and (b) between the first and later editions of Kellogg and Allen's *American Bird Songs*.

From the list of discs it will be seen that the countries of publication are: Britain, 2; Canada, 2; France, 1; Japan, 1; New Zealand, 1; Sweden, 2; and the U.S.A., 9. The recordings htemselves were made in these countries and also in: Denmark, Iceland, Kenya, Venezuela and the Sudan.

Among the published records only one is specifically devoted to wildfowl, Kellogg and Allen's recent issue: *Dawn in a Duck Blind,* which gives 14 species. The same authors' *Field Guide to Bird Songs* includes 16 forms, and the North-Simms *Sound-Guide,* 23 species. The only other sizeable group of published wildfowl vocalisations is contained in the Swedish collection of Sture Palmér with 10 species.

The BBC collection includes 44 forms of 42 species.

It is worth mentioning one further disc, called *Duck and Goose Calling* on which Russell Hofmeister and Roy Miller demonstrate "calling" with whistles, for the benefit of hunters. This amusing record, No. D7-KW-5597 (7 inch, 45 r.p.m.) is published by Herters Inc. Waseca, Minnesota, U.S.A.

LIST OF FORMS OF ANATIDAE WHOSE RECORDED VOICES ARE AVAILABLE

Note: the numbers refer to the list of discs on p. 149-50 : those in italics refer to recordings of captive birds. Sub-species are inset under the nominate race.

Black-billed or Cuban Whistling Duck	*1*
White-faced Whistling Duck	*1* 3 15
Red-billed Whistling Duck	*1* 3
Black Swan	*1*
Mute Swan	1 12 13
Whistling Swan	6 7 9
Bewick's Swan	1 12
Whooper Swan	1 4 12 13
Trumpeter Swan	10
Swan Goose	*1*
Western or Yellow-billed Bean Goose	*1 12* 13
Pink-footed Goose	1 12
European White-fronted Goose	1 12
Pacific White-fronted Goose	9
Lesser White-fronted Goose	*1 12*
Western Greylag Goose	1 *1* 12 13
Bar-headed Goose	*1*
Emperor Goose	*1*
Lesser Snow Goose	*1* 9 *12*
(Blue Goose)	*1* 9
Greater Snow Goose	*1* 10
Atlantic Canada Goose	1 *1* 6 7 9 10 12 13
Lesser Canada Goose	6 7
Barnacle Goose	*1* 12 13
Russian or Dark-bellied Brent Goose	1 12
Hawaiian Goose or Ne-Ne	*1*
Red-breasted Goose	*1 12*
Paradise or New Zealand Shelduck	*1* 18
Australian Shelduck	*1*
Common Shelduck	1 12 16
Egyptian Goose	*1* 12 14
Abyssian Blue-winged Goose	*1*
Ashy-headed Goose	*1*
Ruddy-headed Goose	*1*
Upland Goose	*1*
Cereopsis Goose	*1*
Northern Pintail	*1* 9 10
European Green-winged Teal	12 13
Mallard	1 6 7 8 9 10 12 13 16
North American Black Duck	9
Gadwall	1 9 12
American Wigeon	9 10
European Wigeon	1 12
Blue-winged Teal	9 10

Garganey	1 12 13
Shoveler	1 12 13
Blue or Mountain Duck	18
European Eider	1 12
Canvasback	9 10
Redhead	9 10
Tufted Duck	1
Lesser Scaup	9 10
Australian Wood Duck or Maned Goose	*1*
North American Wood Duck	8 9 10
Spur-winged Goose	*1*
Long-tailed Duck or Old Squaw	1 9 10
Barrow's Goldeneye	9
American Goldeneye	9 10
Red-breasted Merganser	2
Goosander	1 12
North American Ruddy Duck	9

LIST OF GRAMOPHONE RECORDS WHICH INCLUDE VOICES OF THE ANATIDAE

1. BBC Natural History Recordings Library. Duplicate sets of discs are available at the British Trust for Ornithology at Oxford, Madingley Ornithological Research Station at Cambridge, and a part-set at the Laboratory of Ornithology, Cornell University, U.S.A.
2. Gunn, W. W. H. 1959a. *A Day in Algonquin Park* 2nd edn (revised). One 12-inch 33 r.p.m. disc. Ontario: Federation of Ontario Naturalists.
3. Gunn, W. W. H. 1959b. *A Day at Flores Moradas* (Venezuela). One 12-inch 33 r.p.m. disc. Ontario: Federation of Ontario Naturalists.
4. Hoshino, K. and Kabaya, T. 1959. *Japanese Bird Songs.* Two 10-inch 33 r.p.m. discs, nos. LV.519 and LV.520. Yokahama: Victor.
5. Kellogg, P. P. and Allen, A. A. 19 . *American Bird Songs.* Vol. 1. An album of six 10-inch 78 r.p.m. discs. Ithaca, New York: Comstock.
6. Kellogg, P. P. and Allen, A. A. 1951. *American Bird Songs* Vol. 2. An album of five 12-inch 78 r.p.m. discs. Ithaca, New York : Cornell University Records.
7. Kellogg, P. P. and Allen, A. A. 1953-4. *American Bird Songs.* Two (Vols. 1 and 2) 12-inch 33 r.p.m. discs. Ithaca, New York : Cornell University Records.
8. Kellogg, P. P. and Allen, A. A. 1958. *An Evening in Sapsucker Woods.* One 10-inch 33 r.p.m. disc. Ithaca, New York: Cornell University Records.
9. Kellogg, P. P. and Allen, A. A. 1959. *A Field Guide to Bird Songs of Eastern and Central North America.* Two 12-inch 33 r.p.m. discs. Boston: Houghton Mifflin.

10. KELLOGG, P. P. and ALLEN, A. A. 1960. *Dawn in a Duck Blind.* One 10-inch 33 r.p.m. disc. Ithaca, New York: Cornell University Records.

11. NORTH, M. E. W. 1958. *Voices of African Birds.* One 12-inch 33 r.p.m. disc. Ithaca, New York: Cornell University Records.

12. NORTH, M. E. W. and SIMMS, E. 1958. *Witherby's Sound-Guide to British Birds.* Thirteen 10-inch 78 r.p.m. discs, nos. HFG 1 to 13, and two books. London: Witherby.

13. PALMER, STURE, 1958-60. *Radio Bird Records* (Swedish). Twenty 7-inch 45 r.p.m. discs, nos. RFEP 201-30. Stockholm: Sveriges Radio.

14. QUEENY, EDGAR M. 1951a. *Songs of East African Birds.* Three 12-inch 78 r.p.m. discs. New York: American Museum of Natural History.

15. QUEENY, EDGAR M. 1951b. *Birds of Lake Nyibor.* One 12-inch 78 r.p.m. disc, New York: American Museum of Natural History.

16. ROCHE, JEAN-CLAUDE. 1959. *Birds in the Camargue* (French). One 10-inch 33 r.p.m. disc. no. LDP-B250 Med. Paris: Pacific.

17. WEISMANN, CARL. 1952. *Voice Recordings of Danish Birds.* One 12-inch 78 r.p.m. disc no. 17. Sweden: Oxhult, Hishult.

18. WILLIAMS, G. R., BIGWOOD, K. and BIGWOOD, J. 1959. *A Treasury of New Zealand Bird Song.* Three 7-inch 45 r.p.m. discs, nos. EC-14 to 16 and a booklet. Wellington: A. H. and A. W. Reed.

Major Sources of Unpublished Recordings

Serious workers anxious to search out recordings which may be additional to those listed would be well advised to contact the libraries listed below. The only two additional *species* known to have been recorded are the Greater Scaup (Ohio University) and Ring-necked Duck (W. W. H. Gunn).

The Library of Natural Sounds, the Laboratory of Ornithology, Cornell University, Ithaca, New York, U.S.A.

The Laboratory for the Study of Animal Sounds, Department of Zoology, Ohio State University, Columbus, Ohio, U.S.A.

The Neotropical Institute, a/c York Venezuela, c.A., Apartado 1766, Caracas, Venezuela.

The private collection of W. W. H. Gunn, Ph.D., 178, Glenview Ave., Toronto 12, Canada.

The private collection of John Kirby, 10 Wycherly Avenue, Linthorpe, Middlesbrough, Yorkshire, U.K.

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BOSWALL, JEFFERY. Towards a World Catalogue of Gramophone Records of Bird Voice. *Bio-Acoustics Bulletin.*

KOCH, LUDWIG. 1910. One 12-inch 78 r.p.m. disc of bird songs. Berlin: the Beka Gramophone Co.

SCOTT, PETER. 1957. *A Coloured Key to the Wildfowl of the World.* Slimbridge: The Wildfowl Trust.

RADIOACTIVE CONTAMINATION IN BIRDS

J. M. Harrison and J. G. Harrison

IT IS perhaps hardly surprising that evidence is beginning to accumulate on the effect of radioactive contamination in birds. The first suggestion that birds were being affected by radioactive fallout was made by Mr. John Williams, Ornithologist to the Coryndon Museum, Nairobi, who wrote to *The Times* in December 1955 stating that certain wading birds had appeared that autumn in Kenya in what appeared to be fresh summer plumage, the species in question being Greenshank and Sanderling. He commented that " It makes one wonder if these birds have been in a radioactive area in northern Russia, which has somehow affected their moulting sequences."

On 9th November of that same autumn we had collected a female Redshank of the Icelandic race on the Medway Estuary in Kent (Harrison and Harrison 1956a), which was already in advanced freshly-moulted summer plumage, the breast and flanks being heavily spotted and streaked and the back, the head and neck showing the black streaks and barring of summer, the whole plumage being strikingly different from another female in normal winter plumage, which was shot on the same day. It is well known that some gonadal recrudescence occurs in autumn and this is responsible for autumn song and courtship, in such species as the Chaffinch, Song-Thrush, Dunlin, Redshank and Mallard, but we could not trace any record of a wading bird actually assuming summer plumage.

