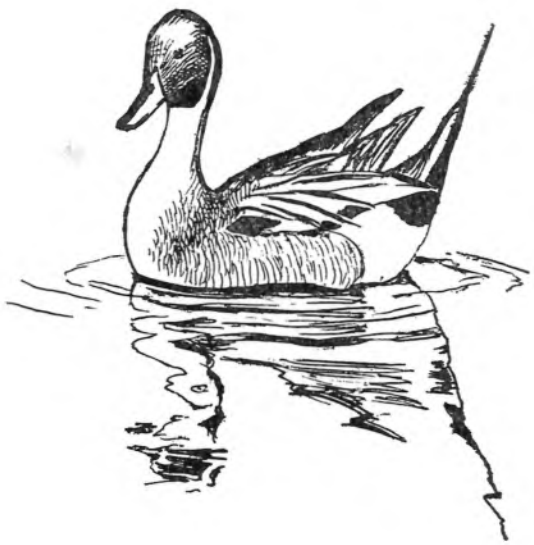

The fifteenth Annual Report of

The Wildfowl Trust

Edited by Hugh Boyd
Illustrated by Peter Scott

17/6

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The Wildfowl Trust

Patron HER MAJESTY THE QUEEN

President H.R.H. 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, G.C.B., D.S.O., M.B.E., A.D.C.
Sir Percy Lister

Trustees
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O.
The Rt. Hon. the Earl of Mansfield

Hon. Treasurer Guy Benson

Hon. Director Peter Scott, C.B.E., D.S.C., LL.D.

Council

John Berkeley	K. Miller Jones (F)
Dr. Bruce Campbell (S)	Christopher Marler
Michael Crichton (F)	E. A. Maxwell
H. H. Davis	R. E. M. Pilcher (S)
J. O. Death (F)	Dr. G. W. Storey (S)
H. C. Drayton (F)	Miss P. Talbot Ponsonby (F)
Capt. J. A. Fergusson-Cunninghame	Major General C. B. Wainwright, C.B. (S)
J. J. Jamieson (F)	J. P. Williams
G. M. Jolliffe	

Invited to attend Council Meetings ex officio
Sir Landsborough Thomson, C.B., O.B.E., D.SC., LL.D. (*Chairman of Scientific Advisory Committee*)
A. G. Hurrell (*Ministry of Education Assessor*)

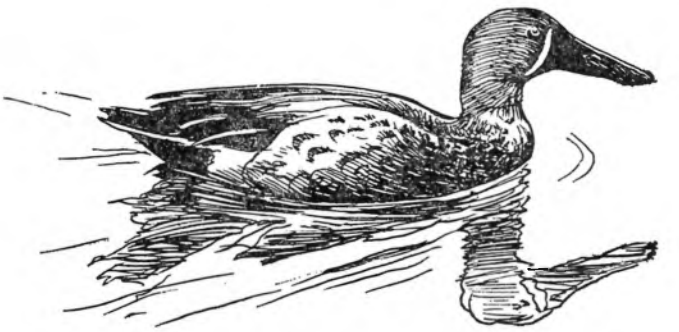
(*F*) *Member of Finance Committee*
(*S*) *Member of Scientific Advisory Committee*

Scientific Advisory Committee
Those indicated above and:

Dr. A. J. Cain	Dr. R. A. Hinde
R. K. Cornwallis	R. C. Homes
Dr. H. D. Crofton	Sir Julian Huxley, F.R.S.
Dr. J. H. Crook	Dr. A. R. Jennings
Dr. G. M. Dunnet	Dr. L. Harrison Matthews, F.R.S.
Prof. K. R. L. Hall	
Prof. J. E. Harris, F.R.S.	R. E. Moreau
Dr. J. G. Harrison	Dr. W. H. Thorpe, F.R.S.

Finance Committee
Those indicated above and:

James Fisher	R. C. P. Hollond



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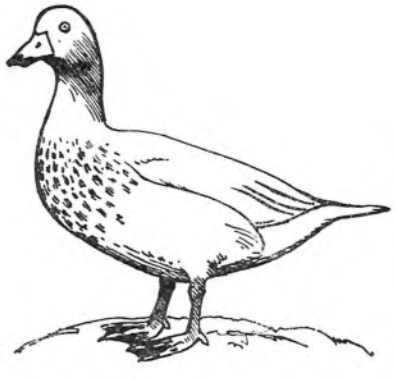
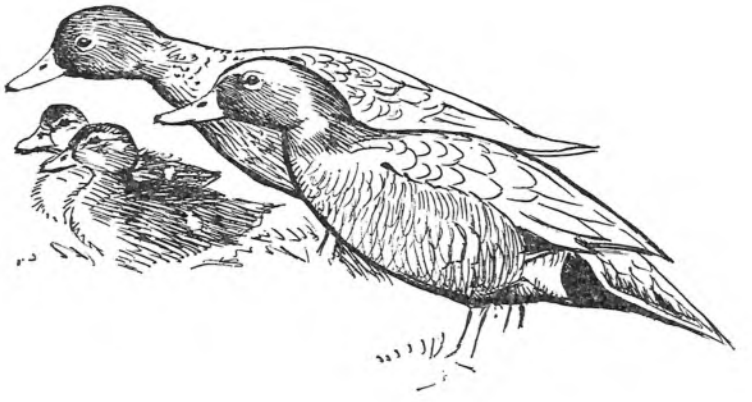


Blue Duck



Section 1

Annual Report 1962-63

Royal Visits

In 1963 the Trust was honoured by two visits by its President, His Royal Highness, The Duke of Edinburgh. He came to Slimbridge on 5th April, inspected the laboratories in the evening and stayed the night in the Hon. Director's house and on the following morning made a tour of the collection before taking the Chair at a meeting of the Council. On 31st May he visited Peakirk and after a picnic lunch at Borough Fen Decoy made a tour of the Waterfowl Gardens in the afternoon before departing by helicopter.

Council and Committees

The Officers, Council and Committees of the Trust, as at 31st December, 1963 are shown on page 2. Council meetings were held in 1963 on 6th April at Slimbridge and on 20th May, 18th July and 23rd October in London. The Finance Committee met on 27th March, 2nd July, 9th October and 18th December. The annual meeting of the Scientific Advisory Committee was held on 5th April.

Annual General Meeting and Dinner

The Sixteenth Annual General Meeting was held at the Royal Society of Arts on 20th May, and the Annual Dinner took place at the Park Lane Hotel the same evening. His Royal Highness, The Duke of Edinburgh, was in the Chair at the Annual General Meeting and presided and proposed the health of the Trust at the Dinner. Other speakers at the Dinner were Mr. Peter Scott, C.B.E., D.S.C., LL.D., Sir Julian Huxley, F.R.S., and Sir Compton Mackenzie, O.B.E., LL.D. The minutes of the Annual General Meeting will be found on page 6.

Exhibitions

The Trust had a display at the Observer Wildlife Exhibition in London during National Nature Week from 17th to 25th May, 1963 of which the central feature was a representation of one of the Trust's Observation Hides, from which visitors could view a series of stereoscopic photographs of wildfowl taken from the hides at Slimbridge.

The Trust also had an exhibit again at the Game Fair, which was held at Burghley Park, Stamford, on 26th and 27th July.

Identification Competition

A Wildfowl Identification Competition for Schools was held at the New Grounds on 23rd February and in spite of very bad

weather 56 boys and girls from 14 schools took part. Monmouth School won a very close contest with Leighton Park "A" second and Winchester "A" third.

Borough Fen Decoy

Thanks to the efforts of Mr. and Mrs. R. E. M. Pilcher the duck decoy at Borough Fen was open to visitors on the afternoons of 25th and 26th May and 27th and 28th July.

Gosling Party

The annual party for Gosling members was held on 21st December, 1963. David Attenborough talked and showed films to an enthusiastic audience of about 200.

Members' Collections

During the year the following members kindly showed their collections of waterfowl to fellow members of the Trust: Arthur Cadman, T. Curtis, J. O. Death, A. W. E. Fletcher, R. Law, Miss E. Manasseh, E. A. Maxwell, Mrs. B. Michell, Mrs. C. Mumford, F. W. Perowne, R. E. M. Pilcher, G. R. Pryor, G. L. Reid, E. O. Squire, R. J. Stainsby, Noel Stevens, Mrs. T. V. Upton, Mark Vinson, J. P. Williams, D. Wintle.

Visitors

As is shown by the following figures there was a drop in the number of visitors to the Trust's collections in 1963: but it is not possible to say how much this was due to the bad weather and to what extent it resulted from the increased admission charges which were introduced on 1st January, 1963.

	1960	1961	1962	1963
Slimbridge	102,555	151,533	162,030	130,143
Peakirk	26,531	33,203	30,982	29,434
	129,086	184,736	193,012	159,577

Staff

Mr. H. G. Gower retired in September, 1963 after eight years service with the Trust and his place as Bursar was taken by Sqn. Ldr. J. R. Branford-White.

Mr. Noel Dudley, the Curator at Peakirk since 1959, left the Trust on 1st September 1963 and Mr. Frank Reitz moved from Slimbridge to Peakirk to take his place.

Finance

In 1962 expenditure exceeded income by £6,431 and although this was to some extent offset by an increase in the value of gatehouse stocks, it was clear that an increase of income was essential to meet rising costs. The Council therefore decided on the increases in the charges for admission which were announced in the Fourteenth Annual Report. As a result of the over-expenditure in 1962 the Trust's overdraft reached an unprecedented size in March 1963: but the situation was saved by a magnificent donation of £5,000, from an anonymous source, for which the Trust is profoundly grateful. Apart from this the income in 1963 as a result of the new admission charges exceeded expenditure by some £6,000 and this will enable the Trust to repay some of its outstanding loans, which on 31st December, 1963 still amounted to over £14,500.

Minutes of the Sixteenth Annual General Meeting

1. The Sixteenth Annual General Meeting of The Wildfowl Trust was held at The Royal Society of Arts, John Adam Street, London WC2, on Monday 20th May, 1963, at 5.00 p.m.

2. The following Officers and Council Members and 57 Members of The Wildfowl Trust were present:

H.R.H. The Prince Philip, Duke of Edinburgh, K.G., K.T., *President*
The Rt. Hon. the Lord Howick of Glendale, G.C.M.G., K.C.V.O., *Vice-President*
Peter Scott, Esq., C.B.E., D.S.C., LL.D., *Hon. Director*
Guy Benson, Esq., *Hon. Treasurer*
Michael Crichton, Esq.
J. O. Death, Esq.
Captain J. A. Fergusson-Cunninghame
G. M. Jolliffe, Esq.
K. Miller Jones, Esq.
R. E. M. Pilcher, Esq.
Dr. G. W. Storey
Miss P. Talbot-Ponsonby
Major General C. B. Wainwright, C.B.

3. Apologies for absence were received from:

His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O., *Trustee*
The Rt. Hon. The Earl of Mansfield, *Trustee*
General Sir Gerald Lathbury, G.C.B., D.S.O., M.B.E., A.D.C., *Vice-President*
Captain R. G. W. Berkeley, *Vice-President*

Sir Percy Lister, *Vice-President*
John Berkeley, Esq., *Council Member*
Dr. Bruce Campbell, *Council Member*
H. H. Davis, Esq., *Council Member*
Sir Landsborough Thomson, C.B., O.B.E., *Council Member*

4. The Minutes of the Fifteenth Annual General Meeting previously circulated with the Agenda were taken as read and signed by the President.

5. The Hon. Director gave a brief account of the year's activities at Slimbridge and Peakirk after which he moved the adoption of the Report of Council. This was seconded by Mr. T. L. Outhwaite, and carried unanimously.

6. The Hon. Treasurer proposed the adoption of the accounts for the year ending 31st December, 1962. The motion was seconded by Mr. J. O. Death and carried unanimously.

7. Mr. K. Miller Jones proposed and Mr. Q. T. P. M. Riley seconded a resolution approved by Council altering the wording of Rule 7 (5) by substituting 'March' for 'November' in line 7, and ratifying the Council's action in authorising the Secretary to accept nominations up to 1st March 1963. The motion was carried unanimously.

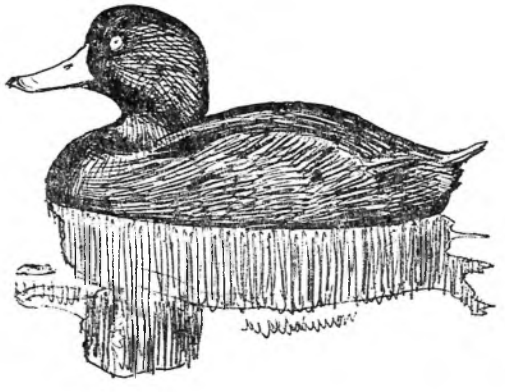
8. The following Councillors retired under Rule 13 (1):
H. H. Davis, Esq.
K. Miller Jones, Esq.
R. E. M. Pilcher, Esq.
Miss P. Talbot-Ponsonby

Five candidates were nominated to fill the vacancies and the following were elected by ballot:
Christopher Marler, Esq.
E. A. Maxwell, Esq.
Michael Crichton, Esq.
J. P. Williams, Esq.

9. Mr. H. K. Hallam proposed the election of Officers for the ensuing year. The motion was seconded by Mr. C. A. Norris and the following were elected unanimously:
H.R.H. The Prince Philip, Duke of Edinburgh, K.G., K.T., *President*
Captain R. G. W. Berkeley, *Vice-President*
The Rt. Hon. The Lord Howick of Glendale, G.C.M.G., K.C.V.O., *Vice-President*
General Sir Gerald Lathbury, G.C.B., D.S.O., M.B.E., A.D.C., *Vice-President*
Sir Percy Lister, *Vice-President*
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O., *Trustee*
The Rt. Hon. the Earl of Mansfield, *Trustee*
Peter Scott, Esq., C.B.E., D.S.C., LL.D., *Hon. Director*
Guy Benson, Esq., *Hon. Treasurer*

10. The Hon. Treasurer proposed that Messrs. S. J. Dudbridge and Sons of Stroud, Gloucestershire, be re-appointed Auditors to The Wildfowl Trust for the ensuing year pursuant to Rule 19 (1). Mr. J. O. Death seconded the motion which was carried unanimously.

11. The business of the meeting was concluded at 5.30 p.m. and followed by an illustrated talk by Mr. Scott on species threatened with extinction.



THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1962

	EXPENDITURE	£ s. d.	£ s. d.		INCOME	£ s. d.	£ s. d.
	To Administration:				**By Membership:**		
4810	Salaries and Superannuation	5334 17 10		*8241*	Subscriptions, Ordinary	8521 13 0	
406	Travelling	234 0 11		*1280*	Subscriptions, Life Members	420 0 0	
2495	Postages, Telephone and Miscellaneous Expenses	2564 3 2		*3925*	Donations	1886 13 7	
2015	Printing and Stationery	1788 1 6		*362*	Receipts from Sale of Annual Reports	316 0 4	
614	Loan Interest	564 10 0		*640*	Receipts from Annual Dinner	350 2 6	
164	Bank Charges less interest earned	282 4 6		*3457*	Income Tax repaid on Covenants	1921 16 10	
2191	Printing Annual Report	2596 1 6					
586	Expenses of Annual Dinner	315 9 2					
1346	Advertising	1664 11 0					
14627			15343 19 7	*17905*			13416 6 3
	New Grounds and Peakirk:				**New Grounds and Peakirk:**		
10864	Salaries, Wages and Superannuation	10730 2 6		*25846*	Gate Takings	27272 1 0	
332	Travelling	760 1 0		*4583*	Sales of Surplus Wildfowl	3866 9 9	
4041	Purchases and Transport of Wildfowl and Eggs	2562 2 9					
6214	Food for Wildfowl	7243 2 0					
861	Rent, Rates, Water Rates and Insurance	894 16 5					
2984	Materials, Repairs and Replacements	2582 9 10					
1116	Transport and Mechanical Equipment and Maintenance	902 12 10					
1060	Fuel and Power	1491 2 9					
204	Hostel Upkeep	753 11 5					
992	Miscellaneous	855 0 4					
28668			28775 1 10	*30429*			31138 10 9
	Gate Houses:				**Gate Houses:**		
15727	Purchases for re-sale	17278 11 7		*20025*	Sales, General	21996 18 10	
—	Printing 2nd Edition of Coloured Key	4147 14 7		*2283*	Sales, Coloured Key Publications	2726 9 11	
574	Royalties Coloured Key Publications	697 11 6					
2416	Salaries, Wages and Superannuation	2957 10 4					
18717			25081 8 0	*22308*			24723 8 9

	Scientific and Educational:					
10071	Salaries and Superannuation			9991 11 9		
4237	Travel and Miscellaneous Research Expenditure			3366 5 11		
1115	Abberton Ringing Station			1068 4 1		
906	Borough Fen Decoy			927 13 9		
16329					15353 15 6	
	Capital Expenditure:					
	New Grounds and Peakirk:					
	Restaurant					
	Expended during year	5560 6 4				
	Less Contributions received	5362 10 0				
—		197 16 4				
620	Development	362 7 1				
206	Gate House Extension	303 9 2				
411	Equipment	425 9 2				
100	Lavatories	1805 15 11				
—	New Water Supply	1060 0 0				
1337					4154 17 8	
	Scientific and Educational					
125	Equipment			— — —		
	Properties					
555	Patch Farm, expended thereon			— — —		
2017					4154 17 8	
80358	To **TOTAL EXPENDITURE FOR THE YEAR**				88709 2 7	
17321	Valuation, 31st December, 1961				19750 0 0	
598	Written off Buildings				597 16 3	
4777	Balance, carried down				— — —	
103054					£109056 18 10	
—	To Balance for year to 31st December, 1962 brought down				2214 5 0	
4800	Transfer to Accumulated Fund				— — —	
39	Balance, 31st December, 1962				— — —	
4839					£2214 5 0	

	Scientific and Educational:					
11863	The Nature Conservancy Grant			12120 15 0		
263	Donation from Abberton Ringing Station			315 0 0		
436	Duck Adoption			463 13 1		
100	Donations for Research			100 0 0		
12662					12999 8 1	
83304	By **TOTAL INCOME FOR THE YEAR**				82277 13 10	
19750	Valuation, 31st December 1962				24565 0 0	
—	Balance, carried down				2214 5 0	
103054					£109056 18 10	
62	By Balance, 31st December 1961				38 19 8	
4777	Balance for year to 31st December 1962, brought down				— — —	
—	Balance, 31st December 1962				2175 5 4	
4839					£2214 5 0	

NOTE.—The figures in the margin are those for the year ended 31st December 1961 and are given for the purpose of comparison

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE
BALANCE SHEET, 31st DECEMBER, 1962

	LIABILITIES	£ s. d.	£ s. d.
12148	**Sundry Creditors**		12502 10 7
	Peterborough Provincial Benefit Building Society:		
	Balance, 31st December 1961	1560 12 5	
	Less Repaid during year	26 10 5	
1561			1534 2 0
	Loan Accounts:		
	Balance, 31st December 1961	12362 13 10	
	Add Further Advance	3800 0 0	
		16162 13 10	
	Less Repaid during year	1650 0 0	
12363			14512 13 10
	Research Centre Fund:		
	Donations during year	5000 0 0	
	Add Interest Received on Deposit per contra	72 19 2	
—			5072 19 2
	Accumulated Fund:		
15700	Balance, 31st December 1961	15700 0 0	
39	Less Income and Expenditure Account, Balance per Account	2175 5 4	
			13524 14 8
41811			£47147 0 3

	ASSETS	£ s. d.	£ s. d.	£ s. d.
5561	**Cash at Bankers and in Hand**			293 19 11
—	**Cash on Deposit re Research Centre Fund**			5014 11 9
1000	**Investment at Cost (Market Value £1,000)**			999 15 0
1738	**Sundry Debtors and Payments in Advance**			3110 0 8
	Valuation (as valued by the Honorary Director).			
	Membership and Administration:			
500	Equipment		450 0 0	
	New Grounds and Peakirk:			
9400	Wildfowl	8900 0 0		
710	Transport	1060 0 0		
3465	Miscellaneous Equipment	4010 0 0		
325	Hostel and Restaurant Equipment	735 0 0		
13900			14705 0 0	
	Gate Houses:			
3350	Stock for re-sale	5110 0 0		
—	Coloured Keys	2300 0 0		
			7410 0 0	
	Scientific and Educational:			
2000	Equipment		2000 0 0	
19750				24565 0 0
	Freehold Properties:			
7186	Amount, 31st December 1961, at Cost or Valuation			7185 10 5
	NOTE.—The freehold Properties are vested in The Wildfowl Trust (Holdings) Ltd.			
	New Buildings, New Grounds, Slimbridge, Gloucestershire:			
	Amount, 31st December 1961		11362 13 10	
	Less Written off to 31st December 1961	4786 15 1		
	Written off in year ended 31st December 1962	597 16 3		
			5384 11 4	
6576				5978 2 6
	NOTE.—The New Buildings, etc., to be written off over a period not exceeding that of the Lease.			
41811				£47147 0 3

We have examined the above Balance Sheet of the Wildfowl Trust dated 31st December, 1962, 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.
6th April, 1963

S. J. DUDBRIDGE & SONS,
Auditors.

MEMBERSHIP

There was a substantial increase in Membership, particularly in Junior Membership, during 1963 as indicated by the following table:

Class of Membership	1 Jan 1962	1 Jan 1963	1 Jan 1964
Life	298	299	304
Full	3360	3423	3584
Associate & Parish	1704	1764	2039
Junior Compounded	6	9	10
Gosling	296	285	759
Corporate	88	107	101
Contributors	34	32	42
	5786	5919	6839

CLASSES OF MEMBERS

Life Members: Fifty guineas. 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. 2. 0d. Entitled to free access to pens and observation huts at the New Grounds and at Peakirk, with one free guest, to one free copy of the Annual Report and of all Bulletins and to attend and vote at General Meetings.

Junior Compounded Members: Only persons under 21. One payment of £10. 10. 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. 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. Admission to the Trust's collections for Corporate Members is on payment for each member of the party of the entrance fee in force at the time of the visit. Members of corporate bodies in parties of not less than 10 nor more than 35 are entitled at times previously arranged with the Gate Houses to a conducted tour of the enclosures at the New Grounds or at Peakirk and to access to the observation hides at the New Grounds in the company of a warden. One free Annual Report, one copy of all Bulletins.

Contributors: Organisations, institutions and establishments which do not qualify for corporate membership, may become Contributors by subscribing not less than one guinea a year. Contributors receive one copy of the Annual Report and of every Bulletin.