Following the exhibition of the Icelandic Redshank at a meeting of the British Ornithologists' Club, consequent upon Mr. Williams' remarks in *The Times,* arrangements were made with Dr. John Loutit of the Radiobiological Research Unit of the Atomic Research Establishment at Harwell for the examination of the bones of any further birds suspected of radioactive contamination. On 24th December, 1955 a further Redshank (Harrison and Harrison, 1956b) was obtained at Rye Harbour which showed incipient summer plumage and on dissection the ovary and oviduct were more fully developed than is normal in individuals collected at that time of year. Part of the skeleton was therefore sent to Harwell where it was dissolved in nitric acid and the presence of radioactive contamination was confirmed by Dr. G. E. Harrison and Mr. W. Raymond using a Veall Geiger Counter, and a graph prepared of the decay of the skeletal activity over the next two weeks. Dr. Loutit's report stated that " at least it proves that the bird had been exposed to some radiation," but he went on to add that of course in a series of one there is no control. The ovary and oviduct were submitted to Dr. A. J. Marshall who reported that " the slides show quite clearly that the bird has become sexually advanced. You will see that the oocyte diameter (in the largest cases) is somewhat in excess of what would be expected for an ordinary wintering bird. This probably connotes oestrogen liberation. The oviducal proliferation is of course a consequence of oestrogen liberation."

Dr. Loutit thought that the effect, although it appeared like a stimulatory action of radiation, was more likely to have resulted from an initial depression and a subsequent rebound phenomenon; the radiation first depressing cellular activity and thus delaying the assumption of summer plumage, and then as the effect wears off, the bird going into breeding plumage as a late phenomenon and out of its proper season.

The findings on Redshank although factual were still in a highly speculative category. Two further papers have recently taken the problem considerably further. Lofts, Marshall and Rotblat (1960) have reported on the experimental effects of whole-body irradiation on the breeding plumage of the Weaver Finch, *Quelea quelea.* This is a bird in which the male assumes a bright breeding plumage, but is at all other times of the year indistinguishable from the dull-coloured female. Six groups, each of six males in breeding dress and six females, were subjected to X-ray doses at 50 r., 200 r., 400 r., 800 r. and 1,000 r. respectively, the sixth group being used as a control. Feathers were plucked from the facial mask of all the birds which were then left four days for new feathers to begin to grow prior to radiation. In all cases except one the regenerated feathers in the males were of the black breeding plumage, the exception being the three survivors of the 1,000 r. group in which the regenerated feathers were of the drab non-breeding plumage. In the females, in which these feathers are pale and unpigmented, regenerated feathers in the 50 r., 200 r. and 400 r. groups showed a black central band of melanin deposition, thought to be due possibly to pituitary stimulation from the lower dosages. It would seem likely therefore that the radiation had upset the pituitary cycle, which regulates much of the sex characteristics of birds, and lends support to the theory advanced in the case of the Redshank.

In America, Willard (1960) has carried out a radioassay of tissues of birds living on the Oak Ridge White Oak Lake bed, an area contaminated by low-level atomic wastes, showing that the gross beta activity was highest in those species feeding close to the lake bed, in this case the Water-Thrush and Song-Sparrow and lowest in those species living in the higher vegetation, notably the Humming-Bird and Cardinal. In all species examined the gross beta activity could be correlated directly with known habitat selection of the species. Seasonal changes suggested the radioactive uptake was via food, particularly insects, in summer, while in winter the uptake was by ingestion of contaminated soil. Concentrations of Strontium 90 in Oak Ridge birds were found to be higher, both on average and maximum, than could be risked in man. Willard's paper contains no reference to interference with breeding cycles, but further experiments are taking place to determine the effects of various doses at different stages of the life cycle.

These are all problems of vital significance in every sphere of life. The risks to wildfowl populations are but one minute facet, but wildfowl may perhaps be particularly susceptible, especially those breeding in the far north, where the hazards from radioactive fallout may be at their greatest. The added risks from the disposal of radioactive industrial waste products may again render wildfowl and sea-birds more susceptible than other groups of birds.

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HARRISON, J. M. and J. G. 1956b. "Abnormal season assumption of spring plumage in the Redshank in association with possible radioactive contamination." *Bull. B.O.C.* 76 : 60-1.

LOFTS, B., MARSHALL, A. J. and ROTBLAT, J. 1960. "Effects of whole-body irradiation on the breeding plumage of the Weaver Finch, *Quelea quelea.*" *Nature*, 187 : 615-6.

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SMALL CANADA GEESE IN GREAT BRITAIN AND IRELAND

H. Boyd

ON 5th April, 1958, J. Sheppard found in a flock of Barnacle Geese *Branta leucopsis* on Islay, Argyll, a small dark short-necked Canada Goose. This record appeared in the " Report on rare birds in Britain and Ireland in 1958 " (*British Birds* 53 : 153-72 at p.162) with the comment by the Rarity Records Committee " clearly an example of one of the small races of *B. canadensis* breeding in the North American Arctic." A note by Mr. Sheppard later appeared in *Scottish Birds* 1(9) : 274-5. Recent observations have produced three more examples of Canada Geese likely to be of transatlantic origin. It seems worthwhile to draw attention to the possibility of distinguishing such vagrants from wanderers from the feral stocks in the British Isles.

B. canadensis is a very variable species, including both the largest and smallest of all true geese. The breeding range of the species in North America is very wide, from about 37°N northwards to Alaska and the northern Canadian islands up to about 72°N and extending from the Pacific to the Atlantic. The largest geese breed in the south, the smallest in the north. In the east the body colour is pale, in the west it is dark. Taxonomists have expended much effort on sorting the geese into recognisable races. Their solutions differ considerably and none seems likely to achieve general approval. Earlier authors split the group into two, three and even four species. The latest reviewer, J. Delacour (*Waterfowl of the World,* vol. I, 1954) recognises a single species divided into twelve named races, with the possibility that these will have to be increased when more is known about the details of breeding distribution and migration, since many intermediates are to be found.

Where such confusion exists it is foolish to suppose that field observations can lead to individuals always receiving the right subspecific label. But for the purpose of detecting transatlantic vagrants in the British Isles this does not much matter, providing that observers can be persuaded to take the trouble to describe the geese they see in some detail.

In taxonomic and morphometric studies of Canada Geese in North America, wing length and length of exposed culmen have been found the most reliable criteria for differentiating groups (Hanson, *Auk* 68 : 164-173, 1951). For the field observer wing length is nearly useless, but the length of the bill, especially relative to the size of the head and neck, is helpful. Other relevent features are some measure of body-size, the relative length of the legs, the body colour, particularly that of the region immediately below the black neck, and the voice. Male Canadas tend to be larger than females and young birds are lighter in build than older ones, though not markedly smaller in linear dimensions. These differences help to blur the distinctions between races. The juvenile plumage, which is duller and softer than that of older geese, creates few practical difficulties, because most of it is quickly replaced by feathering indistinguishable from the adult plumage.

Of the twelve races named by Delacour two, possibly three, are believed extinct. Figure 1 depicts the ranges of individual size to be found within six of these races, using the crude measures of total length and weight; it also includes comparable figures for the five common species of geese in Britain.

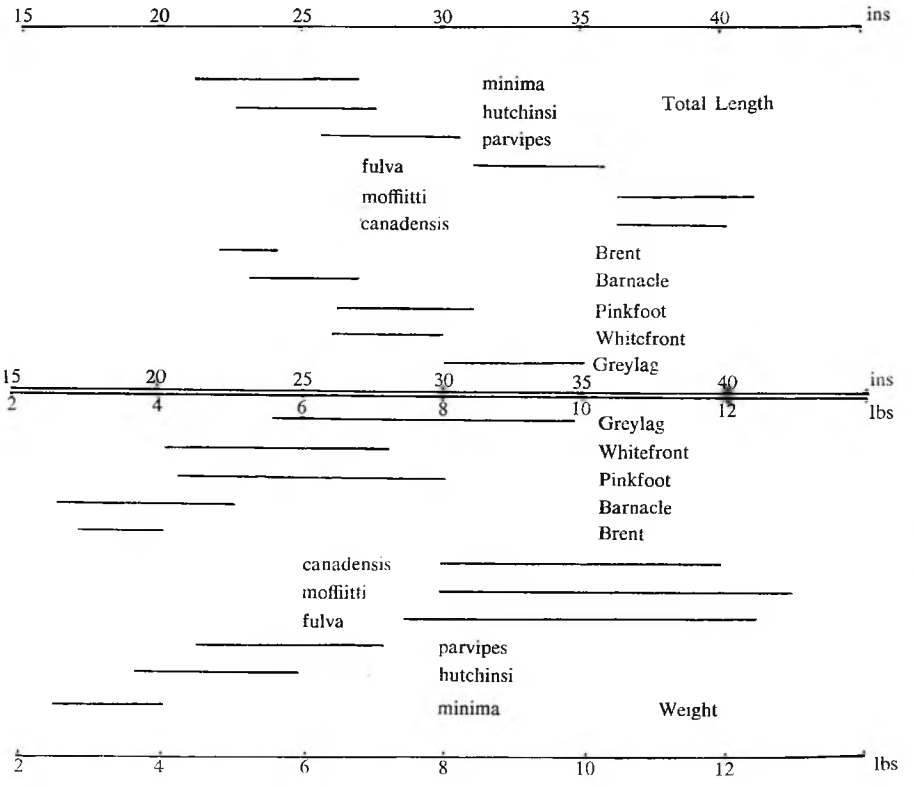

Figure 1. Comparative length and weight of 6 races of Canada Geese and of other goose species found in Great Britain and Ireland.

Feral Canada Geese in this country are almost entirely derived from *canadensis* and possible vagrants from eastern Canada cannot be distinguished from them. The two other large races—*interior* and *moffitti*—are also not likely to be identifiable in the field, though the former tends to be slightly smaller and darker and the latter slightly larger, with longer bill and legs. *B.c. interior* is in any case a poorly differentiated race known to embrace at least four stocks with distinguishable breeding and wintering areas. *B.c. moffitti* has been less intensively studied but is also likely to be heterogeneous.

The races so far mentioned are all bigger than the Greylag *Anser anser*, itself the largest native British goose. The remaining six are all appreciably smaller than the Greylag. This is a useful criterion: any Canada Goose seen with other British geese which is no bigger than they are belongs to a race other than *canadensis* and hence is likely to be of transatlantic origin.

The six smaller races may be further grouped into three pairs. *B.c. fulva* and *occidentalis* are very noticeable dark on the breast and back: *fulva* is little smaller than *canadensis*, *occidentalis* is about the size of a large Pinkfoot *A. brachyrhynchus*. Both these forms live on the Pacific coast of southern Alaska and British Columbia and are nearly sedentary. Thus any dark goose

attributable to either seen in Britain is almost certain to be an ' escape.' Few are in fact kept in Europe and no full-winged flocks are known at present.

B.c. parvipes, the Lesser Canada, and *B.c. taverneri,* Taverner's Canada, vary in size within the range of the Pinkfoot. They intergrade between themselves and with *moffitti.* The Lesser Canada is very similar in proportions and colouring to the larger southern races, especially *moffitti,* having a long bill and neck. Taverner's is similar but rather smaller, with shorter bill and neck, and is usually, but not always, darker in body colour. The two are not separable in the field and can perhaps most usefully be classed as ' Lesser Canadas,' tending to *parvipes-* or *taverneri-* type as the case may be. Taverner's, from the interior of Alaska, is relatively unlikely to occur as a vagrant in Britain, but (like *parvipes*) is kept in a number of European collections and so may occur as an escape. Lesser Canadas seen here are more likely to be vagrants than escapes, though a few collection birds are believed to be full-winged in Co. Down, N. Ireland.

The remaining two races, *B.c. minima,* the Cackling Goose, and *B.c. hutchinsi,* Richardson's Goose, are readily distinguished from the others by their very small size and by their voices. The voices of both are high-pitched and cackling, unlike the ' honk ' of the larger races. The Cackling Goose is the smallest of all, overlapping the Brent. It has a tiny bill, a short neck and relatively long legs. The black on the neck runs into the dark grey brown of the upper back and the deep chocolate of the breast without any obvious break, a distinctive feature of the race. Part of a white ring may be present at the base of the black neck in front. Adults are easily identified, but immatures, which are usually lighter in colour below and duller on the back, may not be very obviously different from dark individuals of Richardson's Goose. The latter are usually larger, with relatively long and high bills, often nearly as pale-breasted as *canadensis* but occasionally much darker. Cackling Geese are kept and bred in several European collections, though no full-winged birds are known. Richardson's Geese have rarely been kept and are not known to have bred in captivity in Europe, so are unlikely to give rise to escapes. The Cackling Goose breeds along the shore of Western Alaska and winters from southern British Columbia to southern California: Richardson's Goose breeds on several of the eastern Canadian Arctic islands and has recently been found breeding in west Greenland, and migrates along the western shore of Hudson Bay to the Middle West. Thus Richardson's Goose seems more likely to occur in Britain as a vagrant than does the Cackling Goose.

The description of the small Canada Goose seen on Islay in April, 1958, was submitted to Peter Scott as well as to the Rarity Records Committee. In his view the bird described was not *hutchinsi* but sounded like *minima,* despite the unlikelihood of an Alaskan bird reaching Scotland.

On 6th November, 1960, H. Boyd saw a very small Canada Goose in a flock of Greenland White-fronted Geese *A. albifrons flavirostris* near Loch Gruinart, Islay. This appeared to be *B.c. hutchinsi*: though it was a fairly dark-breasted individual for that race it was not dark or brown enough for *minima.* From its vigorously aggressive behaviour it was probably an adult, unpaired, but apparently attached to a family of six Whitefronts. The occurrence of this goose on the same island where the other was seen in 1958 suggests that both records might refer to the same individual, but this is

unlikely, since the 1960 bird was lighter in colour, and probably larger, than that of 1958. If the latter had been a first-year *minima* it would have become darker, not lighter, in adult plumage.

On 22nd November, 1960, E. A. Maxwell and H. Boyd saw two Canada Geese with Greenland Whitefronts on the North Slob, Co. Wexford. They were in the same small group but not apparently paired to each other or to Whitefronts. One was markedly smaller than the Whitefronts, the other much the same size while on the ground and appearing rather larger and longer-winged when in flight. The two Canadas differed from each other not only in body size but also in the proportions of their heads and bills and in body colour. The larger was paler-breasted and had a bill looking as long as its head, while the smaller, darker bird had a small bill, much shorter than its head. From their size both these birds were "Lesser Canadas": but though the larger appeared typical of *parvipes* the smaller seemed very much like *taverneri*. Part of the discrepancy may be attributable to a difference in sex, the larger bird looking and behaving like a male. It would in any case be unsound to argue that the difference in appearance required the birds to have originated in widely separated breeding areas, but the occurrence of a *taverneri*-type suggests that the geese are rather unlikely to have come from the eastern extremity of the range of *parvipes*, which is closest to Britain. The possibility that these geese were escapes from English or Irish collections has been checked and eliminated, so far as that can be done.

Both birds were still present in February, 1961, when they were seen, independently, by James Cadbury and Major R. F. Ruttledge. At that time a third Canada Goose was apparently paired to the larger of the two geese described above. This third goose was larger and probably a typical *canadensis*. Major Ruttledge believes that the Canada Geese which have appeared on the slobs in other years have also been *canadensis*.

Since the census of breeding Canada Geese in Britain in 1953 (N. G. Burton Jones, *Bird Study* 3 : 153-170, 1956) the distribution has been extended very considerably by introductions, for example, in Westmorland, Pembroke and Perth. and by geese escaped from collections establishing themselves, as in Dumbarton and Renfrew, so that the appearance of Canada Geese in unexpected places may often be evidence of an attempted introduction rather than of transoceanic vagrancy. It is, however, well worth while examining strays with some care and submitting detailed descriptions for the consideration of editors of local reports.

BRITISH LITERATURE ON EUROPEAN WILDFOWL 1957-1960

M. A. Ogilvie

THE Tenth Annual Report for 1957-58 (1959) included, at pp. 162-175, a list of books, papers and notes published in Britain in the years 1945-1957 and dealing specifically with the European Anatidae. The titles which follow form a first supplement to that list and cover publications in the years 1958 to 1960, with a few from 1957 not noticed previously. The titles are listed alphabetically by authors' names. Published details of wildfowl ringing are listed separately at the end.

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SHORT NOTES

Ducks as botanists

DURING the shooting seasons of 1957-58 and 1958-59 a number of Teal and Mallard were sent to the Trust for food analyses from one area in Kent, and were found to contain the seeds of Marestail *Hippuris vulgaris* L. This plant is in fact only found locally in Kent in eight or nine places (Dr. F. Rose, pers. comm.), and it had not before been recorded from this particular area, so that this was probably a case of the botanist being beaten by the bird. In August, 1959, a visit was made to the area, and in company with the gamekeeper several fairly large patches of Marestail were found, all of them being in seed. The plant had been noticed for the first time the year before, and was regarded as being a weed of no food value to wildfowl. Now it is being encouraged and a possible reflection of this is that the number of Teal and Mallard now using the area has increased; the birds sent in from this area in 1959-60 were still using Marestail as part of their diet.

A similar problem of detection was posed by a Mallard shot in September 1958 over Milford Hope Island in the River Medway, Kent. More than 150 seeds of *Zostera hornemanniana* (=*angustifolia*) were found within the food tract and it was obvious from the almost perfect state and the position of the seeds that the bird had found them only a very short time before being shot. The distribution of *Z. hornemanniana* is not yet fully known, but there appears to be only one locality in Kent and this is approximately 20 miles from Milford Hope. It is also recorded from Essex, the nearest locality being approximately 12 miles away from the island. Although these distances represent probably less than half an hour's flying time, the state of the seeds and the fact that a number were found at the mouth end of the oesophagus suggested that the bird had been feeding immediately prior to being shot, and that there was therefore a growth of *Z. hornemanniana* close to or on the Medway islands. A search of this area has not yet revealed any *Zostera*, but as it is extremely difficult ground to cover, there may well be a patch eluding us, though not the birds.

I am most grateful to Professor H. Godwin and Miss C. Lambert for confirming the identification of *Zostera hornemanniana*, and to Dr. F. Rose, E. G. Philp, and the Botanical Society of the British Isles Distribution Map Scheme for information on the distribution of *Zostera hornemanniana*. I am also indebted to Dr. J. G. Harrison and those members of the Kent Wildfowlers' Association who sent in these particular birds.

P. J. S. Olney.

A curious nest site of a Mute Swan

ON 11th May, 1960 I noticed a Mute Swan *Cygnus olor* sitting on a large mound of seaweed at the edge of the channel in the Ythan river at the Inches, Newburgh, Aberdeenshire. The tide was out. I investigated and much to my surprise found a warm egg in the nest. The nest was composed entirely of seaweed *Fucus* spp. and mussel shells *Mytilus edulis* and was about two feet in height and diameter. There was a similar mound 100 yards downstream. At high water both these nests would have been covered with about five feet of water.

The following day when Dr. G. M. Dunnet and I went to photograph this unusual nest site, one egg was lying at the base of the nest and another

one in a pool of water several yards downstream. Later that day, with an ebbing tide when the top of the nest was just visible as a small island in a large expanse of water, the female was standing on the nest and pulling at bits of seaweed in a desultory manner with her mate looking on. After a week both birds lost interest in the nest. They made no attempt at breeding elsewhere.