General Public: The grounds are open to the public daily (excepting Christmas Day). Visitors are admitted from 9.30 on weekdays (from 12 noon on Sundays) up to 6.30 p.m. during the period of Summer Time and up to half-an-hour before sunset during the rest of the year. Sunday mornings are reserved for members. Charges for admission: Slimbridge – adults 5/-, children under 16 3/-; Peakirk – adults 3/6d., children under 16 1/6d.

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 Council has learned with regret of the death of the following Members and Associates, notified since the last issue of the Report:

Sir Cecil Armitage, C.B.E., D.L.
Lt.-Col. N. R. Blockley
Mrs. A. Booth
A. W. Botham
Lt.-Col. Barwick Browne, F.S.A.
C. Budenberg
Major-General Lord Burnham, C.B., D.S.O., M.C.
Lady Ethel Carpenter
Lt.-General Sir Adrian Carton de Wiart, V.C., K.B.E., C.B., C.M.G., D.S.O.
Lady Clarke
G. R. Cobb
P. Crewe
E. Crisp
R. Dodd
F. L. Felton
Col. F. W. Wilson Fitzgerald
Miss M. C. Foster
Major A. J. Fraser
Dr. D. M. M. Fraser

Obituary—continued

Miss E. A. Garden
Miss H. L. Gjers
Miss N. M. Gray
Sir Charles Hambro, K.B.E., M.C.
Mrs. H. S. Huxley
E. C. Layton
A. R. Loaring
P. H. Martin
Mrs. M. Maw
The Very Rev. E. Milner-White, C.B.E., D.S.O.
F. G. Mitchell
J. M. Oakey
Mrs. V. Osborne
Miss E. L. Pagan
E. W. Player
Mrs. Valentine Powell
Sir Harry Railing
Lady Margaret Sackville
J. W. Sampson
D. Seth-Smith
J. Swinfen-Cottrell
Admiral Sir William Tennant, K.C.B., C.B.E., M.V.O.
Mrs. N. A. Vaughan
M. Vinson
Miss O. Vlasto
Sir Hereward Wake, Bt., C.B., C.M.G., D.S.O.
Dr. Agnes E. Westwood
Miss I. E. Wilson

The Collections in 1963

S. T. JOHNSTONE

The long spell of severe weather at the beginning of the year brought about the deaths of some 9% of the collection at Slimbridge (see p. 50). The limited heating accommodation was crowded with the more delicate waterfowl, and those that were taken in at the start of the cold spell survived very well but those that were caught up as the Arctic conditions continued suffered heavy losses. Cuban, Fulvous and Red-billed Whistling Duck were casualties. On the other hand, Javan, Spotted and White-faced Whistling Duck, which were given priority, came through without loss. A species that had heavy losses was the North American Ruddy Duck. In the autumn there had been twelve pairs in the Rushy Pen and some odd males. When the spring arrived these had been reduced to five females and eight males.

Two months of continuous frost varying between 10 and 29 degrees posed several problems. The rhine from which our main water supply is derived was frozen up so that no supply came from the main pump. Ice 18 inches thick was sawn out in blocks from the House pond. A submersible pump was lowered into the water and by this means the relatively warm water from the bottom of the pond was brought to the surface. Not only the residents of the Rushy Pen but large numbers of wild ducks took advantage of our efforts. The combined effort of the pump and swimming ducks kept the area free of ice.

The extreme cold delayed, of course, the nesting, and the first eggs were three weeks late. But once the weather broke the breeding season reached its peak very quickly. There was a record number of birds raised – over 1,300 at Slimbridge and 300 at Peakirk. 104 kinds nested and 96 kinds were reared. Andean Geese were reared for the first time, bringing the number of forms of waterfowl reared at Slimbridge to 123.

One factor contributing to the success of the breeding season was the operation of the new 'duckery'. Under the new scheme each brood of ducklings has clean water supplied direct from water bearing sand fifteen feet below ground. The water is fed to a small concrete pond in each pen and leaves by way of a drainage ditch. Some thirty pens are so supplied and by this means the possibility of waterborne infection from one brood to another is obviated. The layout enables a large number of ducklings to be fed and maintained with a minimum of effort.

The collection now contains some 2,250 birds of 160 kinds and races. Unfortunately the Black-headed Duck (*Heteronetta atricapilla*) is no longer represented. The male, the only one in Europe, that had been here for five years, died during the cold weather.

Interesting arrivals have been additions to the Greater, Cuban and Chilean Flamingos, and a male Bronze-winged Duck for our tame female – it is hoped that having laid eggs for the last four years, she will do so again this year and that the eggs will be fertile. We have exchanged one of our two female Buffleheads for a male and this delightful little bird can be seen on the House pond in the Rushy Pen.

Breeding Results 1963: Slimbridge

	date of first egg	*eggs*	*reared artificially*		*reared by parents*		*Total reared*
			hatched	*reared*	*hatched*	*reared*	
Magpie Goose	22.6	8	1	1	4	3	4
Fulvous Whistling Duck	20.4	10	3	3	29	22	25
Red-billed Whistling Duck	30.4	10			24	8	8
Black-necked Swan	10.3	2	1	1	3	2	3
Swan Goose	2.4	23	5	5			5
Western Bean Goose	24.4	2	2	2			2
Russian Bean Goose	27.4	10	4	2			2
Pink-footed Goose	25.4	21	2	2			2
Greenland White-fronted Goose	19.4	16	2	1			1
Lesser White-fronted Goose	25.4	20	3	3			3
Western Greylag Goose	4.4	17	9	9			9
Eastern Greylag Goose	20.3				4	4	4
Bar-headed Goose	6.4	19	6	4			4
Emperor Goose	29.4	59	26	15			15
Lesser Snow and Blue Goose	21.4	46	12	8			8
Greater Snow Goose	25.4	39	14	14	5	3	17
Ross's Goose	5.5	30	10	6			6
Atlantic Canada Goose (*B.c. canadensis*)	23.3	18	13	13			13
Giant Canada Goose (*B.c. maxima*)	1.4				7	7	7
Manitoba Canada Goose (subsp.?)	27.3	13	8	7			7
Taverner's Canada Goose (*B.c. taverneri*)	10.4	7	3	1			1
Dusky Canada Goose (*B.c. occidentalis*)	7.4	6			2	2	2
Hawaiian Goose	27.3	120	20	16			16
Barnacle Goose	28.4	25	18	14	20	17	31
Black Brant	17.5	17	12	11			11
Red-breasted Goose	28.5	16	8	6			6
Cape Shelduck	12.3	8	7	7			7
Common Shelduck	12.5	15	9	9	5		9
Egyptian Goose	19.3	10	5	5	13	13	18
Abyssinian Blue-winged Goose	8.6	19	7	6			6
Andean Goose	10.6	5	2	1	3	2	3
Ashy-headed Goose	7.4	13	4	2			2
Ruddy-headed Goose	9.4	5	3	1	4	1	2
Greater Magellan Goose	2.4	19	11	9	10	7	16
Lesser Magellan Goose	9.4	10	3	3	12	9	12
Cereopsis Goose	9.2	4	0		3	2	2
Andean Crested Duck	25.3	10	4	4			4
Marbled Teal	18.4	107	97	77			77
Cape Teal	19.4	23	26	13	12	8	24
Versicolor Teal	26.3	19	4	2			2
European Green-Winged Teal	10.5	11	5	2			2
Bahama Pintail		35	29	26			26
Chilean Pintail	13.4	20	14	14			14
Northern Pintail	27.4	19	14	14			14
Kerguelen Pintail	23.4	16	9	8			8
Chilean Teal	3.5	10	8	8			8
Sharp-winged Teal	11.4	10	2	2			2
Falcated Teal	30.5	14	4	4			4
Chestnut-breasted Teal	29.3	28	23	23			23
New Zealand Brown Teal	23.3	13	0		16	10	10
Laysan Teal	30.4	81	49	47			47
North American Black Duck	25.4	4	4	2			2
Indian Spotbill	3.5	4	3	3			3
Chinese Spotbill	19.4	23	22	22			22
New Zealand Grey Duck	26.4	25	25	25	7	5	30
Australian Black Duck	28.4	14	12	12			12
Philippine Duck	3.5	26	24	22			22

	date of first egg	*eggs*	*reared artificially hatched*	*reared artificially reared*	*reared by parents hatched*	*reared by parents reared*	*Total reared*
African Yellowbill	22.3	12	6	5			5
Abyssinian Yellowbill	11.6	12	10	8			8
African Black Duck	1.4	22	8	6			6
Gadwall	29.3	37	35	35	9	5	40
European Wigeon	26.4	56	44	44			44
American Wigeon	9.4	19	5	5			5
Chiloe Wigeon	19.4	48	30	18			18
Blue-winged Teal	11.5	17	16	15			15
Cinnamon Teal	10.4	12	5	1			5
Garganey	28.4	15	5	2			2
Red Shoveler	12.5	7	3	3			3
Cape Shoveler	2.6	14	7	6			6
Common Shoveler	28.4	54	42	41			41
New Zealand Shoveler	16.5	28	17	12			12
Ringed Teal	26.4	84	64	41			41
European Eider	30.5	9	5	5			5
King Eider	30.4	10	2	0			0
Red-crested Pochard	7.4	54	44	39			39
Rosy-bill	?	14	8	7			7
Southern Pochard	19.3	13	4	3			3
European Pochard	30.5	4	1	1			1
Redhead	24.5	10	10	8			8
Common White-eye	16.5	17	16	12			12
Australian White-eye	24.5	33	29	24			24
New Zealand Scaup	25.4	37	27	22			22
Tufted Duck	22.5	5	4	4			4
Lesser Scaup	9.5	28	24	22			22
Greater Scaup	31.5	16	6	6			6
Brazilian Teal	25.5	14	5	5			5
Mandarin Duck	12.4	77	64	51			51
North American Wood Duck	21.3	207	165	145			145
Hartlaub's Duck	1.7				12	4	4
Muscovy Duck	10.4	13	9	8	10	10	18
Common Scoter	imported	4	1	0			0
Barrow's Goldeneye	9.6	24	5	3			3
European Goldeneye	12.4	15	7	3			3
Smew	1.6	11	8	5			5
Red-breasted Merganser	imported	25	16	10			10
Ruddy Duck	24.5	9	4	1		10	20

In addition, the following ten forms laid eggs none of which hatched: Cuban Whistling Duck, Black Swan, Trumpeter Swan, European White-fronted Goose, Ruddy Shelduck, New Zealand Shelduck, Patagonian Crested Duck, Puna Teal, Australian Grey Teal, Spur-winged Goose.

Breeding Results 1963: Peakirk

	No. of breeding pairs	*No. of eggs laid*	*No. of eggs hatched*	*No. reared*
Black Swan	1	10	8	5
Black-necked Swan	1	5	2	1
Swan Goose	2	18	3	3
Pink-footed Goose	4	8	6	3
European White-fronted Goose	2	6	2	–
Lesser White-fronted Goose	2	14	6	6
Western Greylag Goose	4	25	21	21
Emperor Goose	2	3	3	2
Blue Snow Goose	3	9	3	3
Greater Snow Goose	1	5	1	–
Ross's Goose	2	5	5	–

	No. of breeding pairs	*No. of eggs laid*	*No. of eggs hatched*	*No. reared*
Taverner's Canada Goose	1	7	3	3
Cape Shelduck	1	6	6	6
Common Shelduck	5	19	13	13
Marbled Teal	4	18	10	6
Cape Teal	6	29	10	6
Puna Teal	2	19	12	1
Red-billed Pintail	1	6	6	6
Bahama Pintail	5	69	50	43
Northern Pintail	10	56	35	28
Falcated Teal	1	16	2	1
Chestnut-breasted Teal	6	28	12	12
Laysan Teal	2	20	12	8
North American Black Duck	1	17	4	4
Chinese Spotbill	2	30	10	8
New Zealand Grey Duck	1	6	6	6
Philippine Duck	2	8	8	7
African Black Duck	1	3	2	2
Gadwall	5	29	19	11
European Wigeon	9	32	12	12
American Wigeon	4	26	18	14
Blue-winged Teal	1	7	7	7
Cinnamon Teal	2	20	18	6
Garganey	2	7	5	5
New Zealand Shoveler	2	6	3	1
Common Shoveler	3	48	24	19
Red-crested Pochard	4	54	18	11
Rosybill	3	38	25	20
Redhead	1	19	13	13
Common White-eye	2	14	10	10
Australian White-eye	2	14	10	7
Tufted Duck	4	22	17	11
European Greater Scaup	2	12	5	3
Brazilian Teal	1	19	19	17
North American Wood Duck	5	35	11	9
Ruddy Duck	4	40	14	1

A total of 383 young birds of 44 species were reared. A further 8 species laid eggs which failed to hatch: Abyssinian Blue-winged Goose, Fulvous Whistling Duck, Hawaiian Goose, Barnacle Goose, Hawaiian Duck, Chiloe Wigeon, Ringed Teal, New Zealand Scaup.
Three hybrid ducks were also produced.

Ne-Ne Progress Report, 1963

1963 saw further improvements in the state of the known population of the Hawaiian Goose (*Branta sandvicensis* (Vigors)). The rearing programme at Slimbridge had another disappointing year, with only 20 goslings hatched and 16 reared from 120 eggs laid, but 54 goslings were reared at Pohakuloa in Hawaii. 42 of the Pohakuloa birds were released into sanctuaries on the Island of Hawaii, bringing the total released in the last four years to 129, very many of which appear to have survived in the wild state.

The 35 birds released on the Island of Maui in 1962 (see *14th Annual Report*, pp. 17-18) have also done well, though none are known to have bred in 1962-63. In the summer of 1963 a further 29 were released on Maui. 19 of these were sent from Slimbridge, 5 from the collection of Dr. Dillon Ripley in Connecticut and 5 from Pohakuloa. It is hoped to release another group of about the same size on Maui in 1964.

The distribution of the known stocks of Ne-Ne in January 1964 is set out in the following table:

The world population of the Hawaiian Goose in January, 1964

IN HAWAII: 250–300

50 in pens at Pohakuloa, 9 at Ainahou and 3 at Honolulu; *c.* 125 survivors from releases of full-winged birds on the Island of Hawaii; *c.* 60 survivors from releases of full-winged birds on the Island of Maui; an unknown number, perhaps 35-50, of wholly-wild birds on Hawaii.

IN ENGLAND: 84

68 at Slimbridge, 2 Peakirk, 2 Whipsnade Zoo, 2 London Zoo, 10 in private collections.

IN EUROPE: 22

2 Antwerp Zoo, 5 Basel Zoo, 2 Berlin Zoo, 4 Cleres, 2 Cologne Zoo, 4 Copenhagen Zoo, 3 Rotterdam Zoo.

IN NORTH AMERICA: 29

13 in the collection of Dr. Dillon Ripley; and 8 other pairs, in the collections of Mr. J. Kiracofe and Mr. K. Sather and in the zoos at Calgary, New York (Bronx), Philadelphia, Portland, San Diego and Washington.

WORLD TOTAL: 380 (to 430)

It is extremely difficult to make an accurate estimate of the numbers living in the wild state on Hawaii, because the geese live in country that is very hard to examine, but there seems no reason to believe that the stock of truly wild birds has fallen below the 35 seen by W. H. Elder in July 1957. Observations of banded geese have shown that some mixing of wild and of released birds has occurred on Hawaii, though the extent of this mixing has not yet been assessed.

The success of the release programme of the Department of Land and Natural Resources in Hawaii and the effective dispersion of the captive stocks elsewhere promise well for the survival of this threatened species, but anxiety will remain at least until some considerable improvement in the fertility of extra-Hawaiian stocks is achieved.

Research and Conservation

Recently there has been encouraging progress in the fostering of wildfowl conservation and research on a truly European scale. The preparation of papers and other documentation for a series of international conferences has occupied much of the Research Unit's time. In November 1962 the 'MAR' International Conference on Wetlands gathered at Stes. Maries de la Mer in the Camargue, S. France. One of the outcomes will be the publication of a List of European Wetlands, pin-pointing areas of importance, particularly to wildfowl, so that their relative importance can be assessed and steps taken to preserve them against drainage and other 'development' schemes. Mr. Olney, largely responsible for the British list, has been seconded to the International Wildfowl Research Bureau headquarters at La Tour du Valat, Camargue, to bring the data from the rest of Europe together. Another publication is an educational brochure stressing the importance of Wetlands to civilised Man, being prepared by Mr. Atkinson-Willes.

Then in October 1963 the International Union of Game Biologists met at Bournemouth to discuss the technical aspects of research and conservation. A tour of the main wildfowl areas in Scotland was followed by the First European Meeting on Wildfowl Conservation held in St. Andrews. Organised jointly by the I.W.R.B. and the Nature Conservancy, this conference was attended by representatives of all the relevant international organisations and of seventeen countries, many in the capacity of official Government Delegates. All aspects of the problem were dealt with in a determined invigorating and effective way. Again our staff was deeply involved in the conference itself and in carrying out its decisions. In particular it was fortunately possible to make available our new book 'Wildfowl in Great Britain' published by the Nature Conservancy as the third in their series of Monographs (Ed. G. L. Atkinson-Willes, H.M. Stationery Office, 45/-). Based particularly on the regular wildfowl counts and the ringing programme, but incorporating our other studies on wildfowl food and the relation of wildfowl to Man,

this book is a definitive outline of our knowledge of wildfowl populations and distribution in the country at the present time.

The excessively severe and prolonged cold spell, while hampering field activities to some extent, was seized as an opportunity to assess the effects of extreme conditions on wildfowl populations. The immediate effects are discussed in several papers in the Yearbook (p. 20-56), the longer-term consequences and the extent of recovery are one of our present pre-occupations. Such abnormal events stress the importance of the routine counting and marking programmes (p. 18). These take up a great deal of time without immediate spectacular results but provide the essential background knowledge for comparison.

In our population studies attention has been focused on the Greylag, partly because of the intrinsic interest of a completely closed yet migratory population, partly because of its undoubted increase in recent years and partly because of complaints from farmers, both in its Scottish wintering haunts and in the breeding areas in Iceland. Besides organising national censuses in November and in March, Mr. Boyd and Mr. Ogilvie went to Iceland in July to carry out an aerial census to establish the breeding distribution and numbers. Dr. Kear, following her study of the relationship between geese and agriculture in Scotland, was invited by the Icelandic Government to make a similar investigation in their country. The first stage involved a tour of all the farming areas of Iceland in September. Lastly, since relatively few Greylag had been ringed, the rocket-netting team returned to goose-catching for a fortnight in November 1963.

The exact effect of geese on cereal crops was further investigated by a series of grazing trials, using a small flock of hand-reared Greylags and Pinkfeet, at the Rosemaund Experimental Husbandry Farm near Hereford. Dr. Kear also carried the study of feeding behaviour back to first principles by examining the inborn preferences, for colour in the first instance, of newly hatched ducklings and goslings of forty species hatched at Slimbridge. The unrivalled opportunities for behaviour studies afforded by the Collection were also used by two visiting workers from Dr. Konrad Lorenz's team at Seewiesen, Wolfgang van der Wall and Helga Fischer. They were particularly concerned with the 'triumph' display and its presence or absence in geese and whistling ducks. Another worker coming from abroad to study our methods and use our facilities, Dr. Luc Schiess, University of Basle, arrived in August.

The orientation behaviour of Mallards was further investigated by Dr. Matthews, attention being focused on biological time-keeping mechanisms in relation to solar and lunar orientation. He gave an invited lecture at the International Zoological Congress at Washington and visited Harvard to advise and consult. Mr. Olney likewise attended the Congress with the help of American funds and took the opportunity to visit and work at the Ontario Waterfowl Research Foundation (p. 139) and the Patuxent Migratory Bird Research Station, Maryland. The orientation studies were made the subject of an exhibit presented at two Royal Society Conversaziones and at the Presidential Evening of the Linnean Society.

Routine post-mortem examination of birds dying in the Collection and elsewhere were continued by Dr. Beer (p. 40 and 50) and the reference collections of skins and other mortal remains were enriched. Ducks, waders and other birds caught by Mr. Cook at Borough Fen and on the Wash were examined for parasites by workers from the Medical Research Council. At Slimbridge Mr. R. A. Avery of Bristol University continued his doctorate studies on the dynamics of parasite populations within Mallard.

The composition of the Research Unit remained as listed in the 14th Annual Report. So largely did the array of several hundred voluntary observers on whose efforts we depend for much of our information. One gap in their ranks which will be particularly hard to fill resulted from the early death of Miss Betty Garden (p. 18, 77 and 93).

Finally, it is a pleasure to record that we continued to receive invaluable financial support from the Nature Conservancy.

Ringing, 1962-63

Ducks. 6,323 ducks were ringed by the Trust and its collaborators during the season 1962-63 (Table I). Though this was over 1,600 fewer than in 1961-62 it remains a very substantial contribution to scientific data about the ducks visiting Britain. Major-General C. B. Wainwright, C.B., had another successful season at Abberton, Essex, despite having to cease trapping during the cold weather of January and February, 1963. The Trust-operated decoys at Borough Fen and Slimbridge had good but in no way outstanding seasons. Messrs. C. A. and M. R. Boardman ringed 200 Mallard at Ludham, Norfolk, nearly all during the cold spell: early recoveries of these birds show that a very high proportion were immigrants. Trapping at Deeping Lake, Lincolnshire, has now ceased; the Trust is grateful to the late Mr. C. Dandridge and his sons for their efforts from 1954 to 1962.

Duck ringing in Scotland continued to be frustratingly difficult, though some valuable recoveries were obtained. Miss E. A. garden, who had worked hard and enthusiastically in Aberdeenshire since 1957, died after a long illness on 2nd September, 1963. Her loss is a serious blow to the Trust, for she had also acted as Scottish organiser for the Wildfowl Count scheme. Two records of her achievements will be found elsewhere in this Report: descriptions of successful patterns of duck- and swan-traps (at p. 93) and a summary of the recoveries so far reported of ducks ringed by her (at p. 77). The notable success of her traps on the Ythan estuary in catching diving ducks early in 1963 brought her great satisfaction. We are grateful to those of her friends who assisted in this work, especially Miss V. M. Thom, Mrs. L. S. Barrus and Mr. C. Young.