Elizabeth A. Garden

Continuous musical note produced by the primaries of gliding Mute Swans

WHILST at Blagdon Reservoir, Somerset, on 2nd April, 1956, I observed two Mute Swans *Cygnus olor* gliding on to the reservoir from a considerable height. Against a light breeze the descent lasted about 25 seconds and not until immediately prior to alighting could I detect any movement of their outstretched wings. I was particularly interested as the birds' primaries made a pleasing and continuous musical note which throughout appeared to remain at an even pitch, though the sound intensity decreased as the birds descended. On numerous occasions I have heard the fluctuating notes made by swans flying, but never before, or since, have I heard a noise like this.

Bernard King.

A Greylag family homing on foot

EARLY in April, 1960, my Greylag gander (full-winged) which came from Slimbridge in July, 1958 disappeared with one of my two full-winged Greylag geese, which have been here (Sandhurst, Kent) since 1954, but after an absence of about a week they both reappeared, only to depart again a few days later. Soon I located them on a friend's farm just under two miles away where they had settled in near one of his small ponds. I decided they had considered the population of my own pond (about 25 geese of various sorts, mostly Canadas, and about 100 duck) too congested for breeding, though in 1959 they had nested and reared 3 out of 4 successfully hatched.

On 12th June, at about 7.30 a.m. when I went to feed my birds, I was astonished to see a couple of greylags walking outside my perimeter wire. I immediately recognised them as " Yellow " the gander and " Green " his mate from their chicken rings and to my utter amazement a two- or three-day old gosling was with them.

I immediately telephoned my friend who after, inquiring of his man, said they had been seen on his pond on Thursday, 9th June, with two small goslings, but no one had seen them since.

The plain facts therefore, are that this pair of geese had come home on foot over 2 miles of rather enclosed country, including crossing a stream, usually at this time of year only a few feet wide, but with rather high precipitous banks five or six feet high, taking some fifty to sixty hours for the journey and losing one of their two offspring on the way.

Is there any other possible explanation of how they travelled? Is there any record of geese having carried their young as for instance woodcock have been proved to do? I would have said quite impossible for a number of

reasons. Why did they decide to move from a very suitable habitat, good grazing, a pond with some cover and a small island? Certainly they are fed corn here as well as having pretty adequate grazing, whereas at my friend's farm they only have grazing plus perhaps a little corn robbed from his chickens.

Airborne of course, there would be not the slightest difficulty in finding the way back but on foot—well quite remarkable is the least one can conclude. The gosling showed no signs of distress after his long trek. They could certainly have heard my Canadas honking and used that as a beacon, but what was the urge to make the journey?

G. L. Reid

Tuberculosis in Eiders

DURING the past five years I have had 173 Eiders *Somateria mollissima* from the Ythan Estuary, Aberdeenshire, post-mortemed. Four of these birds were suffering from avian tuberculosis. Details of the post mortems are as follows:

8/2/55 Ad. ♂

Post mortem examination showed the bird to have died in poor condition. It was affected with avian tuberculosis. There was a very large tubercular lesion involving the right coracoid and clavicle and the muscles around them. Small lesions were in the spleen and the intestines, and there was tuberculous material in the sternal, left anterior thoracic and abdominal air sacs. A few acanthocephala were in the small intestine.

12/2/57 Ad. ♀

Post mortem examination showed the bird to have died in good condition. It was affected with tuberculosis. Tuberculous ulcers were in the intestines and a large lesion was on the surface of the gizzard, the lining of which was ulcerated. A full bacteriological examination failed to show any organism of significance. There were a large number of acanthocephala of varying sizes, in the lower half of the ileum. No parasites were in the gizzard or the kidneys.

26/11/57 Ad. ♂

Post mortem examination of the bird showed it to be emaciated as a result of advanced tuberculosis and aspergillosis affecting chiefly the left lung and the left abdominal air sac. A large mass of tuberculous material was also present in the pericardial sac attached to the tip of the left ventricle.

28/4/60 Ad. ♂

Post mortem examination showed the bird died in poor condition and was affected with tuberculosis. There were typical lesions in the liver and spleen and there were numerous acanthocephala in the intestines. A bacteriological examination was negative.

None of these birds showed any evidence of having been attacked by a predator.

I have also had cases of tuberculosis in three other species: Common Gull (*Larus canus*), Black-headed Gull (*L. ridibundus*) . . . " one intestinal

nodule was almost as big as a thrush's egg," and Cormorant (*Phalacrocorax carbo*), in which the bone marrow was involved.

I am most grateful to Dr. J. E. Wilson, Mr. R. H. Duff and Mr. J. W. Macdonald of the Ministry of Agriculture and Fisheries Veterinary Laboratory, Lasswade, Midlothian, for carrying out the post mortems.

Elizabeth A. Garden.

Pre-dusk gathering of Goldeneye

In North Somerset, after years of consistent counting, it was found that Goldeneye *Bucephala clangula*, usually are to be found in their largest numbers during March and early April, although on present standards it is exceptional for fifty or more Goldeneye to be counted on any one occasion.

It was also discovered, especially at Blagdon Reservoir, and then in more recent times at Chew Valley Reservoir, by Stephen Chapman and others, that the species revealed a marked tendency to gather, sometimes on the deepest waters, about an hour or so before dusk, and there to stay in close association—they form into long and irregular lines or bunch closer together, until the oncoming darkness prohibits further observations. For how long these 'rafts' of Goldeneye remain as described is still unknown, but on the few occasions I have made dawn visits to the areas where they have been seen to gather the previous evening the birds were well scattered and, perhaps in consequence, the total numbers were below the pre-dusk counts.

On searching through the British ornithological literature at my disposal, I have failed to find data of a similar nature, although from the following details by James W. Campbell it is evident this communal behaviour is not confined to Somerset. Campbell states (1953—personal comm.) 'There seems to be a tendency with Pochard (*Aythya ferina*), Tufted Ducks (*A. fuligula*) and Goldeneye, to collect an hour or so before dusk and then I think shift at flight time. I first became interested in this in Benbecula where several times in the dusk large lots of Pochard and Tufted came into a loch and then shifted on their own accord. Apart from Abberton Reservoir, Essex, I've never been in a district with large numbers of Goldeneye. At Abberton my experience was the same as yours; large counts in late afternoon with the birds concentrating in an area, although there was there a marked tendency at all times for Goldeneye not to scatter as much as they do in some places.' In a recent letter (1960), Campbell further comments 'I still have no solution re the 'disposal' of these late p.m. gatherings.

It would be advantageous to further the knowledge of communal behaviour by Goldeneye, and other species of 'diving-ducks,' of which little is as yet apparently known. Readers who have ready access to areas where Goldeneye regularly gather may, in consequence, be able to furnish observations of a more detailed nature.

Bernard King.

Male Teal displaying to shore roosting females

While on a visit to the Clevedon marshes, Somerset, on the 21st April, 1951, and in company with W. L. Roseveare, a party of at least 150 Teal *Anas crecca* were observed swimming on the outgoing tide, as well as a few roosting on a small and shallow bank which the tide had left uncovered.

As the light conditions were good it seemed worthwhile to make a sex count of these Teal, and for this I used a x 30 telescope. I soon discovered, however, that a small party of drakes appeared to be displaying amongst themselves. For instance, every time the tide drew the birds away from close by the shallow bank they immediately returned, either by swimming back quickly or by scurrying low level flights across the surface of the water—then the 'normal' displays began over again. But observations of a more prolonged nature revealed after all that the behaviour was directed towards twelve shore roosting birds, ten of which were female Teal—in fact the drakes ceased displaying as soon as the former birds finally departed to feed along the tidal edge.

Bernard King.

Great Skua attacking ducks

On 24th November, 1960 off Stert Point, Somerset, I witnessed a series of attacks by a Great Skua *Stercorarius skua* on a number of ducks, mainly Wigeon *Anas penelope* but also Mallard *Anas platyrhynchos* and Teal *Anas crecca.*

It was high water at the time with a heavy and confused sea running. The Great Skua came into the area between Stert Point and Stert Island from seaward and landed on the water where it rested for 40 minutes.

There were several hundred duck present in the area mainly in small groups of up to 50 birds. I then noticed a group of 28 Wigeon on the water quite close to the Skua. Whilst I was watching, the Wigeon took wing, and the Skua immediately went after them with surprising acceleration and appeared to single out the last bird in the flight and relentlessly pursued it with great vigour. After a short chase the Wigeon, which I assume was becoming exhausted, took to the sea again.

At this point the Skua broke off the attack and climbed to about 100 ft., and at this height patrolled over the area very slowly, until another group of ducks took wing, whereupon the Skua would dive rapidly from the patrol position and pursue the group as before.

The 'patrolling' and 'attack' performance was repeated many times, and in all lasted 8 minutes.

The Skua then flew off and landed on Stert Island.

J. V. Morley,
Warden, Bridgwater Bay Nature Reserve.

Feral North American Ruddy Ducks in Somerset

In the autumn of 1957 a few (probably less than ten) full-winged young North American Ruddy Ducks *Oxyura j. jamaicensis,* which had been reared by their parents in the Rushy Pen at Slimbridge, flew away. One was discovered at Villice Bay, Chew Valley Reservoir, north Somerset, in November of the same year, During the subsequent winter the number present at Chew Valley increased to four and an equal number, presumed to be the same birds, were also observed over long periods on the nearby Blagdon Reservoir. In addition, single *jamaicensis* were occasionally reported to me from the reservoir at Barrow Gurney. It is reasonable to suppose that at least five Ruddy Ducks,

all of which assumed adult male plumage in the early spring of 1958, were present in north Somerset during 1957-58. This small group was augmented in later years by odd immatures and it is curious that up to the time of writing (autumn 1960) no authentic reports of full-winged female Ruddy Ducks have been made.

I believe that two independent groups have now become established at Chew Valley and Blagdon, consisting of four and three males respectively. They appear reluctant to take flight and even in the presence of predators prefer to " break contact " by diving and retiring to their favourite reedy areas, from which they seldom stray during the summer months. Only in the early days of their stay at Chew Valley did I see them fly frequently, usually in low level flights of short duration. Often these were immediately followed by one or more of the birds rearing up off the water and flapping their wings with amazing rapidity, for periods of up to thirty seconds.

In spite of the absence of females of the same species the males are sufficiently stimulated during the spring and summer to display among themselves, though the displays comprise little more than swivelling round with bills depressed and tails tilted well forward. The Somerset birds occasionally associated with other ducks and sometimes appear to display to them. This feral behaviour may differ from that of wild Ruddy Ducks, because Richard H. Pough (*Audubon Water Bird Guide,* p. 116) mentions that " they seldom associate with any other birds except Coots (*Fulica americana).*" The behaviour of one isolated male on the catchment water, a small pool alongside Chew Valley Lake, on 14th June, 1960 is particularly worth mention. Every time female Mallard *Anas p. platyrhynchos* swam near it the male Ruddy went into the full courtship display, tilting the tail far forward, bouncing its bill on its puffed-out breast, and splashing up water with both feet. Only once in the course of the ten minutes the male was in the area did it cease displaying to female Mallard and then only to display to a drake Mallard in an advanced state of eclipse: other males were ignored.

Bernard King.

A rare water-beetle found by a Mallard

A drake Mallard *Anas platyrhynchos* shot in the Pett Levels, Sussex, on 27th November, 1959 was found to contain a single male of the rare water beetle *Graphoderus cinereus* L. This extremely uncommon Dytiscid is only known at the present date from one locality in Hampshire, at least 60 miles from the Pett Level area. The almost perfect condition of the beetle and its presence in the oesophagus indicate that it could only have been ingested some minutes before the bird was shot. It is most unlikely that the bird would have held the beetle within the oesophagus for any length of time, certainly not for the time it would take to fly 60 miles. It seems therefore certain that the beetle originated from the area in which the bird was shot and that the Pett Level must be considered as a new locality for this beetle. The rest of the meal consisted mainly of the winter buds of Frog-bit *Hydrocharis morsus-ranae* L. and various insects, including *Noterus clavicornis* Degeer, *Haliplus* sp. larvae, Polycentropid larvae and Odonata larvae.

I am most grateful to J. Balfour-Browne for identifying this beetle and for details of its distribution. I am also indebted to Dr. J. G. Harrison for obtaining this bird.

A note on the discovery of this beetle was published in the *Ent. mon. Mag.* 96 : 56 in 1960 by J. Balfour-Browne.

P. J. S. Olney.

Eating of metal by ducks

1. A female adult Tufted Duck *Aythya fuligula* shot on 30th January, 1960 over a gravel pit near London, described as being in poor condition, was found to have a 1½″ long nail through the gizzard wall which actually penetrated to the skin of the back (photograph). Where the nail had pierced the back there was local inflammation of the skin and some suppuration. From the position of the nail and the fact that the sharp pointed end was on the outside of the gizzard, it was obvious that the nail had been swallowed and had then worked its way out through the gizzard wall. There was no sign at this stage of any internal haemorrhage and it appeared that the nail had been there for some time. When shot the bird was apparently flying as fast as its companions.

2. A Mallard *Anas platyrhynchos* of about 8 weeks, one of a large number of hand-reared birds, was picked up dead during July 1960 before it had been put out on water. When examined it was found to have eaten a 1½″ piece of wire and 37 copper tacks (photograph). Only one bird was known to have died in this way, though previously a bird had been found dead after having eaten the brass heads of several cartridge cases. It seems likely that the only time copper tacks had been used was during the electrification of the building in which the ducks were kept, and that many years later some of them left behind had been found by this unfortunate duck.

3. A Falkland Island Flightless Steamer Duck *Tachyeres brachypterus* which died at Slimbridge in September 1959 had been ill for several days and had taken no food but drank large volumes of water.

At post mortem examination the bird was found to be in poor condition with a reduced pectoral muscle and depleted visceral fat. The left posterior thoracic and abdominal air sacs contained a foul smelling blackish fluid while the left lung showed severe caseating pneumonia. The probable cause of this condition was three pieces of wire which had penetrated the wall of the gizzard and damaged the liver and small intestine. The longest piece, 6 cms., had damaged the small intestine, which developed a series of adhesions and an associated foreign body capsule 3 cms. x 1.5 cms. Two more pieces of wire, each 3 cms. long, were found in the liver encased in a black material and had presumably come from the gizzard.

A second bird of this species, which died of inanition, had the shaft of a fish hook embedded in the wall of the gizzard and surrounded by a black material. The piece of metal probably came from an eel fed to the bird.

4. A first winter European Scaup *Aythya marila* drake which had been reared at Slimbridge had a piece of wire, 1.5 cms. long, embedded in the wall of the gizzard. One end protruded into the lumen of the organ and the other end pushed the outer surface of the gizzard into a conical shape. This bird died of renal and cardiac disease.

Small pieces of wire have occasionally been found in the gizzards of several other species, especially the European Eider *Somateria mollissima*.

In each case where tissue had been penetrated it would appear that the wire was ingested, and for a time acted as grit since considerable wear had occurred on the pieces. Then the wire moved into such a position that the muscular activity of the gizzard forced it into the wall of the organ and, in the case of the Steamer Duck, right through the wall into other organs.

It seems probable that most of the metallic objects found in these birds had been selectively ingested, though why they should have been remains an enigma. Possibly the smaller pieces were taken as a form of grit, but the larger pieces are quite unlike the normal grit or food of any of the birds concerned. It may be that the shiny appearance of such objects is an attraction. Perhaps the same reasons are involved which cause some birds to ingest lead pellets, with subsequent fatal results (Olney, P. J. S. 1960. *Eleventh Ann. Rep.* : 123-134). Whatever the reasons are, it seems to be extremely unwise to leave metallic objects about where wildfowl can find them.

We are most grateful to J. Moller and Dr. J. G. Harrison for obtaining the first two examples and to R. Young for supplying details of the second bird mentioned.

P. J. S. Olney and J. V. Beer.

A cheap form of semi-permanent binding for journals

THE reference library at Slimbridge continues to grow and more than fifty journals are regularly received by subscription or exchange. At the moment we have no funds for permanent binding of the quite long runs we have accumulated. Yet some form of binding is essential to prevent the separate parts being lost. The solution we have adopted has always roused the interest of visiting scientists, who are also faced with the problem, so it is thought worthwhile setting the details out for wider circulation.

The binding material is polyvinylchloride electrical tape (in our case obtained from Gordon & Gotch (Sellotape) Ltd., London). This is available in a number of pleasing colours and is strongly self-adhesive.

Two parts of the journal are laid spine to spine, the first face down, the second face up. They are then hinged together by running a strip of two inch wide tape down the length of the joint, one inch on each side. A third part is hinged to the back of the second in the same way, and so on. Finally a strip of tape is run down the back of the pile of parts, overlapping the front of the first and the back of the last part. At least half an inch should overlap to ensure firm attachment; if the pile is more than one inch thick, two widths of tape will be needed for the spine. The number of parts that can be bound together in this way depends on their thickness and the relative rigidity of their covers, but four or six make a firm volume in most cases. If desired, cardboard covers can be added, but this is not usually necessary. The tape should not be stretched when applying or it will tend to creep back in time.

The volumes may be neatly labelled by stencilling an abbreviated title on to white card and covering with transparent Sellotape to keep it clean. The

cards are then fixed to the spine of the volumes by further strips of narrower ($\frac{3}{4}$″) polyvinylchloride tape.

Binding a volume in this way costs less than ninepence, compared with fifteen shillings or more using conventional methods.

The method was first used two years ago and experience has shown that the binding lasts well and easily stands up to the amount of use that journals receive in a research unit. The smooth surface of the tape prevents the collection of dust and gives a clean cool appearance to the library shelves. It is worth noting that the method in no way prevents subsequent permanent binding of the journals, since only the covers are involved in the process of attachment.

G. V. T. Matthews.

11th Annual Report—Correction :

p. 115. In the paper ' The Shelduck population in the Bridgwater Bay moulting area,' it was stated that nine Shelduck in flightless moult were present on Swanscombe marshes, Kent in July, 1959. Mr. C. D. Jolly informs us that this was not so, the birds being advanced juveniles, not adults.

REVIEWS

Earl L. Atwood and Clinton F. Wells Jr. 1960. Waterfowl harvest in the United States 1959-60 hunting season. *U.S. Fish and Wildlife Service Special Scientific Report—Wildlife No.* 52. Laurel, Maryland, 225 pp.

Since 1953 the Fish and Wildlife Service has conducted annual surveys to obtain information from hunters (=shooters or wildfowlers in Britain) about the amount of shooting they have done, the number of ducks they have shot, the specific composition of the bag and the numbers of ducks shot but not retrieved. Results for the earliest years were not published and those for recent seasons were incorporated in the annual reports on the status of waterfowl. Now for the first time the ' harvest survey ' is published by itself.

The survey is made immediately following the shooting season. The procedure is to select at random a series of Post Offices where Migratory Bird Hunting Stamps are sold and ask these offices to give an address card to each person who buys a stamp. (All duck hunters must buy a stamp). The card requests the hunter to send his name and address to the Bureau. When he does this he is sent a questionnaire. A large sample is selected from each of the four " Flyways " into which the country is divided. In 1959-60 55,493 questionnaires were sent out and 38,378 (69.2%) were completed and returned. Tendencies to exaggerate hunting activity and kill are corrected for by procedures that have been partially described in previous papers. The species composition of the kill is accepted as reported. The methods of estimating the totals and averages given are described in the report but will not be given in this review.