During 1963 Mrs. Barrus also began to operate traps at Loch Strathbeg, a major wildfowl haunt where a ringing station would be of great value. Most unfortunately Mrs. Barrus had to return unexpectedly to the U.S.A. in December 1963 and there is no immediate prospect of continuing trapping at the loch. Another regrettably short-lived trapping programme was that begun by Mr. R. H. Dennis in the Beauly Firth and on the shore east of Inverness in November 1962. Severe ice conditions damaged the traps and spoiled trapping. The appointment of Mr. Dennis as Warden of Fair Isle Observatory in September, 1963 has made it impossible for him to continue for another season and so take advantage of the experience so hardly won in his first season. Mr. D. R. Anderson continued trapping at Duddingston Loch, Midlothian, but he too was hampered by the hard winter.

Geese. On 2nd February, 1963, 316 Barnacle Geese were caught with a rocket-net near the Dumfriesshire shore of the Solway Firth. This first successful attempt at the mass-capture of Barnacle Geese in Britain is described at p. 75.

37 Canada Geese were ringed at Frampton Gravel Pits, Glos., on 28th June, 1963. A more important ringing of Canada Geese was achieved by a team organised by Mr. R. H. Dennis who succeeded in catching 39 moulting Canadas on the tidal waters of the Beauly Firth in July, 1963. This operation (described at p. 71) has provided striking evidence of a moult-migration from Yorkshire to the Beauly Firth, a most unexpected result.

Mr. Dennis trapped and ringed 2 Greylag Geese on the Beauly Firth in December, 1962. In July, 1963 a team led by Mr. John G. Young ringed 12 moulting Greylags in Wigtownshire.

No catch of White-fronted Geese could be made at Slimbridge in 1963.

A new rocket-net was generously presented to the Trust by British Nylon Spinners, Ltd., and has already seen service.

Swans. The Wildfowl Trust has continued to pay for all B.T.O. rings used on Mute Swans in the British Isles. Nearly 3,900 swan rings were issued in 1962 and a further 3,000 in 1963. The ringing effort is likely to diminish, if only because a very high proportion of trappable birds is now marked. Some results of Mute Swan ringing are discussed at p. 37.

Three Whooper Swans were ringed at Newburgh, Aberdeenshire, and one near Inverness during the winter of 1962-63. Attempts to catch large numbers elsewhere in north-east Scotland during the winter failed ignominiously.

Four wild Bewick's Swans were trapped and ringed at Slimbridge between January and April, 1963.

Waders. The Wildfowl Trust rocket-netting equipment was again used by the Wash Wader Ringing Group in August and September, 1963. 6,017 birds of 14 species were caught, including 329 recaptures, 18 of foreign-ringed birds. Though Dunlin remained the most numerous species taken (2,639 ringed), 2,457 Knot were ringed, much the largest number yet handled in Britain. 4 of these Knot were recovered in Senegal within six weeks, and another in

Table I. Ducks ringed 1962-63

Species	*Abberton Essex*	*Borough Fen Northants*	*Slimbridge Glos.*	*Ludham Norfolk*	*Scotland*	*Total 1962-63*	*Total 1961-62*
Shelduck	2				2	3	*46*
Pintail	10		32			42	*44*
Teal	1987	379	41		21	2428	*3052*
Mallard	386	1280	1574	200	38	3478	*4628*
Gadwall			1			1	*16*
Wigeon	2		1		46	49	*53*
Garganey	19	1				20	*8*
Shoveler	26	20	13			59	*65*
Eider					25	25	*5*
Pochard	14				1	15	11
Tufted Duck	48	1	1		124	174	*34*
Scaup	1				14	15	*14*
Goldeneye	1				12	13	*1*
	2496	1681	1663	200	283	6323	*7977*

Liberia (travelling about 3,500 miles in only 8 days), providing the first evidence of an onward passage of Knot from Britain to West Africa. Among the other species ringed, the total of 383 Grey Plover was notably high and that of only 12 Redshank remarkably low. Redshank had evidently suffered very severely in the early months of 1963 (see p. 23). The Trust and the W.W.R.G. were again greatly indebted to Group Captain R. Smyth-Pigott for financial support of wader-ringing in 1963.

Wild Geese at the New Grounds, 1962-63

European White-fronted Goose (*Anser albifrons albifrons* (Scopoli))

The first seen were seven on the late date of 11th October, 1962. There was an increase to 51 on 17th October and then a slow build-up to 330 on 14th December. Cold weather reached Holland in the week preceding Christmas before rapidly spreading to Britain and there were large influxes of geese to bring the total to 1,450 on 21st December and about 3,000 on 30th December. The geese left again during the first half of January and there were only 100 present on 16th. This dropped to 25 on 19th January and many of these were weak and allowed themselves to be picked up. Numbers remained at this very low level until the second week of February when a gradual return took place. 600 were counted on 9th and 1,450 on 17th February. By the end of the month there were about 3,000 again and this figure was maintained until 25th March when the main departure occurred. The last seen were 5 on 28th March.

Young birds were scarce this winter with the highest proportion of 20·0% early in the autumn, dropping to 13·3% in early December with an average brood-size of 3·2, and falling again at the end of the month to 9·2% with an average brood-size of 2·5. Counts made in late February and early March after the return of the geese gave a further reduction to 4·7% young birds and 1·9 average brood-size.

Greenland White-fronted Goose (*A. albifrons flavirostris* Dalgety & Scott)

A single bird of this race was seen on 21st December 1962.

For only the second winter since the Trust was formed, no Lesser White-fronted Geese (*Anser erythropus* (L.)) were seen at Slimbridge in 1962-63.

Bean Goose (*Anser fabalis* (Latham))

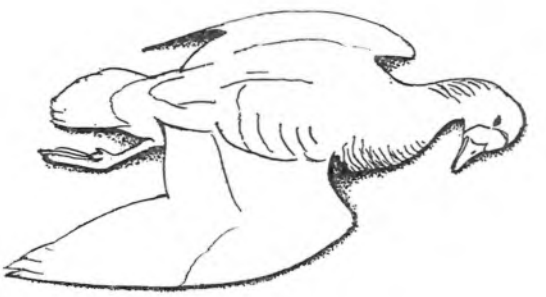
A party of 4 were seen on 28th February, 1963.

Pink-footed Goose (*Anser brachyrhynchus* (Baillon))

The first arrival in the autumn was quite early with 28 birds on 18th September, 1962. The total reached 54 on 21st October and there were 62, the maximum count, on 29th November. These stayed until the onset of the hard weather when they left abruptly, the last two being seen on 30th December. There was a single bird present on 27th February.

Barnacle Goose (*Branta leucopsis* (Bechstein))

Two were seen on 17th February and 3rd March, 1963.



Section 2

Effects of the cold winter of 1962-63 upon wildfowl in Britain

The exceptional severity of the weather in western Europe in the winter of 1962-63 aroused much concern for the welfare of birds as well as causing much attention to be paid to unusual occurrences. Though it is too early to measure the lasting consequences, if any, of this winter on wildfowl populations, it seems desirable to place on record some of the effects immediately apparent. The ten short papers which follow are chiefly concerned with reports upon those species which seemed to be affected by the cold weather, rather than with the larger number that showed few, if any, changes in abundance.

Wildfowl and other water-birds found dead in England and Wales in January-March 1963

HUGH BOYD

In appeals published in the journal *British Birds* and in the Bulletin of the Wildfowl Trust bird-watchers were asked to report details of all birds found dead during and after the exceptionally cold spell from late December, 1962, to early March, 1963. Over 70 informants recorded nearly 4,000 wildfowl and water-birds, of 34 species, as well as noting the occurrence of uncounted quantities of several of these species. Records from Scotland, where the winter was comparatively less severe, are being dealt with in *Scottish Birds*. Birds listed by R. E. M. Pilcher (p. 23) and J. Harrison and M. Hudson (p. 26) are included here.

The bodies found are listed by species and by month of finding, where known, in Table I. Six species of wildfowl (Mute Swan, Shelduck, Mallard, Wigeon, Tufted Duck, Black Scoter) and the Red-throated Diver, Great Crested Grebe, Moorhen and Coot are represented by more than 50 individuals each, suggesting pronounced vulnerability. Ten wildfowl species, two divers and two grebes are represented by fewer than ten individuals each and so merit little further attention. However it is worth remarking that if all 24 wildfowl species included in Table I are ranked in order of likely mid-winter abundance (data, modified by removal of Scottish totals, from

Table I. Wildfowl and other water-birds found dead in England and Wales during, and shortly after, the cold weather of January – March 1963.

species	when found: January	February	March	date uncertain	total	estimated national abundance
Mute Swan (*Cygnus olor*)	9	56	8	23	96	14,000
Bewick's Swan (*C. columbianus bewickii*)		2		17	19	2,000
Whooper Swan (*C. c. cygnus*)	2	2	2		6	500
Bean Goose (*Anser fabalis*)	5				5	200
Pink-footed Goose (*A. brachyrhynchus*)		2			2	15,000
White-fronted Goose (*A. albifrons*)	12			3	15	8,000
Greylag Goose (*A. anser*)		2			2	1,000
Brent Goose (*Branta bernicla*)	3	22	1	1	27	13,000
Shelduck (*Tadorna tadorna*)	98	417	88	151	754	30,000
Pintail (*Anas acuta*)		4	1	3	8	10,000
Teal (*A. crecca*)	4	7	2	10	23	120,000
Mallard (*A. platyrhynchos*)	22	52	4	42	120	220,000
Wigeon (*A. penelope*)	34	123	15	131	303	180,000
Shoveler (*A. clypeata*)		3	1	1	5	6,000
Eider (*Somateria mollissima*)	8	28	3		39	4,000
Pochard (*Aythya ferina*)	1	7	1		9	13,000
Tufted Duck (*A. fuligula*)	29	31	16	5	81	30,000
Scaup (*A. marila*)	1	14	5	5	25	3,000
Black Scoter (*Melanitta nigra*)	14	108	13	10	145	10,000
Velvet Scoter (*M. fusca*)	6	27	3		36	1,000
Goldeneye (*Bucephala clangula*)	4	2		1	7	2,000
Smew (*Mergus albellus*)			1		1	300
Red-breasted Merganser (*M. serrator*)	1	6	1		8	1,500
Goosander (*M. merganser*)	4	3	3		10	1,500
all Anatidae	257	918	168	403	1,746	
Black-throated Diver (*Colymbus arcticus*)	1			12	13	
Great Northern Diver (*C. immer*)			1		1	
Red-throated Diver (*C. stellatus*)	12	47	27		86	
Great Crested Grebe (*Podiceps cristatus*)	40	113	37	1	191	
Red-necked Grebe (*P. grisegena*)	4	7			11	
Slavonian Grebe (*P. auritus*)		1			1	
Black-necked Grebe (*P. caspicus*)		1			1	
Little Grebe (*P. ruficollis*)	2	6	5		13	
Moorhen (*Gallinula chloropus*)	29	58	9	65	161	
Coot (*Fulica atra*)	50	129	14	160	353	
all other waterfowl	138	362	93	238	831	
total	395	1,280	261	641	2,577	

Reports received too late for inclusion here have increased the number of dead birds found by several hundreds. In general, the relative abundance of duck casualties has been little affected. The numbers of Divers have been greatly augmented, to at least 25 Black-throated, 6 Great Northern and 152 Red-throated. At least 135 Mute Swans and 46 White-fronted Geese are now known to have been found.

Boyd in G. L. Atkinson-Willes, *Wildfowl in Great Britain*, 1963, pp. 249-305) there is a strong association between specific abundance and the numbers found dead (the Spearman rank correlation coefficient is 0·61, with a probability of less than 0·01). Three species had appreciably more casualties than expected from their abundance ranking: the Eider and the Black and Velvet Scoters. Three other species were found dead in much smaller numbers than might have been expected: the Pink-footed Goose, Pintail and Teal. The scarcity of dead Teal was probably due to massive emigration. In proportion to the numbers likely to have been present, the Shelduck suffered most severely.

The relative abundance of the divers and grebes in England and Wales is not known in any detail but the four species of which more than one dead bird was reported (Great Crested Grebe, Red-throated Diver, Little Grebe and Red-necked Grebe in descending frequency) are likely to have been present in that same order, though with Little Grebes more nearly as plentiful as Red-throated Divers than the casualties would indicate.

It is somewhat surprising that bodies were found much more frequently in February than in January or March, because the severest cold occurred in late January and a general thaw did not occur until March. Perhaps bird-watchers were making special efforts to look for casualties as soon as the weather permitted (see, for example, R. E. M. Pilcher, at p. 23). The scarcity of known casualties in December, 1962, even though continuous frosts began about 22nd, conforms to other evidence that a delay of two weeks or more is usual before large birds succumb in numbers to the effects of cold or starvation. There are very few specific departures from the monthly pattern. Dead Mallard were notably few in March; Tufted Ducks were relatively scarce in February, when Black Scoters were unusually frequent. Among the non-Anatidae, Red-throated Divers and Great Crested Grebes provided more March-found bodies than expected, while casualties among Moorhens and Coots included relatively large numbers found in January.

Reports were received from 37 coastal and 30 inland localities. 33 of the 34 species listed were represented in the coastal samples but no more than 13 species were found inland. The only species found more plentifully inland were the Moorhen and Little Grebe. Superficially this suggests that water-birds suffered more severely on the coast than inland. This cannot be verified, because too little is known about the extent of shifting from frozen inland waters to later-freezing or open coastal waters, or about the relative extent of emigration overseas from these two habitats. Nor is it possible to determine the relative extent of the searching effort in different areas. Perhaps it is merely because of inadequate sampling that no clear regional differences in the specific composition of the casualties is apparent. But it seems rather unlikely that the preponderance of casualties in the south-east, from the Wash to Sussex, is due solely to concentration of observers in that region, especially since it is known that freezing of the inter-tidal zone was especially prevalent there (see Harrison and Hudson, p. 26).

In the difficult conditions, no one was able to examine a large number of casualties thoroughly so as to determine the causes of death, though R. E. M. Pilcher (see p. 23) has attempted to classify casualties on the Wash by likely date of death and by general condition. Wasting due to starvation was widely reported and this was presumably the principal cause of death.

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Effects of the cold winter of 1962-63 on birds of the north coast of the Wash

R. E. M. PILCHER

The exceptionally severe winter of 1962-63 offered opportunities, possibly not equalled for over a century, of observing the effect of hard weather on wild life in general. This report is concerned solely with its effect on the salt marsh, shore- and sea-birds on the north coast of the Wash, in Lincolnshire.

The arctic conditions which reached the west coast of Britain on Christmas Eve did not really reach the Wash until the early hours of Boxing Day. Here they arrived ushered in by a biting north-westerly wind and a slight fall of snow. These conditions continued, apart from a very occasional and very slight mid-day thaw, for ten weeks; they were characterised by hard frosts, very cold winds, but very little snow. Many of the tides on the marshes froze and left behind large ice floes, which packed in masses, first in the creek bottoms and then on the creek sides. During the third week in January the River Witham was completely frozen at Boston and the port was closed to shipping. When the frozen river was broken up, partly by ice-breakers and partly by spring tides, packed ice floated down the river to be left on the mud-flats and green marsh.

The conditions of birds, mainly Dunlin and Knot, caught at intervals in mist nets on the saltings during this period appeared to be good; otherwise mist-netting would have been discontinued. The weather was, however, having its effect. Certain species, and notably Redshanks, habitually very wary birds, appeared to be reluctant to fly far and were relatively tame. It was not however until the tide line had been examined casually that the extent of the mortality among shore birds was suspected.

It appeared that the best time to investigate this mortality more thoroughly would be after the highest of the spring tides at the end of the cold spell, which could not of course be foreseen. On the morning of 26th February the tide rose to 25 ft. 8 ins., completely covering all the green marsh and carrying up to the foot of the sea wall, together with much wrack and debris, the bodies of birds which had died further out. The wrack was exceptionally thick, due to the fact that the ice floes had abraded the taller grasses and vegetation, which had broken off and formed a thick mat of debris covering many of the bodies of the smaller birds. The first investigation took place on the evening of 26th February; the second and third investigations took place on 2nd and 3rd March.

Those who took part in the investigation were: on 26th February, W. A. Cook, T. Richardson and R. E. M. Pilcher; on 2nd March, W. A. C., T. R., R. E. M. P., and M. V. Pilcher; on 3rd March M.V.P. and R.E.M.P.

The species of each bird was determined. This was rarely difficult, but in certain cases, particularly in the case of the divers and grebes, where there had been some oiling or discoloration from vegetable staining, the identity was checked against bill, wing, tarsus and other measurements.

As a guide to the hardiness of each individual, an attempt was made to estimate how long it had been dead; whether it had died early, in the middle of, or late in the cold spell. This estimate pretends only to relative accuracy. A number of birds which had clearly died before Christmas were excluded. In the table of species the birds are divided into three classes: *fresh*, appearing to have died in the last two weeks; *recent*, died two to four weeks previously; *old*, dead four to six weeks. The bodies were also examined as to their condition: whether they were wasted or not, and whether they appeared to have been shot. Evidence of oiling was also noted. A search was made for rings, but none was found.

The area of the investigation extended from Friskney in the north to Freiston in the south. It included the parishes of Friskney, Wrangle, Leake, Leverton, Benington, Butterwick and Freiston. Apart from a small gap of about half a mile at Leake, this represents a continuous frontage of 9 miles.

The number of dead of each species found at the high-water mark is recorded in Table I. What proportion of the total population of any one species succumbed during the cold weather cannot be estimated except within the widest of limits. It appeared on many occasions that birds were passing through and that their stay was brief, and it cannot be known how long they were at risk in the area.

Table I. Number of birds found dead on the north shore of the Wash, 26th February to 3rd March 1963.

species	*fresh*	*recent*	*old*	*total*	*notes*
Black-throated Diver (*Colymbus arcticus* L.)	1	10	1	12	7 oiled
Red-throated Diver (*C. stellatus* Pontopp.)	1	9	2	12	2 oiled
Great-crested Grebe (*Podiceps cristatus* (L.))	1	7	1	9	
Red-necked Grebe (*P. grisegena* (Boddaert))		2		2	
Fulmar (*Fulmarus glacialis* (L.))		1		1	
Gannet (*Sula bassana* (L.))	1		1	1	
Heron (*Ardea cinerea* L.)		1	1	2	
Mallard (*Anas platyrhynchos* L.)	1	3	3	7	
Teal (*A. crecca* L.)		1		1	
Wigeon (*A. penelope* L.)	6	19	10	35	Mostly shot; few in poor condition
Tufted Duck (*Aythya fuligula* (L.))		2		2	
Common Scoter (*Melanitta nigra* (L.))	2	7	1	10	Mostly oiled
Red-breasted Merganser (*Mergus serrator* L.)	1			1	
Shelduck (*Tadorna tadorna* (L.))	7	24	27	58	Condition very poor
Pink-footed Goose (*Anser brachyrhynchus* Baillon)		1	1	2	Both shot
Dark-bellied Brent (*Branta b. bernicla* (L.))	3	6	3	12	Mostly shot
Mute Swan (*Cygnus olor* (Gmelin))	1			1	
Water Rail (*Rallus aquaticus* L.)			1	1	
Moorhen (*Gallinula chloropus* (L.))		1	1	2	
Oystercatcher (*Haematopus ostralegus* L.)			1	1	
Green Plover (*Vanellus vanellus* (L.))	1		1	2	
Grey Plover (*Charadrius squatarola* (L.))	1	4	2	7	
Curlew (*Numenius arquata* (L.))	3	7	5	15	
Bar-tailed Godwit (*Limosa lapponica* (L.))		3		2	
Redshank (*Tringa totanus* (L.))	30	49	65	144	Condition very poor
Knot (*Calidris canutus* (L.))	27	41	36	104	
Dunlin (*C. alpina* (L.))	15	11	7	33	
Greater Black-backed Gull (*Larus marinus* L.)		2	4	6	
Herring Gull (*L. argentatus* Pontopp.)	1	6	1	8	
Common Gull (*L. canus* (L.))	5	24	22	51	
Black-headed Gull (*L. ridibundus* L.)	6	14	6	26	
Kittiwake (*Rissa tridactyla* (L.))		9		9	
Razorbill (*Alca torda* L.)			3	3	
Guillemot (*Uria aalge* Pontopp.)	10	7	2	19	Many oiled

Total number of species = 35 Total number of birds examined = 603

The bodies of several other species were also found, except for Wood-Pigeon (*Columba palumbus* L.), never in any number. They included Partridge (*Perdix perdix* (L.)), Skylark (*Alauda arvensis* L.), Blackbird (*Turdus merula* L.), Meadow-Pipit (*Anthus pratensis* (L.)), Starling (*Sturnus vulgaris* L.), Linnet (*Carduelis cannabina* (L.)), Twite (*C. flavirostris* (L.)) and Reed-Bunting (*Emberiza schoeniclus* (L.)).

As the result of frequent visits to the marsh some estimate could be made of the relative abundance of one species as compared with another. The limits of accuracy are here again very wide, but one could say, for instance, that at the beginning of the cold spell there were many more Knot than Redshank seen alive and that this proportion appeared to be constant or increasing during the period under review; yet when the dead at the tide-line were examined, one found many more Redshank dead than Knot, an indication that the Knot is able to withstand hard weather better than the Redshank.

It proved in fact to be possible to estimate with fair accuracy the relative proportions of individual species in the wader population but in few other groups. When one looks, for instance, at the divers and grebes, one sees that the number of dead of the Black-throated and the Red-throated Diver is the same. I do not think that anyone who observes the birds of the Wash from the land would hesitate to say that the Red-throated is much the commoner of the two. I am not sure that this is so. The Red-necked Grebe is often a very common bird in winter on the Wash, but generally it is too far out to sea to be identified, whereas the Great Crested Grebe tends to stay more in the runs and channels and is constantly seen. Similarly, it may well be that the Black-throated Diver keeps to the more open water and is less commonly seen than the Red-throated, which not infrequently haunts tidal rivers. This suggestion is supported by the fact that of the 12 Black-throated Divers, seven showed evidence of oiling, whereas only two of the Red-throated were oiled.