The number of ducks bagged in the United States (excluding Alaska and Hawaii) in the 1959-60 season was estimated to be 7,051,140, with a further 1,377,720 killed but not retrieved, the total kill being put at 8,428,860. By European standards these are colossal figures, yet the kill is believed to have been the smallest since the sampling system was introduced for the 1952-53 season. The estimated decline from 1958-59 (when over fourteen and a half million were killed) was nearly 42% and the drop below the seven-year average was very nearly as much. The decreases applied to all species except scaup and scoter.

The goose kill in 1959-60 was 876,000, against 1,033,000 in the previous season, a drop of 15.1%. 142,500 were estimated to be killed but not retrieved. Canada Geese made up nearly half the total. 26,800 Brent were included, an increase of 22.6% on the previous season: 20,400 of these were from the Atlantic coast population of *hrota,* the form which winters in Ireland, the remainder being Black Brant from the Pacific coast. This disparity reflects the relatively flourishing state of the Atlantic stock at present.

The number of active hunters fell by 28% in 1959-60, to 1,424,000 (about 3% of the male population over 16). The average seasonal bag of each hunter is not given on a national basis: it increased in each flyway from the Atlantic to the Pacific. The average seasonal bag of ducks by persons over 15 varied from 3.506 (Atlantic) to 8.730 (Pacific) and of geese from 0.304 (Atlantic) to 0.878 (Pacific). Atlantic Flyway hunters averaged 3.442 trips in the season, those in the Pacific Flyway 4.396.

There is a wealth of more detailed information in this report, stimulating all sorts of hypotheses about the relations of shooting activity and success to

the size of wildfowl stocks. It must be a source of real regret to serious students of conservation that there is no prospect of similar information becoming available for western Europe. The many people who dislike and distrust the statistical approach to such an emotionally-charged topic as wildfowling will not of course share this regret. Since most species of wildfowl seem to be 'holding their own,' they may well feel that detailed investigations of this type are unnecessary. This is not so: if we are ever to understand how any species manages to maintain itself in the face of human predatory activity it is essential to investigate the predator as well as the prey.

H.B.

M. S. Dolbik. 1959. The Birds of White Russian Polesie. Publishing Office of the Academy of Sciences of the White Russian S. S. R., Minsk. 268 pp.

The region covered by this work is roughly that best known in this country as the Pripet (more correctly Pripiat) Marshes and extends from just south of Minsk in the north to the Ukrainian frontier in the south, while its eastern and western limits are formed by the River Dnieper and the Polish frontier respectively. A small-scale map of the area is to be found on page 249. The data given are based partly upon the work of the author's not very numerous predecessors (the most useful of these being V. N. Shnitnikov, whose "Birds of the Minsk Government" appeared in 1913) but mainly upon the personal investigations of Mr. Dolbik himself. Between 1948 and 1956 (inclusive) he spent approximately 55 weeks in different parts of the region in a series of mostly one-man expeditions, each of which lasted from two to four weeks, with the purpose of collecting and, to a lesser extent observing, birds. Incidentally, some of his collecting methods will recall to the British reader those of his own Victorian predecessors. For instance we are informed that the author only encountered the Little Gull once, when he found, in 1953, a colony of six pairs with nests and eggs, this being the only breeding record for the region. Of the twelve birds involved he "obtained" eight! It does not seem that any regular observations, apart from those made by the author, are carried on in the area.

A great deal of land reclamation through drainage, and forestry work have been carried on in the region in recent years and the author attempts to show the effect these have already had upon its bird life. He begins by giving an outline of the various sub-areas into which he divides the region and then goes on to give the birds (and to some extent the plants) which occupy different habitats that he describes. A systematic review of the birds follows. The work concludes with a discussion of the factors which have formed the avifauna of the area. There is a useful bibliography.

In the systematic review the author tends to give all the information which he has from the region about the species in question. Much of this is of value but a good deal seems redundant, e.g. when we are given detailed descriptions of the eggs of such very common Russian species as the Lapwing and even a photograph of a bush in which the author found the nest of a Blackcap.

So far as the Anatidae are concerned, there are fewer records of a number of species than might perhaps have been expected. No doubt this is largely due to lack of observation.

The only swan recorded is the Whooper which is described as a rare passage migrant. The Grey Lag Goose, though it may have been breeding up to about 1920, is now only a very common passage migrant, occurring from early March to about mid-April and from early October to about mid-November. The White-fronted Goose is a rare passage migrant and there is one record of a Lesser White-front. The Bean Goose has been recorded on passage but apparently only on a few occasions. The Brent Goose is known as a passage migrant but there seem to be very few recent records.

The Shelduck is a very rare passage migrant and there is one record of the Ruddy Shelduck. The Pintail has been recorded as nesting on one occasion only but is common on passage, from early April to about mid-May and in September and October. Teal are common and widely distributed. They appear in early March and leave in October and November. Mallard are also common and widely distributed. They arrive from early March to mid-April and leave in October and November though a few winter on waters which do not freeze up. In the region as a whole this species has noticeably declined in numbers, mainly as a result of reclamation works. In order to replace food and cover which have been destroyed attempts are being made to introduce "Lake Rice" (no scientific name given but perhaps *Leersia oryzoides*) and have met with some success. The Gadwall is a common and widely distributed breeding species. Arrival has been recorded in March and departure in September, October and November. The Wigeon is believed to be a regular passage migrant but the position does not seem quite clear and few migration dates are given. The Garganey nests commonly but is, in the opinion of the author, much less common than the Teal. March is given as the arrival month but little is known of autumn departure. The Shoveler is rare, both on passage and as a nesting species. It was not once encountered by the author during his expeditions.

The Red-crested Pochard has occurred about three times, on passage. The Pochard is also rare but is known to have bred on one occasion when the author obtained the female and four young out of a brood of seven. The Ferruginous Duck is common both on passage and as a breeding species but there is little information about migration dates. The Tufted Duck occurs in small numbers on passage and has been recorded in summer but without proof of nesting. The Scaup has been recorded on one occasion only. The Velvet Scoter has occurred occasionally on autumn passage though there are no recent records. The Goldeneye nests in small numbers but is common on passage, in March and April and in October and November. A few Red-breasted Mergansers have been recorded in April, October and November. The Goosander occurs more regularly, at the end of April and in November. The southern nesting limit of this species lies not far to the north of the region since nesting has been established on Lake Naroch in White Russia. The Smew has occurred in April and May, on passage.

Thus only six species of duck—Teal, Mallard, Gadwall, Garganey, Ferruginous Duck and Goldeneye, nest regularly in the region.

It should be added that the work is illustrated with a number of photographs of birds and habitats and with some black and white drawings.

D. D. Harber.

Farming for Waterfowl in the Southeastern United States. United States Department of the Interior, Bureau of Sport Fisheries & Wildlife. Atlanta, Georgia. rev. 1959. Pp. 44.

Here is an American production which tells you what to do if you have lots of money, lots of duck and geese, and lots of land. In Britain we have little money, comparatively few duck and geese and a diminishing amount of available land, so that you may think that there is really little need for such a publication to be reviewed here. However, the approach that they suggest, though we need not and indeed cannot emulate it exactly, does hold a number of practical possibilities which might be adapted to our own wildfowl conservation problems.

The pamphlet is, as the title suggests, confined to farming for wildfowl—not *of* but *for* wildfowl; that is actually cultivating land for use by wildfowl. In the Southeastern United States the production of enough food to support the winter concentrations of wildfowl is apparently a major problem. To supplement the loss of natural foods due to an expanding human population with its inherent need for industrialisation and cultivation, it is suggested that the planting of agricultural crops offers a method of producing large quantities of highly nutritious foods in relatively small areas. The establishment of managed feeding areas will also, though this is not a point raised by this publication, afford places to which birds may be herded and fed, so as to be less likely to damage more valuable crops belonging to private landowners.

Most of the publication is taken up with detailed information on the best methods of crop production. Included in these sections are details of the best species to use in a particular area; the correct planting dates; the rate of seeding; the part of the plant eaten, with a rating of usefulness; and any treatment to the crop that is necessary before its utilization. A section which is of interest to people in this country is one which deals with the recovery rates (that is the ability of a plant to grow again after having been eaten down) of various green crops, after close grazing by geese. This is a most important factor in assessing possible damage by geese, of which they are often accused in parts of this country. The authors also stress the tremendous potential for attracting waterfowl there is in using areas which are temporarily flooded during the winter and autumn months, whether the flooding is artificial or natural. Of particular interest, as they could well be adapted to our own wildfowl habitat conservation plans, are the techniques described for managing such areas.

Some of the problems which *arise* from wildfowl habitat management are briefly discussed. One which is causing considerable concern is the huge concentrations of other bird species, in particular the crows, American blackbirds and starlings, which are attracted to the same areas by the easily obtainable food supply. As we know in this country, large amounts of food which are put down can be lost to the wrong species.

This publication is above all a stimulating example of what is being done elsewhere in this comparatively new field of work, where there is enormous scope for ingenuity and inventiveness. For my part, I would have wished it to

be much longer and more detailed and certainly with a bibliography, but then it was after all not written for the beginner, but for the more advanced member of the class.

P.J.S.O.

Lead poisoning of ducks in the Camargue. L. Hoffmann. 1960. Le saturnisme, fléau de la sauvagine en Camargue. *La Terre et la Vie* **1960, No. 2, 120-131.** Reprinted in Station Biologique de la Tour du Valat, Cinquieme Compte Rendu d'activite et Recueil des travaux 1958.

A first report based on the fluoroscopic examination of 7988 ducks of three species during the winters of 1957-58 and 1958-59. The number of birds found carrying lead shot in the gizzard was very much higher than that found in the United States (Bellrose) or in England (Olney). 32% of 203 Tufted Ducks *Aythya fuligula* contained lead shot, as did 24% of 533 Mallard *Anas platyrhynchos* and 4.2% of 7252 Teal *A. crecca.* No significant differences between the sexes or between first-winter and older birds were found, other than an indication that first-winter Tufted Duck were more prone to ingest lead shot than were older birds.