When one comes to the ducks one is on rather surer ground. There can be no doubt that the Wigeon population during this period vastly exceeded that of the Shelduck. It may at times have been fifty to a hundred times greater. On the afternoon of 25th January, flock after flock of Wigeon, amounting to very many thousands, were seen hour after hour to fly to some fresh grazing on the banks of Wainfleet Haven, and large flocks were constantly seen on every visit. Yet the number of Wigeon found dead was few; many of these had been certainly shot, very few of the others were 'wasters'. The number of Shelduck found dead must represent a very high proportion of the total winter population and the hard winter must represent a major disaster to this species. Many had died early in the hard weather and the condition of all the birds found was very poor; many were merely skin, feathers, and bones. Probably a very few had been shot and by far the majority had died of starvation. The Wigeon with its much wider choice of food – *Enteromorpha*, thawed by the water; the grasses of the marsh and of the fields near the sea wall – would feed with difficulty, but appeared to be in no danger of starvation. Very few of the birds shot by the wildfowlers were really poor. The Shelducks, with a more restricted food preference and one which in turn would suffer from hard weather – molluscs, crustaceans and arthropods – failed to survive on a change to a more vegetable diet.

The Mallard, Teal and the two Pinkfeet had certainly been shot. No doubt had the area examined been one regularly frequented by Pink-footed Geese, the number of 'pricked' birds succumbing to hard weather would have been higher. The number of Brent (all *B.b.bernicla*) found dead is high. Some of these were undoubtedly shot; a gunner was seen to shoot into the brown of a flock of Brent and although none fell, some were certainly wounded. Only four were really wasted. Probably the true hard-weather mortality was low.

The diving ducks appear to have fared well. There were throughout this period a considerable number of Scaup and Goldeneye and not a few Long-tailed Ducks, but no bodies were found. Both individuals of the one species found, Tufted Duck, were in fair condition and may have been shot. Except when frozen out from their inland waters, Tufted Ducks are not common on the Wash. Although their food is predominantly animal matter, it is taken at a greater depth than the Shelduck's surface feeding and their food supply was presumably less restricted. The importance of the food supply cannot be over-stressed. It was probably the effect of very low temperatures on the food supply, rather than on the birds themselves, which accounts for the variation in specific mortality. An adequately fed bird withstood the cold, a starved bird died.

Most of the Scoters showed signs of oiling. Their condition was poor and they had probably died miserably of exposure.

Coming to the waders, vast numbers of Knot were present throughout the period and the mortality was probably not at all high. Judging from the proportion of population, the Dunlin probably suffered rather the more. The bird that fared disastrously was clearly the Redshank. The numbers of Redshank never approached those of the Knot – there may have been fifty or even a hundred times more of the latter, but more Redshank died. The cause of this high mortality is again probably differences in feeding habits. Knots feed on the mudflats using the moving tide. Red-

shanks feed far more on the green marsh in the creek bottoms and the creeks were very early packed with ice. Many shore birds however had moved on before the hard weather. The number of Bar-tailed Godwits lessened noticeably early in January and few were left in the area by the end of the month. Oystercatchers, which had been present in very large flocks – well over a thousand strong – moved away at the same time and none was seen after the middle of January. Green Plover and Golden Plover moved away even earlier. None was seen in the area between Christmas and 4th March. From that date on large movements of both species occurred northwards and by mid-March very large flocks of Green Plover were present on grass-land generally and especially on Cowbit Wash.

There does not appear to be any special significance in the number of gulls found. Throughout the year the bodies of gulls of various species can be seen along the high-water mark, dead from one cause or another. Many of the Guillemots and Razorbills were oiled and their deaths need not have been associated with the hard weather.

Summing up, it is quite clear that on the north side of the Wash the two species which suffered most severely during the hard weather were the Shelduck and the Redshank.

Some effects of severe weather on wildfowl in Kent in 1962-63

JEFFERY HARRISON and MICHAEL HUDSON

Summary

Large numbers of wildfowl died in Kent early in 1963. Losses were especially heavy among birds on the Thames and Medway estuaries, where the inter-tidal zone was frozen for long periods. Most losses occurred 15th-26th January. Shelduck and Wigeon were severely affected, because their food became inaccessible. Losses were heavier than during the last comparable cold spell, in 1947, which had lower temperatures but more precipitation and in which the inter-tidal zone was frozen only for short periods.

More duck than drake Wigeon were found dead, even though there was an unusual preponderance of drakes in the local population. Dead Shelduck too were mostly females. Only 4 of 16 apparently starved ducks contained no food. There is evidence that the mortality was selective and that it was the weaker birds which were culled.

Numbers of ducks and geese during and after the cold spell are compared with those in other years. Nesting in 1963 was delayed, though less than in the cold spring of 1962. Breeding success was high for Shelduck and Pochard. Mallard did badly on the Thames, probably because of heavy losses of nests due to flooding of the coastal marshes by abnormally high summer tides.

It is suggested that if wildfowl losses in severe winters are to be minimised in future wildfowling should be stopped, if possible, when the inter-tidal zone freezes.

Introduction

The exceptionally severe weather which lasted from 23rd December, 1962 until 5th March, 1963, unfortunately provided ample opportunities for studying the effects of the weather on wildfowl, particularly in north Kent, where large numbers died. This was in curious contrast to south Kent where very few were found dead. The difference is possibly to be accounted for by the absence of any intertidal feeding zones in south Kent, where wildfowl quickly turned to such plants as kale and sprouts.

This winter was the first since 1947 in which conditions were severe enough to follow up some observations made on Wigeon (*Anas penelope* L.) in north Kent by Harrison and McLean (1947). At the end of January, 1947, it became obvious that duck Wigeon were suffering from the cold spell far more than the drakes. From birds which were shot at that time, it was confirmed that the ducks were relatively thinner than the drakes. Experimental studies in north America suggest that Mallard drakes succumb more quickly to starvation in cold weather than do females (Latham, 1947; Jordan, 1953) but, as is shown below, the observations made on Wigeon and Shelduck (*Tadorna tadorna* (L.)) in 1963 support the findings of 1947.

The cold spell of 1947 differed from the 1963 spell and this was particularly reflected in the icing conditions of the saltings and the inter-tidal zone, which were far more severe and prolonged in 1963 and resulted in a widespread mortality, particularly of Wigeon and Shelduck, which did not occur in 1947.

The majority of our observations were made on the Thames fresh marshes and foreshore in the Cooling – Egypt Bay area and on the south shore of the Medway estuary, covering Greenborough, Milfordhope, Barksore and Chetney Marshes. The Romney Marsh area was visited less often during the cold spell, as for much of the time this was practically impossible. Other notes are included from the Sevenoaks gravel pits.

Comparison of the weather during the winters 1946-47 and 1962-63.

Meteorological data recorded during the two winters at three stations in south-eastern England enable conditions to be compared although, unfortunately, no data are available on the relative snowfalls, or on the number of days of ground frost. Furthermore, precise records of the extent of freezing of the inter-tidal zone do not exist, but the lack of these is to some extent covered by field observations.

In 1947 adverse weather conditions were experienced between 23rd January and 16th March (53 days). In 1962 the cold spell set in on 23rd December and lasted until 3rd March, 1963 (71 days). In 1947 the inter-tidal zone was partly frozen on 31st January and 1st February and wholly frozen from 16th-20th February. In 1963 the inter-tidal zone was partly frozen from 10th-13th January and wholly frozen from 15th-26th January, 1st-3rd February and 23rd-26th February.

Thus the severe weather lasted longer in 1963 and the inter-tidal zone was frozen more often, the longest spell being from 15th January to 26th January, which proved to be the most lethal period. However, there was a greater range of temperature during the cold spell of 1947, coupled with a much greater total precipitation, which may have brought some amelioration of the effect of low air temperatures. The cold spell of 1963 was characterised by more consistently low temperatures even though the minima were not as low as in 1947.

These facts appear to explain the larger number of birds found dead during the severe weather of 1963. The long periods during which the inter-tidal zone was frozen resulted in much hardship for Shelduck which, as Olney (1964) has shown, have no alternative feeding grounds. Continuous low temperatures following snowfalls produced a covering of hard frozen snow over the feeding grounds of Wigeon on the reclaimed grazing marsh at High Halstow, Thames Estuary, for long periods. The congregation of Wigeon on the south facing slopes of the sea wall bore witness to the difficulty of feeding elsewhere. On the wall the Wigeon were able to benefit from the more pronounced thaw produced by the weak winter sun.

Mortality data

Wildfowl did not start dying in any numbers in north Kent until 23rd January, 1963, when the inter-tidal zone had been continuously frozen for nine days. During the last week of January a large number of birds obviously reached the end of their resistance and died. Of the total casualties, about 80% occurred during this week. Table I records the numbers of wildfowl found dead on the Thames and Medway estuaries and differentiates the sexes where known.

Table I. Numbers of wildfowl found dead on the estuaries of the Thames and Medway, early 1963.

species	*total found dead*	*sex-ratio* ♂♂	♀♀	*not sexed*
Wigeon	110	45	57	8
Shelduck	106	8	43	55
Mallard	36	15	19	2
Mute Swan	9			
Tufted Duck	5			
Teal	4	2		2
Pintail	3		1	2
Scaup	3			
White-fronted Goose	3			
Common Scoter	2			
Shoveler	1		1	
Light-bellied Brent Goose	1			

Two facts emerge. First that Wigeon and Shelduck suffered more severely than the other species listed, a fact which can be correlated with their more restricted and susceptible food requirements. Wigeon feed largely on *Enteromorpha* or grass; the former was frozen and the latter snow-covered. Shelduck feed exclusively on the inter-tidal zone which was frozen.

Mallard (*Anas platyrhynchos* L.) and Pintail (*Anas acuta* L.), being more omnivorous, suffered less. The smaller numbers of Teal (*Anas crecca* L.) and Shoveler (*Anas clypeata* L.) are to be accounted for by the fact that many had migrated elsewhere soon after the onset of cold. This seems characteristic of Teal, for they did the same in 1947 in Kent. Even as far south as the Camargue, Teal are reported by Impekoven (1964) to have emigrated in 1963, but not in 1956, when the cold spell on the Camargue did not start until much later, at which time the Teal were physiologically ready to migrate northwards and therefore remained on the

Camargue during the cold, suffering heavy losses.

Secondly, it is apparent that ducks suffered more severely than drakes, as first noticed in 1947. The figures for Wigeon are even more impressive when linked with sex ratio counts made during the period. Under the extreme conditions, it was not possible to differentiate the sexes of Shelduck in the field, but in the case of Wigeon, this was done with considerable accuracy. Counts of 10 different groups totalling 999 birds showed 646 to be males, a higher percentage of drakes than usual in north Kent, where it is rare for one sex to preponderate to any marked extent (Gillham & Homes, 1950). This was first noticed by us both on 8th February when of 700 Wigeon, we estimated that drakes exceeded ducks in a ratio of 60:40. Confirmation of this came from Mr. William Buck, who told us that of 67 caught for ringing on 3rd February, 43 were drakes.

Although parties of Wigeon actually on migration are virtually impossible to differentiate in areas where large numbers are already present, as in north Kent, it is noteworthy that a party of 9 migrating Wigeon seen on the Kent Sand and Ballast Water Reserve at Sevenoaks on 7th March included 8 ducks.

The highest proportion of drakes was recorded on 17th February, the two counts being made, one by each of us independently on the Medway and the Thames, the Medway count being considered an accurate sample of an exceptional concentration of 3,000 Wigeon, which was present on the south shore. In each case the proportion of drakes was 75%. By early April this had fallen to 55%.

When these figures are considered in conjunction with the mortality sex ratios, it will be seen that the ducks suffered even more severely than is apparent at first sight.

A similar disproportion in the sex ratio was noted at Cliffe pools on 24th February in a record flock of 1,400 Pintail which were flighting out to East Tilbury flats. Of 45 which were photographed overhead, 31 (69%) were drakes. No disproportion was noted in Mallard however.

Examination of viscera from starved wildfowl

Viscera from wildfowl found dead on the Medway and Thames estuaries in February 1963 were examined by Mr. Peter Olney, whose findings were as follows:

Wigeon: (5) 2 empty; 2 containing grass; 1 undigested seeds of *Salicornia.*

Shelduck: (9) 2 empty; 7 with the snail *Hydrobia ulvae* (3 traces only); 1 also contained jaws of a Nereid, possibly *Nereis diversicolor;* 1 had also been feeding on ragworms and another on the seeds and stem of *Salicornia.*

Pintail: 1, containing *Hydrobia ulvae.*

Mallard: 1, containing wheat and a single lead pellet in the gizzard, associated with the presence of much green bile. Clinically, this bird was suffering from lead poisoning.

Of these sixteen apparently starved birds, only four contained no food at all. There is some support for the suggestion that the weaker birds were being 'culled'. This is particularly true with the Mallard, which was found dead beside a large supply of wheat put out for wildfowl, on which it was feeding when it died; lead poisoning undoubtedly contributing to its cause of death.

It must be significant that the majority of deaths took place during the last week in January, although the cold spell was to last a further five weeks. Van Troostwijk (1964) also concluded from his observations of White-fronted Geese in Holland during the cold spell that 'it is obvious that the severe winter was selective, and mainly feeble birds died from the cold'.

The role of the persistent chlorinated hydrocarbons may be significant in deaths of starved wildfowl. Being stored in the fat, they are liable to be liberated during severe weather. As yet there are not enough data available, but it is a factor which must be considered.

Abnormal feeding habits

Kale fields, on account of the height of the plants, were often the only green fields not covered by snow and in Kent these attracted a number of wildfowl. White-fronted Geese (*Anser albifrons* (Scopoli)) fed on kale, both in north and south Kent, as did Mute Swans (*Cygnus olor* (Gmelin)) and Wigeon. Inland in the Sevenoaks – Tonbridge area, it was remarkable how often White-fronted Geese and Wigeon were seen in the vicinity of kale fields and a Wigeon shot from a kale field at North Frith near Tonbridge on 19th January contained kale pieces and the seeds of water pepper and buttercup in its crop. Three other Wigeon from the Sevenoaks – Tonbridge area shot between 26th December and 12th January had been eating grass. Mallard have very seldom been recorded as eating fish (Harrison and Harrison 1962), in fact Peter Olney in analysing the viscera contents of over 560 between 1957-1961 found no trace. Yet, two Mallard shot in the Sevenoaks area on 12th January, 1963, which he analysed, both contained, among other things, fish remains.

In East Sussex, White-fronted Geese, Mallard and Wigeon were also feeding on

kale and on brussels sprout leaves and were watched picking maize out of silage. Mr. J. Sutton also tells us that he saw White-fronted geese eating lamb- and ewe-pellets (B.O.C.M.), shaking them in their beaks to break them up. In the same area, Mute Swans were eating cooked meat put out for pigs, which must be unusual, although King (1962) has once recorded this species eating raw meat.

In North Kent, Wigeon fed quite extensively on the sea wall, where snow was melting before that covering the rest of the marshes.

Effect on wintering populations on the Thames and Medway estuaries

(*a*) *THAMES*

The following regular visitors showed *decreases* compared with a normal winter:

Mallard: Although 2,000 were recorded at Cliffe, numbers were below 400 on average, i.e. 20% of normal winter maxima.

Teal: Numbers remained at only about 300, i.e. 16-25% of normal.

Wigeon: In spite of peaks of 3,000 at Cliffe and 2,000 at Egypt Bay, numbers averaged only 1,000, i.e. 25-33% of normal.

Shoveler: A peak of 130 is only 25-30% of recent winter maxima and for most of the cold spell the population was below 50.

The following species showed *increases:*

Pintail: A flock of 1,400 at Cliffe on 24th February is the largest number ever recorded in Kent, but numbers on the estuary were rather lower than usual.

Pochard (*Aythya ferina* (L.)): A flock of 950 at Cliffe is a record and numbers were higher than usual throughout the cold.

Scaup (*Aythya marila* (L.)): A flock of 600 at Cliffe is a record and numbers were higher than usual throughout the cold.

Tufted Duck (*Aythya fuligula* (L.)): A flock of 800 at Cliffe is a record and numbers were higher than usual throughout the cold.

Shelduck: Numbers reached a peak of 10,000 as in early 1956, during hard weather; throughout February they averaged 3-4,000, which is normal.

The only species to show no change compared with the previous winter was the White-fronted Goose which averaged 550-600, although first-winter birds only averaged 4% in 1963, against 35% in the previous winter (see also van Troostwijk, 1964).

(*b*) *MEDWAY*

A considerable effect was made on the wildfowl population of the Medway by Messrs. W. and H. Mouland, who were putting out 3 cwt. of wheat each day for the wildfowl, for about eight weeks. Being genuine wildfowlers, they had stopped shooting and it was estimated that on their two farms at Barksore and Chetney, they were at one time feeding at least 2,000 duck.

(It is noteworthy that a flock of 2,000 Mallard was maintained on the ice at Stodmarsh, in the Stour Valley, during the hard weather, by feeding with corn.)

The following species showed *increases:*

Mallard: About 400 present, largely centred on the two farms mentioned.

Wigeon: Gradually built up to a peak of 3,000 on 17th February on Chetney. Initiated by feeding, when they were regularly taking wheat, the main flock then moved on to a large area of *Salicornia.*

Pintail: 250 on 23rd January was a record for the Medway estuary but, apart from this, numbers were about average.

The following species showed *decreases*:

Teal: After a peak of 1,200 on the south shore on 16th January, only 2 were seen 23rd and none 27th, but 100 had joined the Wigeon on the *Salicornia* flats on 17th February.

Shoveler: Peak of 25 seen 9th January, 4 on 16th January and no more after that.

The following species were in average numbers:

Brent Goose (*Branta bernicla* (L.)) and Shelduck.

Population fluctuations at High Halstow

Owing to the possibility of the weather having a marked effect on populations, the frequency of counts of White-fronted Geese was greater in the winter of 1962-3 than in the two previous winters. It is possible, therefore, that a more accurate picture was obtained for last winter than previous ones. It appears that the 1962-3 wintering flock was subject to much greater fluctuations than usual, and there can be little doubt that these were in some way related to the severity of the weather.

After heavy snow on 20th January numbers fell from 500 to 120 over the course of a few days. After snow on 19th February, numbers fell from 550 to 300. These sudden drops were presumably due to the difficulty of grazing on snow-covered marshes and the necessity to find food elsewhere. However, snowfalls at the end of December and beginning of February were followed by increases in numbers. Furthermore, sudden drops in numbers from 400 to 150 in the first week of March and 440 to 80 in the second week of March were unrelated to snowfalls, and since numbers built up again afterwards in each case it is probable that these were instances of local

dispersal. The pattern of movements was clearly not a simple one.

White-fronted Geese were seen, sometimes in large numbers, in widely scattered parts of the county well away from their normal quarters. Records of 1,000 at Walland Marsh and in east Sussex during the first week of February and 81 at Grove on 12th January increasing to 150 on 24th may possibly have included some Thames birds.

It is possible that the movements which occurred after the snowfalls resulted from the breaking of tradition in the continued use of a favoured wintering ground and the consequent need to search for fresh feeding grounds. This might produce an unsettled flock which subsequently moved periodically between the two areas.

In 1963 White-fronted Geese remained until 2nd April, compared with 22nd March, 1962 and 15th March, 1961. Wigeon were last seen on 28th April, 1963, 21st April, 1962 and 5th April, 1961. A Greylag Goose (*Anser anser* (L.)) was present on the Thames from 2nd April for about 10 days and a Pink-footed Goose (*Anser brachyrhynchus* Baillon) from 16th April to 19th May.

A sharp decline in the numbers of Wigeon from 1,500 to 500 at the beginning of February was apparently related to the weather, though not directly to snow cover. After the middle of February the numbers built up again to 1,100.

Whereas normally Mallard, Teal and Shoveler show a gradual decline after early January winter maxima to the beginning of March, as winter visitors disperse and only summering populations remain, figures for this last winter fluctuated markedly. There was presumably, therefore, considerable movement, probably on a local scale, in a constant search for adequate feeding grounds. The Shoveler population built up from 20 in the third week of February to 90 in the first week of March, at about which time there is normally a marked movement of passage migrants.

Effect of the winter on local breeding stocks

As might have been expected after a winter of such severity, the effects were not confined simply to the period of harsh weather. Both summering and breeding populations of a number of species were abnormal, and the breeding season was delayed. There were, furthermore, indications that clutch size and brood size were larger than normal.

On the Thames the numbers of Shelduck were only $\frac{1}{4} - \frac{1}{3}$ of those in the summer flocks of 1961 and 1962, non-breeders being reduced from 3–400 to 35–40. The Mallard population was about the normal 100 birds. Shoveler, about 40 birds, were about $\frac{4}{5}$ of the 1961 and 1962 populations. There were only one pair of Teal and one or two pairs of Garganey (*Anas querquedula* L.), but these small numbers are usual. Pochard, at least 30 birds, were slightly more numerous than in the previous two seasons.

Breeding season at High Halstow

As a result of low temperatures in March and April 1962 breeding was inhibited to such an extent that the first Mallard nests were started 3 to 4 weeks later than in 1961. A similar postponement was observed in 1963, except that the first nests were started only 2 to 3 weeks later than in 1961.

Apart from the inhibition of nesting behaviour, the low temperatures in the spring of 1962 delayed the onset of spring growth and consequently when temperatures rose to reach the breeding stimulation threshold, there was a marked shortage of adequate cover. An increased number of Mallard nested on saltings where *Halimione portulacoides* offered suitable cover unaffected by the weather. Shoveler were observed breeding on saltings for the first time, 14 nests out of 23 being found on saltings whereas normally nests are found in small tussocks on the grazing marsh. However, the Shoveler ignored the *Halimione* and followed their normal habit of nesting in grass. The salt-marsh grasses, being ungrazed and more rank than those of the grazing marsh, offered more cover than the latter.

While there was no intensive survey of nests in 1963 there was an indication that a similar situation obtained and that Shoveler again nested on the saltings, though perhaps not to the same extent as in 1962.

Table II. Breeding populations at High Halstow

species	*no. of pairs 1963*	*usual no. of pairs*	*no. of broods seen in 1963*
Shelduck	20	30	12
Mallard	40-45	45-50	18
Shoveler	20	25	12
Teal	1	1	1
Garganey	1	1	1
Pochard	15	6-10	15
Mute Swan	1	7-8	1

A few large clutches were recorded in nests found at High Halstow, but since deliberately no systematic search was made others may have escaped notice and no

Table III. Large clutches and broods seen at High Halstow in 1963

species	*large clutches 1963*	*average clutch locally*	*large broods 1963*	*average class I brood locally*
Shelduck	20	12-15	13 (24 June)	11-12
Mallard	14, 15, 15	10-11	14 (8 May), 10 (16 June)	8-9
Shoveler	several 11 & 12	9-10	11 (25 May), 12 (16 June)	7-9
Pochard			9 (24 June)	6-7

assessment can be made of the proportion of abnormally large clutches. The records again suggest a tendency for larger than normal broods (Table III).

In addition, a W.A.G.B.I. hand-reared Mallard at Sevenoaks hatched 14 and reared 11 ducklings in the wild. This was the same bird which last year reared 9 out of 11 hatched in the wild (W.A.G.B.I. ring No. 31374).

Broods counts of wildfowl species are not easily made and for this reason comparison of numbers of different species in late summer may give a better indication of the success of the breeding season (Table IV).

Table IV. Wildfowl counts at High Halstow on 1st August 1961-63

species	*1961*	*1962*	*1963*
Shelduck	5	61	280
Mallard	375	450	250
Teal	50	35	50
Shoveler	45	70	60
Pochard	0	3	100

On 1st August, 1963, numbers of Shelduck and Pochard were higher than in previous years. Teal and Shoveler were about average, while the 1963 Mallard count was considerably lower than in the two previous years. At least 200 juvenile Shelduck were included in the 1963 figure, indicating clearly a very successful breeding season. 1962 was a later season, so that the differences are not to be accounted for by a later moult-migration in 1963 than in 1962.

While the other four species had average or good breeding seasons in 1963, the early autumn 1963 numbers of Mallard were considerably lower than in the previous two years. The breeding population has been estimated as of normal size, so that the low apparent production requires some explanation. From observations on local Black-headed Gull (*Larus ridibundus* (L.)) colonies, D. F. Musson (personal communication) concluded that abnormally high tides in the summer of 1963 had seriously reduced their breeding success. Since a large proportion of local Mallard nest on saltmarsh it is likely that their breeding efforts were also upset by high tides. This is to some extent confirmed by the situation in the Romney Marsh area of south Kent, where nesting Mallard are all inland. On Walland Marsh, Harrison and Romer found 1,500 Mallard at the end of August, while many other broods were still scattered throughout Romney Marsh, so that there were probably at least 2,000 Mallard present. This is the highest population recorded there in at least the past twelve years. Similarly, on the south side of the Medway Estuary, 500 Mallard were seen in September, 50% above the monthly average in recent years. The Priority Wildfowl Counts for September, 1963, issued by the Wildfowl Trust, also suggest that any losses suffered in last winter's cold spell may have been largely replaced, so far as British Mallard are concerned.

The autumn population of Teal is made up almost entirely of immigrants and gives no indication of local breeding success.

The slightly lower autumn 1963 Shoveler count is in proportion to the estimated breeding population. Shoveler are not conspicuous in early autumn and no doubt many escape notice – so that the figures quoted may not give a true representation of the population.

The 1963 Pochard count bears little relation to that of the previous two years, since for some unexplained reason the broods remained in the breeding area later than in the previous years. Hatching dates and distribution of hatching were normal. The estimate of breeding population was considerably higher than in previous years and this is confirmed by the large autumn populations.

Effect of the cold spell on lower salt marsh vegetation

Observations on the Medway Estuary during the autumn of 1963 show that up to 80% of the *Enteromorpha* beds were destroyed by the cold weather, the remaining 20% being on the highest part of its zone, against the islands. It is likely that frozen snow accumulated here and afforded the plant some protection. *Zostera*, which was

first found on the south side of the Medway in 1962, has been quite unaffected by the cold and, in fact, has spread considerably and is establishing itself in areas where the *Enteromorpha* has been destroyed. *Salicornia* on the estuary is quite unaffected, or even more prolific than usual. It seems likely that the holding capacity of the estuary for both Wigeon and Brent will be reduced this year, until either the *Enteromorpha* recovers or the *Zostera* spreads sufficiently to take over as a main food source for these species.

Practical application

On 8th January, 1963, the joint appeal of the Wildfowl Trust and the Wildfowlers' Association to stop shooting ducks and geese until the end of the cold spell was broadcast by the B.B.C. Looking back on events, one can now see that the appeal was timed absolutely correctly so far as Kent was concerned. Already the cold spell had lasted for two-and-a-half weeks and two days after the appeal the inter-tidal zone started to freeze. This, in our opinion, is the key to the problem and is far more important than snow cover, unless the snow is exceptionally deep. The correct time to stop wildfowling is, if possible, when the inter-tidal zone freezes, exactly as happened in 1963.

The voluntary ban was well supported by members of the Wildfowlers' Assocation, but not, unfortunately, by some irresponsible gunners from London and the towns, who owed no allegiance to any wildfowlers' club or to W.A.G.B.I. It is also regrettable that a small minority of big landowners were equally irresponsible and far more lethal and at one time large numbers of wildfowl were on sale in Maidstone Market at prices which cannot have equalled the cost of the cartridges. Several were still carrying rings, which is a further reflection on the irresponsibility of the particular landowner who had brought them to market. It is encouraging, however, that the number of W.A.G.B.I. hand-reared Mallard reported shot in January and February 1963 was not above average (Wardell and Harrison, 1964).

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W.A.G.B.I. hand-reared Mallard in the cold spell of 1962-63

JEFFERY HARRISON and JOHN WARDELL

Summary

Recoveries of W.A.G.B.I. hand-reared Mallard during and after the hard weather of 1962-63 show that these duck undertook a marked weather migration, with a directional bias between S.E., through W. to N.W. Mortality figures as available at present indicate that there was some increase resulting from the cold spell.

In the summer of 1962, the Wildfowlers' Association liberated 8,949 first-year Mallard (*Anas platyrhynchos platyrhynchos* L.) to bring the accumulated total since the rearing scheme began in 1954 to 29,004. We thus had a very adequate sample at risk, all ringed, on which to study the effects of the extreme cold which lasted from 23rd December, 1962, until 3rd March, 1963, and which covered almost the whole of Britain.

For the purpose of comparison, it was decided to use the years 1959-61, the winters of 1959-60 and 1960-61 being a little milder than average and the winter of 1961-62 having a moderately severe cold spell in the New Year.

Table I sets out the release and recovery details of first-year birds, sub-divided to give the January and February figures, showing the recoveries during the cold spell, and recoveries during the earlier part of the season. Movements are divided into local recoveries of under 10 miles from release point, home dispersals of over 10 miles from release point and overseas dispersals.

It will be seen that there was a marked increase in the distances travelled from the recoveries reported in January and February 1963. We have previously shown that there is a relation between the weather and the dispersal rate, late harvests and a good acorn crop appearing to lower the rate owing to abundance of food (Harrison and Wardell, 1963). Thus the autumn of 1962 was characterised by a heavy, late harvest and a good acorn year, and recoveries showed movements well below average. With the onset of the cold spell the whole picture changed and the combined home and overseas dispersal rate rose to 43·8% of recoveries, as compared with 12·6% for the period up to the end of 1962 and 18·0% average in January – February 1960-62. In an earlier review of first autumn dispersal of hand-reared Mallard, Boyd and Harrison (1962) record that the average rate for distances 10 miles or more from release point for W.A.G.B.I. hand-reared Mallard from 1954 to 1961 was only 19·9% of recoveries. Comparative figures for two small groups of wild Mallard from Gloucestershire (133) and Abberton, Essex (500) were 22·9% and 26·3% respectively. The W.A.G.B.I. figure of 43·8% for January – February 1963 is therefore quite unprecedented.

In view of the joint appeal by the Wildfowl Trust and W.A.G.B.I. issued on 8th January, 1963, not to shoot wildfowl which were suffering from the cold, it is encouraging to note that the recovery percentage due to shooting in January – February 1963 at 0·59% compared favourably with the 0·51% average for the previous 3 years. The percentage found dead at this time (0·19%) was significantly increased over the previous 3-year average of 0·09%. When this was reported to the 6th International Conference of Game Biologists (Wardell and Harrison, in press), H. Boyd pointed out that no such increase was found in wild Mallard in Britain and he wondered if this indicated that hand-reared birds are less able to withstand the cold. This is probably not so, the reason for the increased recovery rate being that those birds which have remained on the release reserves and die are more likely to be found and reported than wild casualties. For wild Mallard, Harrison and Hudson (1964, see p. 26) in analysing the mortality of wildfowl in north Kent during the cold spell found that this species was the third most frequent casualty; significant numbers were picked up, although well below those of the more vulnerable Wigeon (*A. penelope* L.) and Shelduck (*Tadorna tadorna* (L.)).

Table II. Recoveries of adult Mallard in January and February in 1963 and 1961-62

average 1961-62		%	*1963*	%
Shot	23	77	36	86
Found dead	5	17	5	12
Others	2	6	1	2
	30	100	42	100
Local	27	90	25	60
Over 10 miles	2	7	13	31
Overseas	1	3	4	9
	30	100	42	100

Table I. First Year Recoveries – January-February 1963 in comparison with other years

release year	*1959*		*1960*		*1961*		*Total 1959–61*		*1962*	
number released	*3,412*		*5,278*		*7,268*		*15,959*		*8,949*	
		%		*%*		*%*		*%*		*%*
1. Recoveries Jan-Feb										
Shot	16	*0·47*	12	*0·24*	54	*0·74*	82	*0·51*	53	*0·59*
Found Dead	5	*0·15*	1	*0·02*	8	*0·11*	14	*0·09*	17	*0·19*
Other	2	*0·06*	2	*0·04*	1	*0·02*	5	*0·03*	1	*0·01*
TOTAL	23	*0·68 = 11·7 %*	15	*0·30 = 8·4 %*	63	*0·87 = 15·9 %*	101	*0·63=12·8 %*	71	*0·79=15·7 %*
Local	21	*91·3*	12	*80·0*	50	*79·4*	83	*82·0*	20	*56·2*
Home Dispersal	–	–	2	*13·5*	11	*17·4*	13	*13·0*	27	*38·2*
Overseas Dispersal	2	*8·7*	1	*6·5*	2	*3·2*	5	*5·0*	4	*5·6*
		100·0		*100·0*		*100·0*		*100·0*		*100·0*
2. Other First Season Recoveries										
Shot	153	*4·47*	158	*2·96*	292	*4·04*	603	*3·79*	314	*3·51*
Found Dead	17	*0·49*	12	*0·23*	38	*0·52*	67	*0·42*	48	*0·56*
Other	6	*0·17*	5	*0·11*	5	*0·06*	16	*0·10*	18	*0·20*
TOTAL	176	*5·13=88·3 %*	175	*3·30=91·6 %*	335	*4·62=84·1 %*	686	*4·31=87·2 %*	380	*4·27=84·3 %*
Local	132	*75·0*	146	*83·4*	258	*77·0*	536	*78·1*	332	*87·4*
Home Dispersal	38	*21·6*	27	*15·5*	70	*20·9*	135	*19·7*	47	*12·4*
Overseas Dispersal	6	*3·4*	2	*1·1*	7	*2·1*	15	*2·2*	1	*0·2*
		100·0		*100·0*		*100·0*		*100·0*		*100·0*
3. Total for Season										
Shot	169	*4·94*	170	*3·20*	346	*4·78*	685	*4·30*	367	*4·10*
Found Dead	22	*0·64*	13	*0·25*	46	*0·63*	81	*0·51*	65	*0·75*
Other	8	*0·23*	7	*0·15*	6	*0·08*	21	*0·13*	19	*0·21*
TOTAL	199	*5·81=100 %*	190	*3·60=100 %*	398	*5·49=100 %*	787	*4·94=100 %*	451	*5·06=100 %*
Local	153	*77·0*	158	*83·0*	308	*77·4*	619	*78·7*	372	*82·5*
Home Dispersal	38	*19·0*	29	*15·4*	81	*20·3*	148	*18·8*	74	*16·4*
Overseas Dispersal	8	*4·0*	3	*1·6*	9	*2·3*	20	*2·5*	5	*1·1*
		100·0		*100·0*		*100·0*		*100·0*		*100·0*

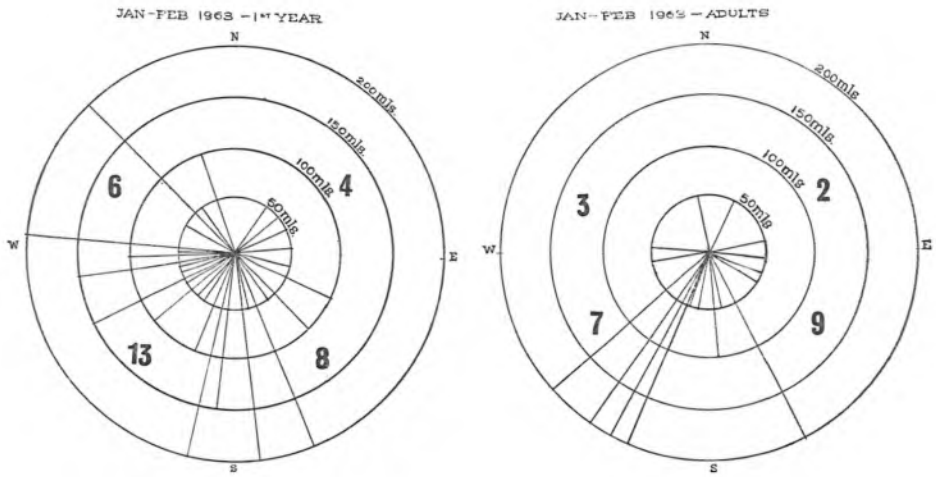

Figure 1. Relative frequency of movement in different directions from ringing-place shown by recoveries in January – February 1963 of W.A.G.B.I. hand-reared Mallard.
Recoveries of birds in their first winter shown on the left, of older birds on the right.

Table II analyses the movements of adult hand-reared Mallard and shows a result very similar to the first-year birds, the combined percentage for recoveries 10 or more miles from release point, including overseas recoveries rising from an average of 10% of recoveries for January – February 1961-62 to 40% for January – February 1963. Recoveries of these age groups in the 1963-64 season include 34% over 10 miles from release point, 14% of these being overseas.

Two orientation charts have been produced to illustrate the directional tendencies shown by the recoveries 50 miles or more from release (Figure 1). These show

Table III. Recoveries of selected first-year weather migrants

W.A.G.B.I. ring no.	*ringer*	*release data*	*sex*	*recovery data*	*direction and distance*
40432	Leics. W.A.	2.7.62. Gumley, Leicestershire	–	Rodez Aveyron, **France.** 13.1.63	S.S.E. 550 miles
30978	Leics. W.A.	1.7.62. Market Bosworth, Leicestershire	♀	River Vienne, Chinon, **France.** 15.9.63	S. 380 miles
40962	Devon W.A.	28.8.62. Exeter Devon	♀	Kilmore, Wexford, **Eire.** 12.1.63	N.W. 180 miles
43173	W. Knott Esq.	1.5.62. Presteigne, Radnorshire	♂	E. Wexford Coast, **Eire.** 17.1.63	W. 170 miles
43157	W. Knott Esq.	1.5.62. Presteigne, Radnorshire	♂	River Blackwater, Co. Cork, **Eire.** 30.1.63	W. 250 miles
43172	W. Knott Esq.	1.8.62. Presteigne, Radnorshire	♂	Kingsbridge, South Devon. 20.1.63	S. 140 miles
43184	W. Knott Esq.	1.8.62. Presteigne, Radnorshire	♀	St. Germans, Cornwall. 26.1.63	S. 140 miles
43185	W. Knott Esq.	1.8.62. Presteigne, Radnorshire	♀	Pell, Somerset. 9.2.63	S. 100 miles
35447	Lt.-Col. Bowring	12.6.62. Kirkby Lonsdale, Westmorland	♂	Grimsby, Lincolnshire. 20.1.63	S.E. 110 miles
37430	South Lincs. W.A.	12.6.62. Boston, Lincolnshire	–	St. Brides Bay, Pembrokeshire. 2.1.63	S.W. 240 miles
34743	W. Potts Esq.	28.7.62. Holywell, Northumberland	♀	Worksop, Nottinghamshire. 20.1.63	E.S.E. 120 miles
40437	Lord Mansfield	12.6.62. Perth Scotland	♂	Colwich, Nottinghamshire. 26.1.63	S. 250 miles

Table IV. Recoveries of selected adult weather migrants.

W.A.G.B.I. ring no.	*ringer*	*release data*	*sex*	*recovery data*	*direction and distance*
21770	Leics. W.A.	4.7.61. Carlton Curlew, Leicestershire.	♂	Villers-sur-mer, Calvados, **France.** 4.1.63	S.S.W. 250 miles
18280	E. Sussex W.A.	1961. Guestling, Hastings, Sussex	–	Hennebont, Morbihan, **France.** 23.1.63	S.W. 280 miles
18171	E. Sussex W.A.	12.8.60. Guestling, Hastings, Sussex	–	Le Portel, Pas de Calais, **France.** 4.1.63	E.S.E. 45 miles
25873	Home Counties W.A.	–.7.61. Tillingham, Essex	–	Nanteuil le Haudoin, Oise, **France.** 6.1.63	S.S.E. 170 miles
3361	Dee W.A.	1960. Dee Estuary, Cheshire	–	Beccles, Suffolk. –.1.63	E.S.E. 216 miles
12256	Leics. W.A.	15.6.60. Ashby de la Zouch, Leicestershire	–	Porlock, Somerset. 12.1.63	S.S.W. 140 miles
30010	Hesketh Bank W.A.	16.6.61. Hesketh Bank, Lancashire	♂	Pagham Harbour Sussex, 14.3.63	S.E. 225 miles

that there was a marked directional bias in January – February 1963 between S.E., through W. to N.W., which in the adults is even more concentrated between S.E. and S.W. Boyd and Harrison in analysing the recoveries of all W.A.G.B.I. first-year birds from 1954 to 1961 showed that there was no obvious directional bias, so that it can be said with certainty that a marked weather migration of hand-reared birds took place in January – February 1963 which must have contributed very materially to their survival.

Tables III and IV list the details of some of the more interesting of these recoveries. The five recoveries of Mr. Knott's birds deserve special mention and it is of interest that both birds released on 1.5.62. went west and a further duck from this batch was recovered in Co. Cork in December 1963. Those released on 1.8.62. went south. Although No. 30978 was not recovered in central France until September, it seems likely that it also originally left as a weather migrant, in view of the other Leicestershire bird recovered in the south of France – the most southerly recovery of any Mallard ringed in Britain.

Recoveries during the 1963-64 season have enabled us to make a preliminary assessment of the mortality that occurred during the hard weather. Table V shows the percentage recovered in each age group in 1963-64 up to the end of January, compared with the 1962-63 season and the average for 1954-63.

Table V. Percentage of recoveries in successive years following release.

year	*one*	*two*	*three*	*four*	*five and after*	*total*
Average 1954-63	4·7	2·0	0·8	0·3	0·2	8·0
1962-63	5·0	1·5	1·1	0·4	0·3	8·3
1963-64	3·3	1·2	0·4	0·3	0·2	5·4

This shows that of the releases during the summer of 1962, 5·0% were recovered in 1962-63 and 1·2% in 1963-64 up to the end of January, total 6·2%. From our mortality tables (Harrison and Wardell 1963), we can deduce that first- and second-year mortality amounts to about 84%. If our 1962 sample was typical, this would mean first- and second-year mortality rates of 67% and 52% compared with an average of 59% and 60%. However, the 1963-64 first-year sample is about 30% lower than average, such as we have come to expect in autumns with late harvests and an abundant food supply. In addition, the season was not a favourable one for wildfowling and also a proportion of recoveries are still to be reported. If we rate up the second year recovery percentage by 30% because of these factors it becomes 1·7% and assuming that the cumulative mortality is still 84%, we can correct the mortality percentage for the two years to 63% and 21% and the mortality rates to 63% and 57%. This second calculation results in a more realistic second-year mortality rate, but we must await further recoveries from this age group before finally assessing the situation. It is clear, however, that the mortality of W.A.G.B.I. hand-reared Mallard as the result of the hard weather was somewhat higher than normal.

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Losses of Mute Swans in England in the winter of 1962-63

HUGH BOYD and MALCOLM OGILVIE

Summary

The cold winter of 1962-63 led to a marked decline in the numbers of Mute Swans in England, though no precise estimate of the losses suffered is yet obtainable. The number of recoveries of ringed swans was exceptionally high in early March, at the end of the cold spell. Casualties attributed to cold were mostly found in late January. Losses due to collisions with overhead wires were abnormally low in January and February 1963. Mortality was much lower in the north-west than elsewhere.

The Mute Swan (*Cygnus olor* (Gmelin)) is the most conspicuous and most urban of the wildfowl in Great Britain and is known to be vulnerable to the effects of cold winters (Hilprecht, 1956). This paper is a preliminary report on the losses suffered by Mute Swans in England from December, 1962 to March, 1963, based very largely on recoveries of ringed birds. Because ringing began on a large scale only in 1960 and because the mortality of swans varies greatly with age as well as from year to year, it will not be possible to make a reliable and detailed comparison of the death-rate in 1962-63 with that in other winters until several more years have elapsed, but even the crude analyses now possible show some features of interest. Relatively few Mute Swans have been ringed in Scotland or Wales and these give no indication that swans in either country were affected by the cold spell, so that attention is here restricted to England, which holds about three-quarters of the British population.

Changes in relative numbers in England

The size of the British population of Mute Swans was investigated as recently as 1961 by means of a sample breeding census (Eltringham, 1963). It was not possible to organise another breeding survey in 1963, so that the only method of estimating changes in total numbers is by an extension of Eltringham's 'Winter Index', based on the monthly National Wildfowl Counts. The calculation of indices of this type is described by Eltringham and Atkinson-Willes (1961). Basically the method consists in comparing the number of swans seen in each month on a national sample of about 300 waters with the number seen in the comparable month of a master season. From these monthly figures, a seasonal index representative of the whole period September – March is calculated. In Table I, indices for 1962-63 and 1963-64 are compared with those for seasons since 1957-58. (These indices differ from those published by Eltringham for Great Britain as a whole.) There are clear indications of decreases in the two latest winters. It is difficult to interpret the index for a period in which exceptional losses may be actually being suffered, and the autumn index is perhaps more effective, but it is unfortunately not possible to determine what proportion of each sample consisted of birds bred in the preceding summer. Thus annual variations in breeding success as well as in mortality affect these indices.

It might be thought possible to investigate survival through the winter directly by paired comparisons of counts from month to month within each season. This method has proved useless, because of variations in the tendency to aggregate or disperse in the course of the annual cycle. Only where it can be shown that changes in numbers are due solely to births and deaths without immigration or emigration can direct counts be used to measure mortality. Observations and evidence from ringing suggest that 'closed' groups of this kind must be quite exceptional in England: in many cases where the numbers at one place remain nearly constant it has been found that many individuals are coming and going.