The last section gives an account of experiments which indicate that lead poisoning may be significantly reduced in muddy areas, such as the Camargue, by sowing fine gravel. This could well be adapted to localities in this country where lead poisoning occurs in areas with little or no available grit.

P.J.S.O.

SECTION III: ADMINISTRATION

STAFF

THE senior members of the administrative staff of the Trust are Brigadier C. E. H. Sparrow, O.B.E., M.C., Controller; Mr. E. A. Scholes, Secretary; Mr. H. G. Gower, Bursar. Mr. D. Eccleston and Mr. C. M. Garside are assistant secretaries. Miss W. Young manages the hostel with the assistance of Mrs. H. Cobb.

Mrs. S. T. Johnstone is in charge of the gate houses and is assisted by Mrs. V. M. Hawkins, Mrs. E. Warren and Miss J. Price at the New Grounds and by Miss N. Hall at Peakirk.

MEMBERSHIP

Class of Membership	Jan. 1958	Jan. 1959	*Jan. 1960*	Jan. 1961
Life Members	138	157	*184*	229
Full Members	3315	3206	*3024*	2813
Associate and Parish Members	1383	1475	*1505*	1590
Junior Compounded ...	1	1	*3*	3
Gosling Members	300	315	*331*	254
Corporate Members	154	174	*169*	112
Contributors	29	24	*28*	28
	5320	5352	*5244*	5029

CLASSES OF MEMBERS

Life Members: (a) up to 50 years of age ... ... £52 10 0 | One
(b) over 50, not over 60 ... ... £26 5 0 | Final
(c) over 60 ... ... £10 10 0 | Payment

Entitled to all privileges of Full Membership (see below) during life, and exempt from payment of any subscription, excepting any sum being paid yearly under Deed of Covenant.

Full Members: Annual subscription £2 2s. 0d. Entitled to free access to pens and observation-huts at the New Grounds and at Peakirk, with one free guest, one free copy of the Annual Report for each year of Membership and of all Bulletins issued during Membership, and to attend and vote at the Annual General Meetings.

Junior Compounded Members: Only persons under 21. One payment of £10 10s. 0d. Entitled to all privileges of Full Membership (as above) until attaining the age of 21. May then, if they wish, pay another 40 guineas and be elected Life Members.

Associate Members: Annual subscription 10/-. Entitled to free access to pens and observation huts, and to free copies of all Bulletins.

Gosling Members: Annual subscription 7/6d. Limited to persons under 18. Entitled to free access to pens at the New Grounds, and at Peakirk, on Saturdays and Sundays. (With the aim of encouraging interest in Wildfowl

among children, a system has been introduced of grades of Goslings, with appropriate distinguishing marks and promotion by recognition-test. Full particulars of this scheme are given in the separate leaflet available at the Gate Hut at Slimbridge or Peakirk).

Corporate Members: Annual Subscription 10/-. Limited to Educational Establishments, Youth Clubs, and bodies which are Members of the Council for Nature. Parties from Member bodies may visit the New Grounds and Peakirk in numbers of not less than ten, and not exceeding one coach load at any one time, on payment of the entrance fee in force at the time of the visit. Times must be arranged beforehand with the Curator, and parties are not admitted before 2 p.m. on Sundays. One free Annual Report, one copy of all Bulletins during membership.

General Public is admitted to the pens only, at 3/6d. (children under 16, 1/6d.) at Slimbridge, and 2/6d. (children under 16, 1/-.) at Peakirk. The enclosures are open from 9.30 a.m. until sundown every day, with the exception of Sunday mornings which are reserved for members only until noon.

Parties: Applications must be made well in advance in writing to Slimbridge or Peakirk. School parties can only be arranged when a Warden is available to show them round, and must not exceed one coach load (35-40 persons).

OBITUARY

The Rt. Hon. The Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C., a Trustee since the formation of the Trust in 1946, died in July 1960.

The Council has also learned with regret of the deaths of the following Members and Associates:

Mrs. J. R. Alderson
H. W. Bennett
Air Commodore C. E. Benson, C.B.E., D.S.O.
Miss Winifred Birt
G. S. Bocquet
Miss E. J. Bostock
Major A. W. Boyd, M.C.
W. C. Camm
Mrs. N. Cooke-Hurle
The Rt. Hon. C. C. Craig, P.C., D.L.
Ethel, Lady Dilke
Lord Egerton of Tatton
P. R. England
W. M. Everett
Lt. Col. J. E. Fasken
C. H. Frankland
H. A. Franklyn
R. S. Hirst
C. J. Holland-Martin, M.P.
The Hon. Lady Howard
The Rev. Canon A. T. Jenkins
A. R. Lee
Miss B. S. Martin
A. C. Mellor
J. P. Mills
R. H. G. Mounsey-Heysham
H. K. Nisbet
Dr. H. F. Patrick
Mrs. E. N. Roberts
Mrs. K. Manwaring Robertson
Mrs. A. M. Skinner
Miss B. L. H. Tasker
E. Thornhill
Mrs. C. M. Watson
Lt. Gen. The Lord Weeks, K.C.B., C.B.E., D.S.O., M.C.
G. M. Wells
Mrs. M. Williams
J. Wright

THIRTEENTH ANNUAL GENERAL

MINUTES

THE Thirteenth Annual General meeting of The Wildfowl Trust was held at The Royal Society of Arts, John Adam Street, London, W.C.2. on Tuesday, 24th May, 1960.

The following Officers and Council Members were present:

Field Marshal the Rt. Hon. the Viscount Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O. *President.*

Guy Benson, Esq. *Hon. Treasurer.*

Michael Crichton, Esq.

K. Miller Jones, Esq.

Dr. James Robertson Justice

Sir Percy Lister

Mr. R. E. M. Pilcher, F.R.C.S.

Miss P. Talbot-Ponsonby

Peter Scott, Esq., C.B.E., D.S.C. *Hon. Director.*

Major General C. B. Wainwright, C.B.

Apologies for absence were received from:

His Grace The Duke of Beaufort, K.G., P.C., G.C.V.O.

The Rt. Hon. The Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C.

James Fisher, Esq.

Before the business of the meeting began, Lord Alanbrooke referred to the sad loss the Trust had suffered by the death during the year of Sir Archibald Jamieson, K.B.E., M.C., a founder-member and supporter of the Trust. He had an enthusiastic interest in the work of the Trust and had been of constant and material help to it in troublesome times. Lord Alanbrooke asked all present to stand in silence as a tribute of respect.

The Minutes of the Twelfth Annual General Meeting which had been circulated with the Report of Council were taken as read and signed by the Chairman.

1. The Hon. Director moved the adoption of the Report of Council and Accounts for the year ending 31st December, 1959. Mr. H. K. Hallam seconded the motion which was carried unanimously.

2. Dr. James Robertson Justice proposed the election of Council's nominees for vacancies on the Council as follows:

Councillors due to retire under Rule 13(1) and nominated for re-election:

H. Howard Davis, Esq.
K. Miller Jones, Esq.
Miss P. Talbot-Ponsonby.

3. The wish of the President, Field Marshal The Rt. Hon. The Viscount Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O., to retire from Office, and the gracious consent of His Royal Highness The Prince Philip, Duke of Edinburgh, K.G., K.T., to accept nomination having been intimated to the meeting, Sir John Craster formally proposed the election of the following Officers:

President : His Royal Highness The Prince Philip, Duke of Edinburgh, K.G., K.T.

Vice-Presidents : Captain R. G. W. Berkeley.
The Rt. Hon. The Lord Howick of Glendale, G.C.M.G., K.C.V.O.
General Sir Gerald Lathbury, K.C.B., D.S.O., M.B.E.
Sir Percy Lister.

Trustees : His Grace The Duke of Beaufort, K.G., P.C., G.C.V.O.
The Rt. Hon. The Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C.

Hon. Director : Peter Scott, Esq., C.B.E., D.S.C.

Hon. Treasurer: Guy Benson, Esq.

The Proposition was carried unanimously.

At this point Dr. James Robertson Justice expressed the immense gratitude of The Wildfowl Trust to Lord Alanbrooke, the retiring President, for all he had done for the Trust. The Council fully realised how fortunate they were in having such a distinguished ornithologist to lead the Trust through its early and difficult days. Dr. Justice thought that the A.G.M. was a splendid opportunity to propose a vote of thanks to Lord Alanbrooke for his generous support and help. Mr. H. K. Hallam, in seconding the vote, and on behalf of the members of The Wildfowl Trust, expressed grateful thanks to Lord Alanbrooke for fulfilling an extremely important Office over fourteen difficult years. The meeting unanimously acclaimed the vote.

4. The Hon. Director proposed, and Mr. K. Miller Jones seconded the following alterations in the Rules of The Wildfowl Trust:

Rule 2. Objects. To delete Rule 2 as it now stands and substitute the following: 'The objects of the Trust shall be to promote the study and conservation of wildfowl and to undertake any activity which in the opinion of the Council is calculated to promote knowledge of and interest in wildfowl in all parts of the world, and to maintain an establishment at Slimbridge, and such other branch establishments as the Council may think fit, which will provide facilities for:

(1) The scientific study of wildfowl in the wild state and in captivity, and related investigations.

(2) The propagation of wildfowl in captivity, especially those species which are in danger of extinction.

(3) The education of the public by all available means to a greater appreciation of wildfowl in particular and Nature in general.'

Rule 5. Members & Associates. (4) (iii) after the word 'Slimbridge' and (4) (v) after the words 'New Grounds' to insert in each case the words 'and at Peakirk.' (4) (vi) to delete the words 'Teachers Training Colleges' and substitute the words 'bodies which are Members of The Council for Nature;' after the words 'New Grounds' to insert the words 'and Peakirk;' and after the word 'Sundays' to add the words 'on payment of the Entrance Fee for each member of the party at the rates in force at the time of the visit.'