Times of recovery of ringed swans

Some measure of the relative magnitude of the losses suffered by Mute Swans in the cold weather of 1962-63 can be obtained by comparing the numbers of recoveries in each month (or quarter) in different years (Table II, upper part). The frequency of recoveries depends on the number of birds at risk and this was changing rapidly in 1962 and 1963 (Table II, lower part). The number of recoveries in January to March of swans ringed in the previous calendar year as a proportion of the number ringed serves as a more nearly quantitative index of losses (Table III). It appears that losses in early 1963 were more than twice as great as in the same period in 1961, though only 30% greater than in 1962. The most striking feature of the distribution of recoveries in 1963 is the large number in March.

The cold spell began about 21st December, 1962, and persisted until early March, 1963, with some amelioration in February, varying considerably from place to place. In Table IV recoveries are grouped into 10-day periods (dates of death cannot be inferred from recovery reports with any great precision: some recoveries included in the monthly totals of Table II and V have had to be omitted from Table IV for this reason). Numbers in late December are low. From January to March they vary about a mean frequency of 26, with rather few in January, a peak in mid-February and an especially marked peak in early March. These peaks do not correspond with the periods of severest cold. They suggest instead that most dead swans were found at times when it was relatively easy to look for them. Deaths attributed to cold or starvation by the finder are, however, spread in quite a different way, with a concentration in the second half of January.

Causes of death

At all times no indication of the cause of death is provided for nearly half the dead swans reported (Table V). The reliability of diagnosis by finders is also not likely to be great, because few people would contemplate making, or arranging for, a thorough post-mortem examination of so massive a bird. Collisions with wires or bridges or cars produce recognisable results, but the 5-6% of swans described as 'sick', 'diseased', 'poor' or 'dying' might or might not be victims of severe weather. The remarkable feature of Table V is that the marked increase in deaths attributed to cold or starvation in 1963 as compared with earlier years is offset by a reduction in the numbers supposed killed in other named ways. In other years collision with wires produced 63 of 242 (26·0%) reported deaths in January–March; in 1963 only 35 of 264 (13·3%). The reduction in wire-casualties was in fact restricted to January and February (4 and 3 respectively, against 18 and 25 in previous years). The fact that so many of their normal haunts were ice-covered might lead one to suppose that swans needed to fly more, rather than less, than usual in early 1963. Perhaps this was not so, or perhaps overhead wires were more readily seen and avoided because thickened by a covering of ice.

All seven recoveries due to the effects of cold in earlier years included in Table V were reported in 1962, five of them between 1st and 3rd January. There was severe cold in England from 23rd December, 1961 to 4th January, 1962. In 1962-63, when the cold spell began on 22nd December, the first casualty ascribed to the cold was not found until 4th January and only 5 of 36 such deaths occurred before 14th January. The ratio of cold-casualties to other recoveries in the period 22nd December – 5th January was 6:12 in 1961-62, against 2:9 in 1962-63, but clear proof that more casualties occurred in the first spell than in the corresponding period in 1962-63 cannot be found.

Regional differences

If recoveries in January – March, 1963 of swans ringed in the year 1962 are used as a measure of relative loss in different parts of the country (Table VI), it is obvious that casualties were much higher in the south and east than in the north and west. That is, losses were heaviest in the region where swans are most abundant (Atkinson-Willes, 1963). Further investigations will be needed to establish whether this was a consequence of the high density of swans or whether it can be accounted for solely by the greater severity of the weather in that part of the country.

Acknowledgement

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Table I. Index of abundance of Mute Swans in England from September to March 1957-58 to 1963-64. Data from National Wildfowl Counts

season	*number of swans counted* *master season (1957-58)*	*season cited*	*season index (Sept-Mar)*	*autumn index (Sept-Dec)*
1957–58			100	100
1958–59	12,488	11,986	96	89
1959–60	11,928	12,520	105	100
1960–61	13,552	13,410	99	92
1961–62	13,481	13,958	104	100
1962–63	11,563	9,329	81	82
1963–64				

Table II. Months of ringing and of recovery of Mute Swans

		Jan	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*	*total*
recovered														
before	1962	19	31	31	26	21	19	16	19	43	59	59	63	406
in	1962	57	52	60	47	40	15	15	11	43	46	49	29	464
in	1963	63	90	112	56	33	18	9	13	23	33	30	7	467
ringed														
in	1960	24	138	119	174	83	83	129	128	131	140	94	69	1,362
in	1961	116	112	332	306	329	209	149	350	270	290	164	272	2,899
in	1962	317	221	168	175	127	187	191	254	250	153	87	182	2,312
	1960–62	457	471	619	655	539	479	469	732	651	633	345	523	6,573

Table III. Numbers of recoveries in January–March 1961-63, related to numbers of Mute Swans ringed in England in preceding year

recovered in	*recoveries in Jan-Mar from ringing in previous year*	*number ringed in previous year*	*recovery rate (%)*
1961	28	1,366	2·05
1962	99	3,035	3·26
1963	106	2,491	4·26

Table IV. Recoveries of Mute Swans from late December 1962 to March 1963, grouped in 10-day intervals. Imprecisely-dated records omitted

	Dec	*January*			*February*			*March*		
recoveries	*22–31*	*1–10*	*11–20*	*21–30*	*31–9*	*10–19*	*21–1*	*2–11*	*12–21*	*22–31*
deaths from cold		3	10	9	3	3	4			
long dead			1		1		1	3	4	2
others	5	15	7	13	22	32	15	37	27	23
total	5	18	18	22	26	35	20	40	31	25

Table V. Reported causes of death of ringed Mute Swans in winter

	1963					*earlier years*				
causes of death	*Jan*	*Feb*	*Mar*	*sum*	*%*	*Jan*	*Feb*	*Mar*	*sum*	*%*
cold, starvation	23	13		36	13·8	6		1	7	2·9
'sick', 'exhausted'	5	8	3	16	6·1	1	6	5	12	5·0
other cause given	11	28	46	85	32·1	30	41	42	113	46·7
no details	24	41	62	127	48·0	38	33	39	110	45·4
total	63	90	111	264		75	80	87	242	

Table VI. Regional differences in rate of recovery in January–March 1963 of Mute Swans ringed in 1962

	south -west	*London & south-east*	*east Anglia*	*east midlands & north-east*	*west midlands & north-west*
recovered	24	30	22	10	20
ringed 1962	456	617	296	219	903
% recovered	5·3	4·9	7·4	4·6	2·2

Deaths of wild White-fronted Geese at Slimbridge in January 1963

J. V. BEER and H. BOYD

Summary

Heavy and persistent snow cover caused a serious shortage of food for White-fronted Geese in England and Wales from late December, 1962, to February, 1963. Fifteen Whitefronts found dead or dying at Slimbridge in January were all underweight and at least four had died from starvation. Recoveries of ringed birds show a similar concentration of losses in mid-January elsewhere in England and Wales, with an exceptional proportion of geese 'found dead' as well as unusually heavy shooting casualties. Recoveries from the Netherlands and France were also exceptionally numerous but do not show marked grouping in mid-January, perhaps because of emergency legal restrictions imposed in those countries.

On 26th December, 1962, the feeding grounds of the White-fronted Geese (*Anser a. albifrons* (Scopoli)) at Slimbridge, Glos., became wholly covered in snow, which remained until early March, 1963. White-fronted Geese are not seriously inconvenienced by light snow cover, searching widely for exposed grass or exposing it for themselves by sitting on the snow until it melts sufficiently for them to pull at the grass beneath. But the snow of late December lay so deep and thick and even that there was nothing for the geese to eat. 3,000 Whitefronts had been counted on 26th December and were still present on 29th. By 6th January the number had fallen to 800 and on 9th there were only 350. Fewer than 50 were seen on any day during the next four weeks. By 5th February, wind action and slight daytime thawing had exposed small areas of grass and thereafter the snow cover was not complete, even though the ground remained frozen until 5th March. By 9th February 500 geese had returned and their numbers increased to 1,200 on 14th, 2,000 on 16th and 2,750 on 25th.

Between 29th December and 28th January 15 dead or dying Whitefronts were brought in for examination. 13 of these were found between 8th and 17th January, when there were hardly any geese living at Slimbridge. None was picked up after the return of larger numbers in February. This paper reports on the condition of the birds that died and discusses why the deaths took place when they did.

Age and sex of casualties

Only two of the fifteen geese handled were first-winter birds. This proportion (13·3%) is little different from that of 9·6% first-winter birds seen in 1,400 inspected at Slimbridge on 21st December. This was the lowest proportion of young birds seen in late December in any year since 1946, when age-ratios were first studied. (The scarcity of young birds seems to have been due to widespread breeding failure in Siberia in 1962.) Since there were so few young geese, any difference in the response of young and older geese to the effects of thick snow cover would scarcely have been detectable in so small a number of corpses.

The sex of one badly-damaged goose could not be determined. Of the others, 10 were males and 4 females. Since the sex-ratio in Whitefronts flocks is normally very close to unity (Beer and Boyd, 1963), this disparity suggests that males were more vulnerable than females.

Causes of death

Four corpses were too badly damaged for the proximate cause of death to be discovered. Six of the remainder (five males) had been shot and four males seemed to have died from starvation. An adult female

picked up in a weak condition was killed by other birds when released some days later among captive geese.

No organised shoots took place at Slimbridge in the winter of 1962-63 but, as the post-mortem findings confirm, the abnormal movements of the geese in their search for food exposed them to considerable 'shooting pressure' even after the broadcast appeal to stop shooting made on 8th January, on behalf of the Wildfowl Trust and the Wildfowlers' Association.

Condition of dead geese

Table I summarises the information on condition given by the weight of each bird, by the presence of deposits of fat under the skin and among the viscera, and by the extent of wasting of the pectoral muscles and of the liver. Beer and Boyd (*loc. cit.*) have shown that in normal winters the weight of a Whitefront is closely correlated with its size, so that its normal weight can be estimated from the equation of regression of weight on wing length. The entries in the column 'expected weight' were obtained in this way, using different equations for males and females and for first-winter and older birds.

All the geese found were lighter than their predicted weights. The shot birds averaged 17% and the starved birds 42% below expectation. All six of the birds with weights less than 80% of expected which were examined after death showed reduction of the liver and five also had wasted pectoral muscles. Only one retained any subcutaneous fat. In three, the intestines were markedly reduced. The condition of the heart varied considerably in the six low-weight geese: it was soft and flabby (and hence probably reduced) in two and apparently normal in one. In two the pericardium was thickened and in one of these the valves were also thickened. In the sixth the right ventricle was distended.

Among the geese with relatively high weights at death only the female picked up on 29th December and a male found on 10th January retained substantial fat deposits. These two and three others (the latest found on 16th January) showed little wasting of the breast muscles or of the liver and intestines. Three of the comparatively heavy birds, including the early-taken female, had greatly enlarged gall-bladders.

The effects of starvation on geese do not seem to have been studied. Latham (1947) included game-farm Mallard (*Anas p.platyrhynchos* (L.)) in an experimental study of the ability of game birds to withstand starvation and low temperatures. His principal finding was that females survived longer than males. Jordan (1953) investigated the effects of starvation on wild Mallard held in captivity. He found *inter alia* that starvation was accompanied by a high rate of body weight loss, rather less in females than males, the internal organs of females being more resistant to atrophy. Males died

Table I. The condition of White-fronted Geese picked up at Slimbridge in January 1963

date found	*sex*	*wing length (mm)*	*recorded weight (kg)*	*expected weight (kg)*	*recorded wt. / expected wt. (%)*	*body fat*	*wasting of breast*	*wasting of liver*	*state when found*
Shot									
8 Jan	♂	408	1·94	2·30	84	0	+		moribund
9 Jan	♂	419	1·82	2·47	74	1			dying
10 Jan	♂	419	2·35	2·47	95	2			dead
12 Jan	♂	407	1·54	2·27	68	0	++	++	weak, died 13th
14 Jan 1st W	♀	379	1·51	1·91	79	0	+	+	died when picked up
16 Jan	♂	433	2·46	2·60	95	1			freshly dead
Starved									
9 Jan	♂	436	1·40	2·63	53	0	++	++	crow-damaged
11 Jan	♂	436	1·28	2·63	49	0	++	++	dead
(17 Jan	♂	414	1·86	2·37	78		++		weak: recovered)
28 Jan	♂	429	1·35	2·54	53	0	++	++	died 29th
Killed by captive geese									
29 Dec	♀	383	1·72	2·09	82	2			weak

'expected weight' derived from regression of weight on wing length, see text.
body fat: scored on a 4 point scale, 0 = no fat deposits, 3 = heavy fat.
wasting of breast muscles and liver: + marked, ++ severe

sooner than females, deteriorating very rapidly after about three weeks starvation. The livers of starved birds lost proportionately more weight than did other organs. In both sexes the gall-bladders were enlarged to nearly three times their normal weight. The condition of the starved geese seems to be consistent with Jordan's findings, although enlargement of the gall-bladder was not recorded in the birds most severely affected.

Since the true weight of each individual at the onset of the severe weather is not known, no estimate of the rate of weight loss is practicable, but in this connection another small series of weights of White-fronted Geese trapped for ringing in the Netherlands is of some interest. Table II compares data published by Doude van Troostwijk (1964) with those from Slimbridge. Nearly all English-wintering Whitefronts spend part of the winter in the Netherlands so that the geese are of a common stock. The comparison is restricted to adult males, the only class with sufficient post-mortem material. The weight of Slimbridge geese in December shown in italic is the average of the hypothetical 'expected weights', obtained as described above. It is included here because of the possibility suggested by the relatively low average of the Dutch December sample that the geese may have been unusually light even at the onset of the severe weather.

There is marked difference between the average weights of Whitefronts trapped in the Netherlands in January, 1963, and of those picked up at Slimbridge. Those birds remaining in good enough condition to fly about and to be caught in clap-nets seem to have lost little weight (the average being scarcely 5% less than in December), being little if any lighter than geese caught in late January 1962, when the weather was not unusually cold. Yet the Netherlands records from late February and March 1956, another period of severe cold, show that appreciable weight reduction probably occurred in that year. The interpretation of these data is made difficult not only by their fragmentary nature but also by the possibility that geese wintering in the Netherlands may tend to weigh rather less than those moving on to England.

The individual listed in Table I as having recovered is of some interest. Picked up on 17th January in a very weak condition, it was kept in a warm room and given a diet of turkey starter pellets. In a very few days it began to regain its strength and after three weeks or so was so vigorous and belligerent that it became difficult to approach and eventually escaped on 20th February by pushing aside the person who had come to feed it. This goose was weighed at frequent intervals (Table III). For a fortnight before its escape the bird was heavier than its 'expected weight'. There is an interesting change in its rate of gain somewhere between the 8th and 12th day, the earlier increase (after the initial lag) being at more than twice the rate of the later ones. This suggests that two methods of gain may have been involved: perhaps a replacement of atrophied tissues initially and the deposition of fat later. Such a sequence would be the inverse of that occurring during starvation (Jordan, 1953). Jordan also studied the rehabilitation of Mallard after starvation and reported that one week after feeding was resumed males had recovered 80%, and females 83·6%, of the weight lost during starvation while after two weeks weights were nearly equal to those at the beginning of fasting. The corresponding intervals for this male goose seem likely to have been about two and three weeks.

Time of occurrence of death

It has already been remarked that 13 of the 15 casualties were picked up between 8th and 17th January and only one later (on 28th January), despite the continued severity of the weather. What significance attaches to the concentration of deaths in mid-January, 2-3 weeks after the ground became completely snow-covered? Jordan (1953) suggested that it was unlikely that even wholly starved Mallard would die in less than two weeks 'in nature in normal winter weather' (average air temperature

Table II. Mean weights of adult male White-fronted Geese picked up at Slimbridge in January 1963 compared with those of adult males trapped for ringing at Slimbridge and in the Netherlands

	December II	*January I*	*January II*	*February II & March I*
picked up at Slimbridge, 1963	*2·47*	1·76 (6)	1·89 (3)	
trapped in Netherlands, 1962-63	2·18 (5)	2·08 (8)	2·08 (3)	2·05 (25)
trapped at Slimbridge, 1958-62				2·45 (87)
trapped in Netherlands, 1962			2·16 (11)	
trapped in Netherlands, 1956				1·96 (11)

Netherlands data from Doude van Troostwijk, 1964. Weights in kg. Sample sizes in parenthesis.

29·8°F., –2°C., in his study). The air temperatures at Slimbridge in early January 1963 remained almost continuously below 0°C. and may have been rather lower than in Jordan's experiment, but the difference seems unlikely to have been enough to be important. Thus it can be argued that the small numbers of known deaths before 8th January show that the geese had not yet been incapacitated by starvation. The virtual absence of known deaths from 17th January to early February was inevitable if there were hardly any geese present to die during that time. Reason and observation suggest that the geese returning in February found enough food to keep them alive.

During January, 1963, White-fronted Geese were reported, often in exceptional numbers, in many of their usual haunts in England and Wales and from many places where they had rarely or never been seen before. The reports of living geese are insufficiently complete to demonstrate whether especial losses occurred in mid-January, nor were useful reports of dead geese received from elsewhere. Recoveries of rings, both from geese ringed in earlier years at Slimbridge and from those ringed in the Netherlands, are of considerable help on this point (Table IV). The recoveries in England and Wales show a concentration in mid-January almost as marked as the timing of casualties at Slimbridge, confirming that this was the worst period for the geese.

Full recovery details of Dutch-ringed geese in 1962-63 have not yet been published. Five of the Slimbridge-ringed geese were reported 'found dead' and five were shot (cause of death of three uncertain); in marked contrast, of twelve recovered in England and Wales in earlier winters, eleven were reported shot and only one found dead. These twelve earlier recoveries were spread over thirteen years, so that the recovery-rate in early 1963 was quite exceptionally high.

Among the recoveries of Slimbridge-ringed birds, including two overseas, eight were males and seven females. Of the five found dead, three were males. The lack of marked disparity between males and females seems to contradict the preponderance of males in the geese found dead at Slimbridge. In conjunction with Doude van Troostwijk's (1964) data, showing little loss of weight of either males or females in the Netherlands in January, 1963, this parity of reported losses away from Slimbridge may mean that males only succumb more readily than females at an advanced stage in their deterioration through starvation. Such an

Table III. Gains in weight of an adult male White-fronted Goose picked up at Slimbridge on 17th January 1963 and kept well fed until 20th February

day	*weight (gm)*	*gain (gm)*	*average daily gain*	*rate of gain (%)*	*day*	*weight (gm)*	*gain (gm)*	*average daily gain*	*rate of gain (%)*
0	1860	–	–	–	20	2470	130	32·5	1·32
2	1890	30	15	0·81	22	2500	30	15	0·61
4	2010	120	60	3·17	23	2530	30	30	1·20
6	2150	140	70	3·48	25	2590	60	30	1·19
8	2250	100	50	2·32	27	2690	100	50	1·93
12	2260	10	2·5	0·11	30	2750	60	20	0·73
16	2340	80	20	0·88	32	2820	70	35	1·27

Table IV. Dates of recovery of ringed White-fronted Geese in England and Wales, from December 1962 to March, 1963, compared with geese found dying at Slimbridge and with recoveries in the Netherlands and France

	period of recovery						
	Dec 21–31	*Jan 1–10*	*Jan 11–20*	*Jan 21–31*	*Feb 1–10*	*late Feb & March*	*total*
Slimbridge-ringed	0	5	3	2	1	2	13
Dutch-ringed	1	3	7	2	1	2	16
found in England & Wales	1	8	10	4	2	4	29
(unringed) geese picked up at Slimbridge	*1*	*6*	*7*	*1*	*0*	*0*	15
found in Netherlands	5	3	5	5	2	0	20
found in France	2	7	8	3	4	11	35

Recoveries of Dutch-ringed birds from Doude van Troostwijk (1964).

inference is consistent with the physiological evidence presented by Jordan (1953).

In the Netherlands and France the timing of recoveries was very different. Shooting was stopped by law in the Netherlands on 3rd January, 1963 and in France from 17th January to 16th February and again from 21st February to 8th March. The ban in France evidently reduced the kill in late January and early February. The situation in the Netherlands is less clear: large-scale emigration occurred after blizzards on 30th December and 3rd-4th January, yet recoveries did not diminish until February, though the rate of loss was relatively low (Doude van Troostwijk, 1964).

A thorough evaluation of the effects of the hard weather of early 1963 on the White-fronted Geese wintering in western Europe cannot be made until several years have elapsed. This preliminary study suggests, however, that losses both from starvation and from shooting were probably much higher in 1963 than in any winter since 1948.

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Shelduck food supply in severe weather

JOHN HORI

Shelduck (*Tadorna tadorna* (L.)) suffered heavy mortality in the Thames estuary during the icy conditions of January and February 1963. On one stretch of shore on Sheppey, Kent, 18 dead birds were found during visits on 10th February, 3rd March and 10th March. On the first date another 22 dead were found on the opposite side of the island by D. Burkett and on 17th February, D. L. Davenport found 33 in a third locality. The recorded dead represented approximately 5% of the birds in the area; actual deaths were probably much more numerous. Further up the Thames other correspondents informed me that some 150 dead were found between 26th January and 10th March (and see p. 26 of this Report).

The stomachs of nine of the birds which I found were sent to P. J. S. Olney who discovered that eight contained food and that this consisted entirely of the small snail *Hydrobia ulvae*. Only three of the birds were emaciated. One of these and one other had been shot; the rest were not obviously starved or diseased. By coincidence my own captive Shelduck 'went off' their food during the same period, ignoring 'rich feed' and consuming only corn. Unfortunately the danger was not realised until one had frozen to death during the night. The others were then found to be in poor condition.

The presence of *Hydrobia ulvae* in the stomachs of the wild birds examined indicates that it is an important part of the Shelduck's diet in the Thames estuary. It also confirms direct observations that during winter this species has a feeding preference for the higher levels of mud flats, since it is there that the snail is most common (C. M. Yonge, *The Sea Shore*. Collins, London, 1949). During the cold spell the upper foreshore was blocked by pack ice and snow for long periods and although the birds managed to find small quantities of snails it is apparent that other essential food was either unavailable or in short supply. It seems probable that most deaths resulted from exposure amongst birds weakened by food shortage, just as my own bird died. It also seems probable that the essential food is in the upper levels of the mud flats and the outer fringe of the saltings since had they wished to feed on marine mollusca they could have done so at most low tides. During the breeding season Shelduck also feed on the fresh marshes (Hori, in press), but they do not use them to any extent in the winter. During the period in question the marshes were, of course, snow covered.