Rule 12. The Council. (1) to delete the word 'ten' and substitute the word 'twelve.'

Rule 17. Trustees. To add a paragraph at the end of the Rule as follows: '(4) The property of the Trust may also be vested in The Wildfowl Trust (Holdings) Limited.'

The Proposition was carried unanimously.

5. The Hon. Treasurer proposed that Messrs. S. J. Dudbridge & Sons of Stroud, Gloucestershire, should be appointed Auditors to The Wildfowl Trust for the ensuing year pursuant to Rule 10(1). Dr. James Robertson Justice seconded the proposition which was carried unanimously.

6. Mr. Michael Boardman regretted that the List of Members was no longer published in the Annual Report, and suggested that it might be printed perhaps once every five years. The Hon. Director stated that the publication of the List had been discontinued owing to the size of the Report which increased year by year and had reached a size above which it was not economical to publish. He agreed, however, that it might be possible to publish the list in one form or another.

Business being concluded, the meeting was closed by the Chairman, who, taking leave, recorded his sincere wish that the Trust would progress from good to better in the years that lay ahead.

NOTE

Members will receive with this Report notices from two kindred societies, which are anxious to enlarge their membership—the Fauna Preservation Society and the Avicultural Society.

It is possible that some of our members may not be aware of the valuable work the F.P.S. is doing for the preservation of wild life all over the world. We feel sure that the enclosed leaflet or any number of Oryx *will convince them how worthy the Society is of support.*

Any member who is starting to keep wildfowl—or any other kinds of bird—in captivity or who contemplates doing so is strongly advised to join the Avicultural Society and the British Aviculturalists' Club. The Society's Magazine and the Club's meetings will give him authorative information on the subject and useful contacts with others aviculturists.

THE WILDFOWL TRUST

BALANCE SHEET, 31st DECEMBER, 1959

LIABILITIES

1958		£ s. d.	£ s. d.
	Sundry Creditors :-		
11943	On Open Accounts		7519 4 1
	Westminster Bank Limited :-		
1157	Overdraft		— — —
	Loan Accounts :-		
11503	Balance, 31st December, 1958 ..	11312 13 10	
—	**Add** Further Advance	4000 0 0	
		15312 13 10	
190	Less Repaid	2650 0 0	
11313			12662 13 10
	Reserve Account :-		
2000	Balance, 31st December, 1958 ..	2000 0 0	
—	**Add** Transfer from Income and Expenditure Account	3000 0 0	
2000			5000 0 0
	Income and Expenditure Account :-		
4992	Balance, 31st December, 1958 ..	4885 13 1	
106	**Add** Excess of Income over Expenditure for the year	159 13 8	
4886			5045 6 9

ASSETS

1958		£ s. d.	£ s. d.
	Cash :-		
133	In Hand		104 5 4
—	At Westminster Bank Ltd., Deposit Account	2000 0 0	
—	**Less** Overdraft do. Current Account	1115 2 10	
			884 17 2
61	At Lloyds Bank Ltd., Current Account		21 19 3
194			1011 1 9
989	**Sundry Debtors and Payments in Advance**		1091 11 8
	Valuation (as valued by the Honorary Director).		
	Membership and Administration :-		
300	Equipment	300 0 0	
	New Grounds and Peakirk :-		
8500	Wildfowl	8500 0 0	
785	Transport	580 0 0	
3252	Breeding Equipm't. etc.	2872 0 0	
540	Hostel Equipment ..	540 0 0	
13077		12492 0 0	
	Gate Houses :-		
4930	Stock for re-sale	4521 0 0	
	Scientific and Educational :-		
765	Equipment	740 0 0	
2300	**Longaston House**	2300 0 0	
21372			20353 0 0

		Narrow Boat :-			
		Valuation, 31st December, 1951 ..		1000 0 0	
		Less Rents to 31st December, 1958 ..	625 0 0		
		Rents in year ended 31st December, 1959	375 0 0		
				1000 0 0	
375					
		New Buildings, etc., New Grounds, Slimbridge, Glos.			
		Amount, 31st December, 1958 ..		11362 13 10	
		Less Written off to 31st December, 1958 ..	2993 6 4		
		Written off in year ended 31st December, 1959	597 16 3		
				3591 2 7	
8369					7771 11 3
		NOTE :-The New Buildings, etc. to be written off over a period not exceeding that of the lease.			
31299					£30227 4 8

NOTE :-The Narrow Boat was hired from the Trust under an agreement, with an option to purchase for ten shillings after rents amounting to £1.000 had been paid.

We have examined the above Balance Sheet of the Wildfowl Trust, dated 31st December, 1959, 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 information and explanations given to us.

STROUD, Gloucestershire.

29th March, 1960.

S. J. DUDBRIDGE & SONS,

Auditors.

THE WILDFOWL TRUST

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1959

EXPENDITURE

1958		£ s. d.	£ s. d.
	To Membership and Administration :-		
2390	Salaries and National Insurance ..	2699 14 11	
212	Travelling	268 18 7	
644	Office Expenses, Postages, etc. ..	754 6 4	
1178	Printing and Stationery, General ..	1072 7 7	
497	Telephone	511 10 9	
249	Bank Charges, less Interest earned	276 10 1	
2792	Printing Annual Report	2409 7 6	
100	Expenses of Annual Dinner ..	458 9 6	
335	Miscellaneous	390 9 9	
8397			8841 15 0
	New Grounds and Peakirk :-		
7239	Salaries, Wages & National Insurance	8023 18 9	
649	Travelling	522 1 4	
2708	Purchases and Transport of Wildfowl and Eggs	1417 7 9	
4815	Food for Wildfowl	5976 2 8	
583	Rent, Rates, Water Rates and Insurance	1082 14 8	
1473	Materials, Repairs and Replacements	1559 4 5	
693	Transport & Mechanical Equipment and Maintenance	711 6 9	
822	Fuel and Power	954 2 3	
82	Hatching Expenses	143 8 10	
926	Hostel Upkeep	911 0 11	
645	Miscellaneous	766 14 6	
20635			22068 2 10
	Gate Houses :-		
7878	Purchases for resale	10611 4 9	
5974	Purchases Coloured Key Publications	— — —	
—	Royalties, Coloured Key Publications	982 10 0	
1888	Salaries, Wages & National Insurance	1886 5 8	
15740			13480 0 5

INCOME

1958		£ s. d.	£ s. d.
	By Membership :-		
7228	Subscriptions, Ordinary	7343 14 4	
217	Subscriptions, Life Members ..	456 15 0	
1181	Donations	744 13 1	
265	Receipts from Sale of Annual Reports	263 11 9	
113	Receipts from Annual Dinner ..	450 4 6	
—	Income Tax repaid on Covenants ..	2128 8 10	
9004			11387 7 6
	New Grounds and Peakirk :-		
20300	Gate Takings	22394 1 6	
2926	Sales of Surplus Wildfowl ..	2763 3 10	
23226			25157 5 4
	Gate Houses :-		
14100	Sales, General	15320 18 4	
2083	Sales, Coloured Key Publications ..	1707 0 4	
16183			17027 18 8
	Scientific and Educational :-		
5875	The Nature Conservancy Grant ..	7367 10 0	
530	Nuffield Foundation Grant ..	132 10 0	
900	Bristol Zoo Grant	250 0 0	
263	Donations from Abberton Ringing Station	262 10 0	
411	Duck Adoption	508 13 0	
116	Fees and Collections from Lectures	100 0 0	
8095			8621 3 0
—	Sale of Narrow Boat		10 0

	Scientific and Educational :-							
5964	Salaries and National Insurance ..				6094	7	10	
519	Travelling				571	10	2	
577	Rocket Netting				502	12	4	
881	Abberton Ringing Station				880	7	2	
29	Orielton Ringing Station				64	10	0	
540	Borough Fen Decoy				847	17	6	
138	Wildfowl Counts				103	12	0	
759	Equipment and Maintenance ..				858	10	0	
1312	Aerial Survey				1467	16	10	
10719								11391 3 10
	Capital Expenditure :-							
275	Peakirk Development				—	—	—	
	New Grounds :-							
180	Hostel Equipment ..	59	8	0				
1746	New Area Development and Aviary ..	833	10	6				
—	Quarantine	97	3	2				
715	Gate House Extension	85	18	1				
249	Equipment	—	—	—				
257	Gazebo	—	—	—				
774	Transport	—	—	—				
3921					1075	19	9	
	Scientific and Educational :-							
328	Coloured Film ..	63	6	9				
136	Equipment	443	17	0				
200	Building Conversion ..	—	—	—				
121	Tape Recorder ..	—	—	—				
56	Wildfowl Counts ..	—	—	—				
106	Trapping Equipment ..	—	—	—				
947					507	3	9	
	Longaston House :-							
863	Expended thereon				53	9	0	
6006								1636 12 6
61497	**TOTAL EXPENDITURE FOR THE YEAR** ..							57417 14 7
15891	Valuation, 31st December, 1958							21372 0 0
598	Written off Buildings							597 16 3
—	Transfer to Reserve Account							3000 0 0
—	Balance, Excess of Income over Expenditure for the year							159 13 8
77986								£82547 4 6

21372	Valuation, 31st December, 1959		20353	0 0
106	Balance, Excess of Expenditure over Income for the year		—	— —
77986			£82547	4 6

NOTE:-The figures in the margin are those for the year ended 31st December, 1958 and are given for the purpose of comparison only.

PHOTOGRAPHS

The Trust is greatly indebted to the following for permission to reproduce the photographs they have taken: Dr. Francis H. Fay, Dr. P. A. Johnsgard, Miss P. Talbot-Ponsonby.

Two members of the staff—Dr. J. V. Beer and Dr. S. K. Eltringham—have also provided illustrations.