Effects of recent hard winters on the Shelducks of the Ythan

COLIN YOUNG

Shelducks (*Tadorna tadorna* (L.)) from the breeding colony on the Ythan estuary, Aberdeenshire spend the winter months moving gradually up the east coast of Britain on their return from moulting grounds on the North Sea coast of Germany. By the critical months of January and February, most of the Ythan birds have reached central Scotland; some in fact arrive back at the Ythan as early as the first week of January. Most of them, however, appear to spend the coldest part of the winter on the great tidal mud flats of the Eden estuary in Fife and in Montrose Basin in Angus, and it is at these stopping places that our birds would have experienced their greatest hardships during the severe winters of 1961-62 and 1962-63.

A count on 22nd February, 1963 at Edenmouth revealed 1,200 Shelducks, a number about average for that time of year as compared with counts by Boase from 1947 to 1954 (*British Birds* 52: 90–96. 1959). A count of 414 in Montrose Basin on 24th February, 1963 was considerably higher than any previous count in that area, Boase giving a February mean of 50 for the years 1952-1954. There have been no records of unusual numbers of dead or dying Shelducks found in either of these areas in 1963.

The early arrivals to the Ythan did however show some signs of the ravages of the hard weather. Many of the birds (perhaps 10%) had frost-bitten feet. In some this appeared only as inflamed swellings on the toes and webs, while in others the webs were completely necrotic and in extreme cases the webs had disappeared altogether. It was also noted that birds arriving back in the spring of 1963 were on the average about 90 gms. lighter in weight than those of 1962 (average 1370 gms.) which might well be a reflection of the scarcity of food during the prolonged freeze-up.

It was only after all the Ythan birds had returned to their feeding territories that a reduction in total numbers became obvious. Counts made during the height of the breeding season showed that the resident population had declined from 115 pairs in 1962 to 92 in 1963 (a reduction of 20%). This may or may not have been a direct consequence of the severe weather. There is a considerable amount of indiscriminate shooting both at Edenmouth and at Montrose (personal observation) and this rather than the climatic factor may have been at least partly responsible for the apparent drop in Shelduck numbers.

The Shelduck population of the Mersey area in summer, 1957-1963

R. H. ALLEN and G. E. RUTTER

The purpose of this report is to show that the summer population of the Shelduck (*Tadorna tadorna* (L.)) in 1963, following the extremely hard winter, was not below average on the coasts of Lancashire, Cheshire, and North Wales. Counts of the Shelduck in the estuaries of the Rivers Mersey, Dee, Clwyd and Conway (hereafter referred to collectively as 'Area A') were first organised in 1957. The object was to find out how the totals for this area compared with the scale of moult migration recorded annually in Cheshire since 1950 (R. H. Allen and G. E. Rutter, *British Birds* 49: 221-226. 1956 and later duplicated reports). Counts were made at the end of June, before migration commenced, and, from 1959 to 1962, again in mid-August when the moult-migrants had departed. The mid-August counts were abandoned after 1962 because the previous four years observations showed consistently that about nine out of ten adults migrated from Area A.

Table I compares the numbers of adults and young counted in Area A on 23rd June, 1963, with those found in late June or early July each year from 1957 to 1962. The numbers of adults found on the Mersey and Clwyd are below the average for the previous six years, continuing a trend of several years duration, but the total for the whole of Area A was very close to the aver-

age and only exceeded in two earlier years, 1961 and 1959. The number of ducklings seen in 1963 was above average, as was the ratio of ducklings to full-grown birds suggesting that nesting success was better than usual. The low ratio of ducklings to full-grown birds in all years is largely due to the accumulation of non-breeders on the Dee.

In 1960, with the aid of more friends and helpers, the area searched was extended to include Anglesey and the Caernarvonshire coasts and in 1963 northwards to include Morecambe Bay. As there have been gaps in some years in the search in these additional areas, no long-term comparisons are possible, but Table II compares numbers recorded outside Area A in places looked at in both 1962 and 1963. The general impression is of no marked change, despite substantial local differences.

A search of the north shore of the Solway Firth from the Lochar mouth, Dumfriesshire west to Port William, Wigtownshire, made by A. F. Airey between 21st June and 20th July, 1963, produced a total of 982 adults and 452 young. No comparable figures for earlier years are available but these figures merit inclusion because they show how large the population of this area is and also because of the many young birds seen.

The results of the moult migration watch in Cheshire in 1963 conflict at first sight with these breeding season counts. No flights of migrants were seen until 7th July and on several evenings with sky conditions ideal no flights were seen. The migration ended on 6th August, with a season total of 894 migrants, the lowest in 14 years of watching and recording. In 1962 the total was 1,582, the annual average has been 2,030 and the highest number 3,857 in 1961. This dramatic reduction in the number of migrants might be attributed to high mortality in the previous winter. This may have been so among birds coming from elsewhere, even though untrue for local residents. In our view, however, this fluctuation, and two previous ones, is more likely to reflect a temporary change in the routes followed by migrants. It is hoped to solve this problem by a further extension of the areas to be counted in future years.

Table II. Numbers of adult and young Shelducks counted in 1962 and 1963 on parts of the coasts of north Wales and north-west England, outside Area A.

	adults		*young*	
area	*1962*	*1963*	*1962*	*1963*
Anglesey	53	54	71	91
Menai Straits	32	118	45	108
Leyn Penin	3	16	10	29
Traeth Bach	32	16	35	13
North Wales total	120	204	161	241
parts of Morecambe Bay	998	1061		
Duddon – Esk	*c.* 300	216		

Table I. Numbers of full-grown and young Shelducks counted in late June or early July, 1957 to 1963, in the estuaries of the Rivers Mersey, Dee, Clwyd and Conway.

	census dates							
estuary	*1957 29 June*	*1958 30 June*	*1959 5 July*	*1960 26 June*	*1961 2 July*	*1962 1 July*	*average 1957-62*	*1963 23 June*
(*a*) *full-grown*								
Mersey	161	70	162	68	84	35	*97*	18
Dee	475	633	1,130	874	1,081	992	*865*	1,012
Clwyd	60	107	14	15	6	21	*37*	7
Conway	60	235	36	281	323	128	*176*	247
seen	756	1,045	1,342	1,238	1,494	1,176	*1,175*	1,284
prior departures*	245	–	290	–	242	–	–	–
corrected full-grown total	1,001	1,045	1,632	1,238	1,736	1,176	*1,305*	1,284
(*b*) *ducklings*								
Mersey	–	5	–	–	26	–	*5*	6
Dee	–	31	69	74	33	7	*36*	34
Clwyd	34	18	56	50	46	7	*35*	43
Conway	32	87	82	97	34	26	*60*	98
total ducklings	66	141	207	221	139	40	*136*	181
ducklings / full-grown %	*6·6*	*13·5*	*12·7*	*17·9*	*8·0*	*3·4*	*10·4*	*14·1*

* an allowance for early emigrants in 3 years, based on observed departures.

Effects of a severe winter on ducks breeding in north Somerset

HUGH BOYD and BERNARD KING

Summary

About 140 pairs of Mallard, 13 pairs of Shoveler and 120 pairs of Tufted Ducks attempted to breed at two reservoirs in Somerset in 1963. These numbers were 6%, 59% and 15% respectively lower than the average for the previous six years. Mallard were more numerous than in 1962. The reduced numbers of Shoveler and Tufted Ducks could well have been due to their exceptional lack of breeding success in 1962. Thus it is unlikely that the severe weather of December, 1962 to March, 1963 increased winter mortality in these populations. Breeding success in 1963 was unusually high.

It is generally supposed that the losses suffered by ducks in prolonged spells of cold weather may be very high. Since the welfare of any population depends essentially on its breeding potential and performance, it is desirable to investigate in as many ways as possible what effects the exceptionally severe winter of 1962-63 may have had on ducks breeding in the summer of 1963. Opportunities for doing so in Great Britain are very few, because so little is known about the numbers of ducks nesting in different parts of the country. A study by members of the Bristol Naturalists' Society that has continued since 1957 enables the numbers and output of ducks in north Somerset in 1963 to be compared with results in the preceding six years. The investigation covers the breeding biology of all the ducks nesting locally, but this paper is restricted to the inhabitants of two large reservoirs and to the three most abundant nesting species: the Mallard (*Anas platyrhynchos* L.), the Shoveler (*Anas clypeata* L.) and the Tufted Duck (*Aythya fuligula* (L.)). Only those data appearing relevant to the effects of the cold winter are discussed here.

Chew Valley Lake, of 1,170 acres when full, and Blagdon Lake, 440 acres, are drinking-water reservoirs owned by the Bristol Waterworks Company, lying 1¼ miles apart and some 12 miles south of Bristol. The methods used to estimate the numbers of adult Mallard present in the nesting season and the numbers of ducklings produced and reared by them have been described by Boyd and King (1960). The breeding population is determined by repeated counts in March, April and early May, males and females being recorded separately and classified as in pairs, in larger groups or singly. For the Shoveler and Tufted Duck the appropriate counts are those made from late April to early June. Production of young is measured, first, by recording the number of ducklings in each brood seen throughout the summer, together with the approximate state of growth and, also, for the Mallard only, by subtracting from the highest total count in August or early September the number of adults present in early May. The latter method is of no use for the Shoveler and Tufted Duck, because many individuals, both adults and juveniles, evidently leave the reservoirs in the course of the summer.

None of the estimates of breeding population and production can be made very precise. Success in finding, counting and classifying the ducks present is affected by many factors which defy standardisation. Weather conditions, the time of day, disturbance, the skill of the observer and the time he can spend, affect the completeness and accuracy of any single census. Climatic variations may affect the timing of different phases of breeding behaviour by several weeks, as may the level of water in the reservoirs. These factors seem to act both directly and indirectly through their effects on the amount of cover available. Some progress has been made in determining their relative importance, but it is necessary to emphasise that the practical difficulty of the field work restricts what can be done, especially in a study like this making use of nearly 50 observers, none of them able to devote much time to the work. For simplicity, the tables in the text include only a single figure for each statistic, where a range might be more appropriate. An adequate treatment of the sampling errors in studies of this type would involve a digression many times larger than the subject matter of this particular report. For the immediate purpose the important point is that there is no reason to suppose that the reliability of the estimates for 1963 departed widely from that of earlier years.

The effects of a hard winter might manifest themselves in several ways, most obviously by a marked reduction in the numbers of adults present in the breeding season. Since among ducks, males tend to be more vulnerable to the effects of starvation than

females (Jordan, 1953), a change in the sex-ratio might also be apparent. A change in the age-ratio might also occur, since first-winter birds tend to be more vulnerable to all mortality factors than older birds, but this would be difficult to detect since yearlings of the three species considered here cannot be identified in the field.

The numbers of pairs of Mallard, Shoveler and Tufted Duck which are believed to have attempted to breed in each year from 1957 to 1963 are set out in Table I. All three species were less plentiful in 1963 than in most recent years, the total stock being about 15% less than the average of the six previous years. To show that the reductions were due to the effects of the severe weather early in 1963 it is necessary to show that losses from 1962 to 1963 were greater than normal. It is possible to estimate the normal losses in various ways and to relate them to the size of the population in 1962 and 1963. Each species has to be treated separately as the methods of estimation differ.

Fewer Mallard attempted to breed at Chew Valley in 1962 than in 1963. The reduced stock seems to have been due chiefly to the low level of the reservoir in the spring making it relatively unattractive, so that unusually many Mallard left the immediate area in the second half of March. The reductions were not caused by mortality in the short spell of late December, 1961, and early January, 1962, which caused heavy losses of some species elsewhere. Numbers in early March were high.

The stock of Mallard at Blagdon and Chew Valley in early April 1963 was probably about 350 birds (180 males and 170 females). The highest count, on 3rd April, was only 235: (180 males, 45 at Blagdon; and 55 females, 12 at Blagdon), when many females were absent at nests. The sex-ratio is here assumed to be 106♂♂: 100♀♀ after Eygenraam (1957) although the excess of males in Somerset may be rather greater (up to 116:100, from Boyd, 1960). It will be noted that in Table I only 138 pairs (276 birds) are estimated to have attempted nesting. The number of 'non-breeders' may have been rather fewer than is suggested by the discrepancy between these estimates, because the lateness of the season may have delayed the departure of some winter visitors. For the present purpose, the relevant point is that the number of survivors of local origin probably lay between 276 and 350.

The annual mortality rate of adult Mallard in north-west Europe is about 48% (Boyd 1962) and that of young birds in their first year from fledging about 69%. Boyd and King (1960) estimated that losses in north Somerset in 1948-59 may have been rather higher: 57% of adults and 76% of first-year birds. They also showed that, in the particular circumstances of this area, the highest number of Mallard counted on the reservoirs in late August can be used to measure the output of fledged young. The population of the two reservoirs in August 1962 was about 860 birds (220 adults and 640 juveniles). Losses between August and April normally comprise about nine-tenths of the total deaths in a year. Using this correction factor it can be shown that the stock of 860 birds in August, 1962, would have been reduced to 370, or 310, in April, 1963, the former figure derived from the 'European' mortality rates and the latter from the earlier estimates for Somerset birds. Thus, on the unverifiable assumption that the hard winter did not produce any exceptional variations in the

Table I. Numbers of pairs of Mallard, Shoveler and Tufted Ducks attempting to breed at Chew Valley and Blagdon Reservoirs, 1957 to 1963.

	Mallard			*Shoveler*	*Tufted Duck*			*combined*
year	*Chew*	*Blagdon*	*total*	*(Chew only)*	*Chew*	*Blagdon*	*total*	*total*
1957	*105*	*28*	133	34	*100*	*4*	104	271
1958	*106*	*33*	139	28	*120*	*3*	123	290
1959	*120*	*45*	165	40	*157*	*5*	162	367
1960	*130*	*32*	162	38	*143*	*7*	150	350
1961	*140*	*35*	175	31	*147*	*7*	154	358
1962	*80*	*30*	120	20	*140*	*5*	145	275
mean 1957-62	*114*	*34*	147	32	*135*	*5*	140	318
1963	*118*	*20*	138	13	*112*	*6*	118	269
% differences between 1963 and 6-year mean	*+4*	*–41*	–6	–59	*–17*	*(+20)*	–16	–15

liability of Somerset-bred birds to abmigrate or of birds bred elsewhere to stay in Somerset, it appears that the number of survivors after the hard winter did not differ greatly from that expected in an average year.

The Shoveler rarely breeds at Blagdon and seems not to have done so successfully in any of the last seven years. At Chew Valley the population appeared to be thriving until 1962 when not only did the birds attempting to breed diminish by one-third but hardly any young birds were reared. This failure, like that of the Tufted Ducks, seems to have been due to the unusually low water levels in the spring and summer which reduced nesting cover and increased predation: due to differences in nest sites, these two species were much more seriously affected than the Mallard. In years when breeding is successful it is difficult to estimate how many young Shoveler are reared at Chew Valley Reservoir, because most of them leave very soon after fledging, as they do elsewhere in England (Ogilvie, 1962). Thus the failure in 1962, when not more than 10 juveniles were reared, was fortunate from the point of view of estimating the likely survival of the stock from 1962 to 1963. A useful approximation is given by multiplying the 40 breeding birds in May, 1962 by the mean annual survival rate of adults in Britain, 56% (Boyd, 1962) yielding 24 survivors, with the addition of up to 6 yearlings for an estimated stock in May, 1963 of 24–30 birds, compared with the 13 pairs believed to have tried to breed. As for the Mallard, it seems that losses at a normal rate could have produced the recorded drop in numbers.

The production of young Tufted Ducks is as hard to measure as that of Shovelers, while the adults disappear in late summer in a baffling way, as Gillham (1958) has described, so that it is again fortunate that hatching and rearing was so poor at the Somerset reservoirs in 1962 that the output of young was almost negligible – not more than 30 birds. Over many years the losses of adults between one breeding season and the next average about 46% (Boyd, 1962). Thus the population of about 200 males and 190 females in May, 1962 (including about 100 non-breeders), might have been expected to have been reduced to about 210, with the addition of up to 15 survivors from the young reared in 1962, 220–230 in all in late May 1963. The observed maximum was about 250, on 30th May. The number of non-breeders in 1963 was very small, as would be expected if non-breeders consist principally of yearlings.

It was noted in the introduction that as males are probably more vulnerable to the effects of cold spells than females some change in the sex-ratio might be apparent in the spring after a hard winter. Because the apparent sex-ratio is affected by such variables as the date of onset of nesting and by the banding together of males when females begin to sit, as well as by a tendency for late emigrants in the spring to include more males, it has proved impossible to demonstrate that any significant change in sex-ratio occurred in 1963. There was an excess of males in all three species, as in all the other years of the study.

In some species of Anatidae there is evidence that winter conditions may affect breeding performance in the following summer. It is thus worth recording that 1963 was a very successful year for the ducks breeding at Chew Valley and Blagdon Lakes, as the statistics of Table II show, for Mallard and Tufted Ducks. Brood data for the Shoveler are too few for effective comparison between years.

This investigation seems, therefore, to have arrived at the somewhat unexpected result that the ducks breeding at the two Somerset reservoirs were not seriously affected by the hard winter of 1962-63. The sample is, of course, small so that it would be unwise to generalise sweepingly from it, but the suggestion that local Mallard and Tufted Ducks were not badly hit is in

Table II. Breeding success of Mallard and Tufted Ducks at Chew Valley Reservoir, 1957 to 1963.

		Mallard		*Tufted Duck*
	year	*mean size of 1st broods*	*young reared per female*	*mean size of 1st broods*
	1957	7·9	3·6	5·0
	1958	5·5	3·7	7·3
	1959	6·9	4·4	5·4
	1960	7·3	4·1	5·5
	1961	7·6	6·4	5·9
	1962	4·9	5·8	4·5
mean	1957-62	6·9	4·7	5·7
	1963	6·8	6·7	7·4

accord with other lines of evidence, such as the indices of the Priority Wildfowl Count scheme and the analysis of recoveries of British-ringed Mallard (Boyd, unpublished). The finding that the Tufted Duck was relatively untroubled is, however, surprising in view of the demonstration by von Haartman (1957) that a great reduction in breeding stocks in Finland occurred after freezing of the Baltic in hard winters.

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Wildfowl mortality in the Slimbridge collection during the winters of 1961-62 and 1962-63

JOHN BEER

Summary

The unusually cold winters of 1961-62 and 1962-63 caused a marked increase in mortality of established Anatidae kept outdoors at Slimbridge. Whistling Ducks (*Dendrocygnini*) showed the highest mortality while the true geese and swans (*Anserini*) were hardly affected. Other tribes were intermediate. In general the smaller species from hotter climates suffered a higher mortality while the increase, compared with normal winters, was proportionately greater in these species than in others. Comparison is made with mortality in wild birds. Practical measures to reduce mortality under these adverse environmental conditions are suggested.

Introduction

Since 1958 as complete a record as possible has been kept of the losses from the Wildfowl collection at Slimbridge, Gloucestershire, where a high proportion of the dead birds is found and reported at all times of the year.

Until the end of 1961 the winters did not show any long period of very low temperatures or heavy snowfall. In 1961-62 and again in 1962-63 the weather was unusually severe for long periods and the mortality in the collection increased markedly both dur-

ing and after the cold weather. This paper compares the trends of mortality in normal and cold years and the influence of taxonomic group, habitat climate and size of bird on mortality. Suggested measures to reduce losses are based on these findings.

Material

The data are confined to those established Anatidae in the collection at Slimbridge, both full-winged and pinioned, that have spent at least part of the severe winters in the open and are adult or first-winter birds. This excludes all the Pygmy Geese (*Nettapus* spp.) many of the Spotted Whistling Ducks (*Dendrocygna guttata* Schlegel), Salvadori's Ducks (*Anas waigiuensis* (Rothschild and Hartert)) and Hartlaub's Ducks (*Cairina hartlaubi* (Cassin)) and other individuals, which normally live in aviaries. The North American Ruddy Duck (*Oxyura j.jamaicensis* (Gmelin)) is not entered as it is difficult to assess the numbers and losses of this species. The Mallard (*Anas platyrhynchos* L.) is similarly excluded since there is a large wild population in the pens. Hybrids are omitted as they entail difficulties in grouping.

The number of birds at risk increased over the 6-year period from 1,240 to 1,700. As figures were not available for every season, estimates allowing for losses and the trend from year to year were used.

Details of the weather are taken from the daily weather reports of the Meteorological Office (1961-63) and from local observations.

Weather

The winters of 1961-62 and 1962-63 were characterised by 1½ and 6½ weeks respectively of night temperatures well below 0°C with daytime maxima often still below freezing. Periods of strong winds and deep snow, especially in 1962-63, increased the severity of the weather. The cold weather is considered to have ended when the minima were regularly above freezing and the ground in most places was no longer frozen. Pockets of snow and ice existing in a few places were ignored, the maxima being near 10°C.

The first period lasted from 24th December 1961 to 6th January 1962, a total of two weeks. At Bristol, 17 miles SSW of Slimbridge, the mean minimum was –5°C with –15°C recorded on 1st January. Maxima ranged from –6° to 4°C with a mean of –0·3°C. Moderate falls of snow covered the ground for much of the time.

The second period was a little colder than the first and lasted for 6½ weeks, from 23rd December 1962 to 6th February 1963. The mean minimum was again –5°C with –14° recorded on 15th January. Maxima ranged from –6° to 4°C with a mean of –0·5°C. Strong winds and heavy falls of drifted snow occurred for nearly all of the period. The cold weather did not finally finish until nearly four weeks later, on 5th March. During this latter period the mean minimum was –2·3°C with the lowest temperature at –7°C. Maxima ranged from 0° to 11°C with a mean of 4°C while the snow cover was reduced for much of the time.

No period of severe weather as defined above occurred between 1958 and the end of 1961. The 30-year (1921-50) mean minimum and maximum for the coldest month

Table I. Weekly mortality of established Anatidae in the Slimbridge collection

		year					
month	*week*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*
January	*1*	5	3	1	2	13	7
	2	0	1	5	6	17	8
	3	2	7	5	7	12	19
	4	1	6	2	4	10	31
February	*5*	5	2	5	6	6	14
	6	1	4	4	2	8	15
	7	2	4	4	7	8	13
	8	4	8	3	9	3	11
March	*9*	1	3	2	3	7	12
	10	1	1	2	3	2	18
	11	1	5	5	3	10	7
	12	2	6	3	4	6	11
April	*13*	3	3	6	6	5	4
	14	1	8	2	7	7	3
	15	2	3	7	6	4	9
	16	4	5	5	6	7	1
	17	2	4	3	7	5	3
May	*18*	2	4	4	15	7	7
	19	1	0	5	2	8	3
	20	2	3	9	4	8	6
	21	5	2	2	6	1	4
June	*22*	2	3	4	2	1	1
	23	0	4	0	5	5	5
	24	3	0	3	4	1	3
	25	2	3	2	1	3	4
July	*26*	2	2	3	0	4	3
	27	0	3	2	1	3	2
	28	1	1	4	1	3	3
	29	0	3	4	1	0	2
	30	0	3	1	2	3	1
August	*31*	3	1	2	3	0	0
	32	3	5	3	1	2	4
	33	1	2	0	3	2	3
	34	3	1	1	1	2	3
September	*35*	1	1	0	3	2	2
	36	1	1	0	1	3	1
	37	1	5	2	1	0	3
	38	0	1	3	2	4	1
	39	3	1	0	1	4	2
October	*40*	4	0	3	1	3	1
	41	2	1	4	4	6	2
	42	3	2	1	1	5	3
	43	3	2	0	2	1	4
November	*44*	1	2	1	3	3	3
	45	1	1	5	6	1	6
	46	1	2	3	5	1	4
	47	2	3	2	1	3	2
December	*48*	2	0	1	7	1	2
	49	2	2	8	3	4	0
	50	2	1	5	5	1	11
	51	1	1	2	1	7	2
	52	3	3	1	5	6	7

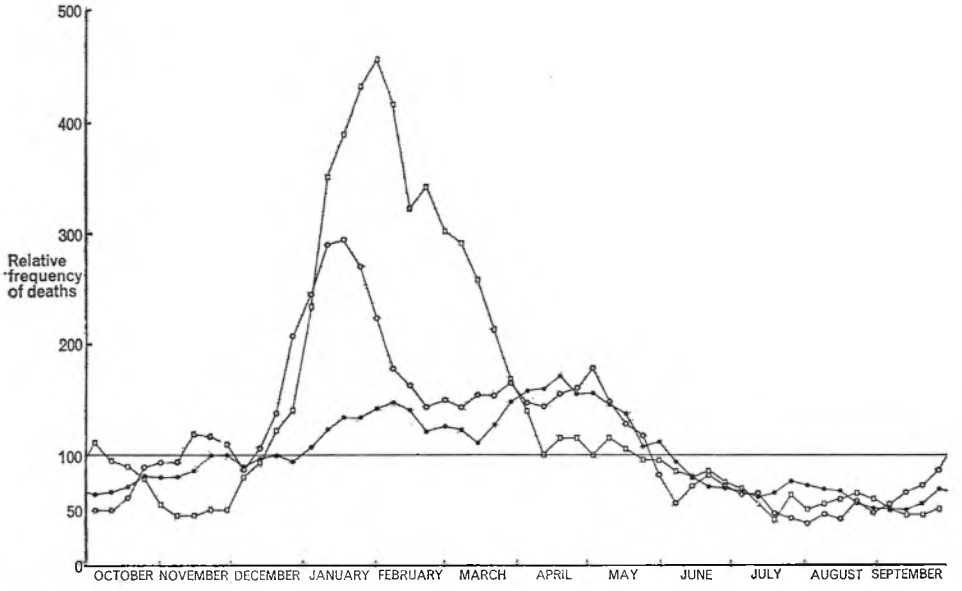

Figure 1. Mortality pattern among Anatidae established in the collections at Slimbridge.
100 = mean weekly mortality over a 12-month period.
Dots – weekly means for 4 years 1958 to 1961; open circles – values for 1961-62; squares – values for 1962-63.

of the year (January) in the north Bristol area are 1·2°C and 5·1°C respectively (Met. Office, 1957).

Mortality pattern and rates

Mortality in 1958-63 is tabulated in weekly intervals in Table I and displayed in Figure 1, in which the means of the combined weekly totals for the normal years 1958-61, expressed as the percentage of the weekly mean over a 12-month period, are plotted as a five-period moving average. In a normal year the mid- and late summer mortality is about two-thirds of the mean for the 12 months. From October until April the level increases to about one and two-thirds of the mean and then, during May and June, drops rapidly back to the summer level.

The two 12-month periods starting in October 1961 and 1962 respectively are plotted separately on the same basis as the normal year but with a correction factor. The weekly mean for the 12-month period is based on a normal year and, in order to avoid influencing the position of the curve by any abnormally high mortality rates, the estimated *extra* losses (deduced from cumulative mortality graphs) are first subtracted from the actual losses. It can be seen that the mortality in each of the cold winters reached abnormally high levels; losses in 1963 being a little later and appreciably higher than 1962. The pattern is otherwise similar to the normal except at three points. The high level in March 1962 may be due to lower than average temperatures while the low level in April-May 1963 may be due to the earlier heavy losses of susceptible birds. The variations in October-November 1962, may be due to a different proportion of first-winter birds in the sample.

The timing of the increase and rates of mortality in relation to the cold periods cannot be readily deduced from Figure 1 because of the use of a moving average. Timing can best be studied on a cumulative mortality graph, shown diagrammatically in Figure 2. Inspection of the graphs shows that there are distinct phases of mortality, the points falling remarkably close to straight lines with relatively rapid change of slope from phase to phase. The most important deviations occurred during the two final thaws when snow- and ice-covered cadavers were finally exposed and found. Also, towards the end of January, 1963, for just over a week the mean minima and maxima fell to –8·2° and –3°C respectively and for a few days mortality was exceptionally high.

Mortality in both cold periods showed a distinct lag phase, lasting 9 days and 3 weeks respectively, after the start of the cold, and then increased by nearly three times in 1962 and four times in 1963 (Table II). From early February 1963, onwards, when the weather improved, the

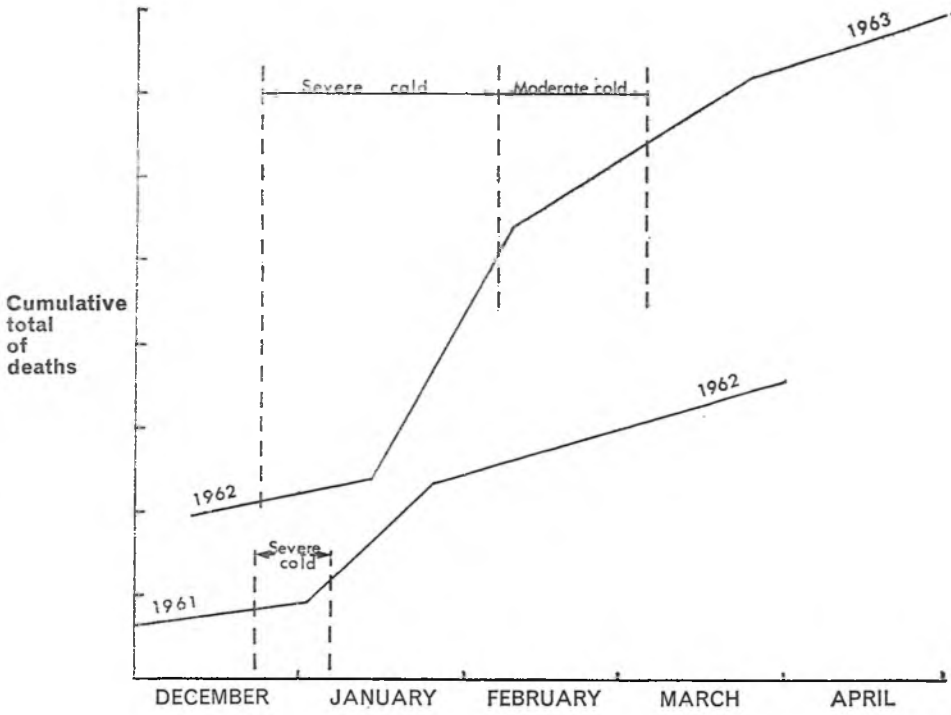

Figure 2. Diagram to show relationships of mortality phases to cold spells in 1961-62 and 1962-63.

rate dropped within a few days to about half that in the previous phase but was still well above normal. When the cold weather was over, mortality did not return to normal until three weeks later.

Mortality and type of bird

It is evident from the detailed data that the species are not equally affected by extreme cold. The following analysis examines the mortality trends in the winter of 1962-63 in relation to taxon, climate (January mean temperature) of the natural habitat and size of bird. Comparison with the 1961-62 winter, and normal winter and summer, is made for a period equal to that of the increased mortality in 1963.

Taxon

Sample size at specific and generic level is small so that it is preferable to group the birds into the Tribes proposed by Delacour and Mayr (1945). The numbers of birds at risk in the Anseranatini, Somateriini, Mergini and Oxyurini are very small (Table III) but the samples of six tribes are sufficient for comparative purposes. In 1962-63 the Dendrocygnini showed the highest mortality, which was considerably higher than in a normal winter. In contrast the Anserini showed little increase of mortality over a normal winter or summer. The other tribes were intermediate.

Climate

In captivity individual birds often live in environmental temperatures quite different from those experienced by the species in its natural habitat, a factor that may well influence mortality importantly. This factor can be analysed by comparing the mortality of species from different climatic regions of

Table II. Mortality rates during the winters of 1961-62 and 1962-63. Expected rates obtained from the mean for the corresponding 12-month period multiplied by the deviation from the mean for the phase in question

mortality phase	*1961-62 deaths per day* expected	actual	*1962-63 deaths per day* expected	actual
pre-cold and lag	0·6	0·6	0·7	0·9
increased — severe cold	0·7	1·9	0·8	3·0
increased — moderate cold	–	–	0·8	1·6
post-increase	0·8	0·9	0·9	0·7

the world and during different seasons of the year at Slimbridge.

The species and sub-species are classified as living in cold (below 10°C, or 50°F), warm (10° to 21°C, or 50° to 70°F) and hot (21°C or 70°F and over) regions in January. Species distributions are taken from Delacour (1954, 1956 and 1959) and regional mean January temperatures from Bartholomew (1922). The data in Table IV show that in general, species from hotter climates are affected more by low temperatures than the species from colder climates, the difference being enhanced in severe winters. (In contrast, the losses of birds from hotter climates are lower in summer.)

Size

The species can be classified broadly into three groups – large (= 'very large and

Table III. Tribal mortality under different weather conditions at Slimbridge

†Mean of 4 seasons. *Mean of 2 seasons. ( ) Birds at risk where no deaths were recorded. Percentages are given to one or two decimals only to allow a closer calculation of the birds at risk.

	winter		*summer*		
tribe	*very cold deaths*	*cold deaths*	*normal mean deaths* †	*normal mean deaths* †	*mean deaths in summers after cold winters**
(Large samples)					
Dendrocygnini	36	20	4·75	1·0	1·0
% deaths	*38·3*	*21·1*	*4·3*	*0·97*	*1·6*
Tadornini	11	8	3·5	3·25	2·5
% deaths	*10·9*	*9·1*	*3·8*	*3·7*	*2·9*
Cairinini	16	8	4·5	4·5	4·0
% deaths	*10·7*	*7·3*	*4·2*	*4·4*	*3·4*
Aythyini	18	5	4·25	0·75	1·5
% deaths	*10·5*	*2·5*	*3·0*	*0·54*	*0·98*
Anatini	59	37	13·5	3·5	6·5
% deaths	*9·8*	*6·2*	*3·1*	*0·86*	*1·2*
Anserini	10	6	5·0	3·75	5·5
% deaths	*2·0*	*1·3*	*1·2*	*0·94*	*1·2*
(Small samples)					
Anseranatini	3	0(16)	0·5	1·25	0(13)
% deaths	*25*	*0*	*3·6*	*9·6*	*0*
Oxyurini	1	1	0·5	0(7)	0(6)
% deaths	*14·3*	*12·5*	*6·3*	*0*	*0*
Mergini	3	1	2·5	2·25	3·5
% deaths	*7·3*	*2·1*	*4·7*	*4·3*	*8·1*
Somateriini	1	0(21)	1·0	0·75	1·5
% deaths	*4·5*	*0*	*5·6*	*4·2*	*7·1*

Table IV. Mortality of captive Anatidae from different climatic regions and of different sizes under various climatic conditions at Slimbridge

†Mean of 4 seasons. *Mean of 2 seasons. ( ) Birds at risk where no deaths recorded. Percentages are given to one or two decimals only to allow a closer calculation of the birds at risk.

			winter		*summer*	
size	*climate*	*very cold deaths*	*cold deaths*	*normal mean deaths* †	*normal mean deaths*†	*mean deaths in summers after cold winters**
Large	Cold	8	5	3·25	3·5	3·5
	% deaths	*2·1*	*1·4*	*1·1*	*1·2*	*1·0*
	Warm	8	3	3·25	0·5	2·5
	% deaths	*5·8*	*2·0*	*2·4*	*0·37*	*1·8*
	Hot	6	2	3·0	4·5	1·0
	% deaths	*8·1*	*2·3*	*4·8*	*7·6*	*1·3*
Medium	Cold	6	4	3·75	3·25	5·5
	% deaths	*6·3*	*3·1*	*3·9*	*3·5*	*5·0*
	Warm	29	14	8·0	4·75	5·0
	% deaths	*7·8*	*4·3*	*3·0*	*1·8*	*1·6*
	Hot	53	21	8·0	2·75	2·5
	% deaths	*26·2*	*9·2*	*3·5*	*1·3*	*1·4*
Small	Cold	0(33)	5	1·25	0(24)	0(28)
	% deaths	*0*	*18·5*	*4·8*	*0*	*0*
	Warm	12	7	2·25	0·5	3·0
	% deaths	*8·2*	*5·3*	*2·3*	*0·52*	*2·3*
Small	Hot	36	25	7·25	1·25	3·0
	% deaths	*14·7*	*11·0*	*4·2*	*0·86*	*1·5*

large' of Scott, 1961), medium (='rather large' and 'medium') and small (= 'small' and 'very small'). Sexual differences in size are ignored. Table IV shows that in general the smaller the bird the higher the mortality, especially in the cold winters. There seems to be less difference between the medium and small birds than between the medium and large birds. In summer the small birds appear to benefit most from higher temperatures.

Interaction between factors

Further examination of the data shows that there is interaction between the three factors. For instance, the Dendrocygnini showed the highest mortality of any group and this can be explained in part by the birds being medium or small species from hot climates. In addition, this tribe may be innately susceptible to low temperatures. In contrast the Anserini show a low mortality, being mostly large and from cold climates. The Anatini are intermediate, comprising medium and small birds from all three climates. Interaction between temperature and size is shown by the highest mortalities occurring in the small and medium birds from hot climates. (The apparent high level in small birds from cold regions in a cold winter seems to be a consequence of a small sample.)

The relative importance of these three factors during the severe winter can be found by an analysis of variance. The percentage mortality in each group is converted to the corresponding angle (Snedecor, 1946) and the ratio F^1, variance within groups to variance between groups, is calculated. A low value of F^1 indicates a greater relative importance of the factor. The values of F^1 are given in Table V.

Thus it appears that taxonomic grouping and the temperature in the country of origin affect susceptibility to cold but that size *per se* does not. It had not been expected that specific relationships would prove most important as it had been thought that temperature would be the most important factor in a severe winter. Also, since some tribes are made up of several different climate- and size-groups, any tribal differences would tend to be reduced. It seems that the climate and size factors only modify an inherent degree of ability to withstand abnormally low temperatures. Thus, as already anticipated, the Dendrocygnini may have a low resistance to the effects of low temperatures and they may be at a further disadvantage by being medium and small birds from hot climates. The apparent non-significance of the size factor may be a consequence of sample size and other sampling difficulties, since the combined data from all relevant groups show a very high degree of significant association of size and susceptibility ($P < 0{\cdot}001$).

Table V. Relative importance of three factors affecting susceptibility to cold.

Factor	F^1	
Tribe	1·3	$F = 2{\cdot}99$, $P < 0{\cdot}05$
Climate	4·2	$F = 4{\cdot}26$, $P < 0{\cdot}05$
Size	43·7	$F = 1{\cdot}3$, $P > 0{\cdot}2$

Discussion

This analysis has been couched in fairly general terms using relatively crude groupings, and despite some combining of the data, the sample sizes of certain groups are still too small. When more material is available a more elaborate investigation should be profitable. For example, the temperature differences between Slimbridge and the normal habitats of the species are probably a better measure of the 'climate' factor and body-weight a better index of size. Such factors as age, sex, whether pinioned or full-winged, wild-caught or hand-reared, inter-current disease and the extent of artificial protection must all influence mortality and need to be considered.

There are some interesting comparisons with mortality in other species. The pattern of mortality is similar to that found by Jennings (1961) in a study of 1,000 deaths of wild birds in Britain, which included only a few Anatidae. Peak deaths were in the early summer with a late summer low and a gradual increase throughout the winter. The ratios of spring to summer mortality are remarkably similar in the two studies.

During the winter of 1962-63 free-living wild European White-fronted Geese (*Anser a.albifrons* Scopoli) in England and Wales were short of food and some birds died of starvation (Beer and Boyd, 1964). Most deaths occurred between 2 and 3 weeks after the onset of the snow, a lag period similar to that of the collection birds. This goose, being a large, cold climate bird, would be expected to be relatively unaffected by low temperatures. Instead they succumbed to another stress, that of inadequate food supplies, after a similar length of time. The longer lag phase in the collection in 1962-63 than in 1961-62 may have been due to the earlier *ad lib.* feeding of pellets and grain. The feeding of extra food at intervals in the previous winter may not have been sufficient to provide all the extra energy required by the birds, thus exposing them to two stresses with a resultant shorter lag phase.

Mortality remained high for three weeks after the end of the cold weather, suggesting that recovery from a severe stress requires a period of this order. Starved Mallard studied by Jordan (1953) and the starved White-fronted Goose reported by Beer and Boyd (1964), required 2-3 weeks for recovery.

These results indicate that it may be possible to learn something about mortality in wild populations by a detailed study of captive populations even when a part of the data refers to other, although closely related, species.

The findings reported in this paper support the *ad hoc* measures taken at Slimbridge to alleviate the effects of long periods of severe weather on water-fowl. For the benefit of aviculturists these are summarised as follows. Any measures should be implemented within a week of the onset of severe cold. The small birds from tropical regions will require far more protection than large species from cold regions. The Whistling Ducks (*Dendrocygnini*) should be given priority and if possible they should be given cover and clean straw or some other warm material (but not hay) to stand on as they, and the tropical Magpie Goose (*Anseranas semipalmata* (Latham)), are particularly susceptible to frost-bite of the feet. Food should be given *ad lib.*, preferably as a mixture of grain and pellets, in a place where even the smallest birds can get at it easily at all times. Extra feeding should continue for 3 weeks after the end of the cold. Warm drinking water may encourage the regular taking of food. Underground water supplies are often above freezing point and can be used to reduce the amount of ice and keep the pond water at a slightly higher temperature. Windproof covers and screens, straw on the snow and ice, and heating lamps are valuable.

Acknowledgements

I am most grateful to Mr. S. T. Johnstone and his staff for regularly bringing in over the years the birds for post-mortem examination, for information about individual birds, the numbers in the collection, and for details of measures taken to alleviate the effects of severe weather.

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Research and conservation in Great Britain

The numbers and behaviour of geese in the Lothians and Berwickshire

WILLIAM BROTHERSTON

Summary

An account of the numbers and distribution of Pink-footed and Greylag Geese in south-east Scotland, based primarily on simultaneous counts at all the roosts in the area once or twice each autumn from 1955 to 1963, supplemented by less complete counts in 1950–54 and by the gathering of memory records from local residents extending back over 30 years. In recent years there have been peaks of about 12,000 Pinkfeet and 1,000 to 1,300 Greylags in the area in October or November.

Pinkfeet were most numerous in 1961 (14,000) and scarcest in 1963 (4,750). Local abundance is largely determined by the amount of food available, principally on stubble fields in autumn and grass in winter. Numbers before the 1939–45 War were at a lower level, the peak probably no more than 5,000. A shift from coastal to inland roosts during the War was due partly to disturbance but, more importantly, to improved mechanical agriculture in the upland area, with a substantial increase in crops of barley and oats and the rotation of grass as a crop.

Pinkfeet arrive from the middle of September, the main arrivals being usually in early October. A peak in numbers soon afterwards is usually followed after only a few weeks by radical changes in distribution with some emigration, the mid-winter population being no more than 5,000. Numbers increase again from the end of February, declining in April, with a final spring departure in the early days of May.

The feeding, roosting and flighting behaviour of both Pinkfeet and Greylags are described. Only one roosting station (Gladhouse) is used by large numbers of both Pinkfeet and Greylags, most of the latter preferring reservoirs not used by Pinkfeet. Greylags prefer grass to stubble and usually feed nearer their roosts than do Pinkfeet. Though still greatly outnumbered by Pinkfeet, Greylags have been more numerous in the last decade than in the period 1935–50.

The occurrence of small numbers of other species of geese is discussed.

Introduction – The attraction of goose watching

The special attraction which exists for many of us in watching wild geese is not hard to explain. They are large birds, moving, feeding and roosting in sociable flocks, are intelligent, generally noisy and superficially easy to watch as they conduct a large portion of their social activities in daylight of varying degrees. The bird watchers who are, or pretend to be, 'anti-goose' say that as a result too high a proportion of time is spent in the watching of geese instead of on watching equally interesting but less readily observable species and that watching lines of geese flying to roost against the light of a fading evening sunset in ever changing pattern may be a form of aesthetic enjoyment but is not bird watching in any proper sense.

It would be hard to deny that on many an occasion there is a considerable degree of aesthetic enjoyment in the watching of geese flight against the sky or that there is a great thrill in seeing and hearing a large flock pouring in a resounding mass towards the roosting loch or whiffling down upon it to the accompaniment of the reception clangour of the flocks already in. On the other hand geese form just one thread in the pattern of winter bird watching and if geese were the only birds which occupied the winter scene around the roosts they would be poor places to go to. It is in the contrast, the mixture, the interplay with the other birds and the animals wild and domestic that are all around and also are part of the scheme, that for me and almost all the other enthusiasts of whom I have knowledge, the real attraction lies. To see the duck flight out often just before the geese come in, with the accompanying quack of the Mallard and whistle of the Wigeon. To see the sheep move to their night quarters and the hare run across the field or moor. To watch the Curlew flight in to roost in earlier autumn and spring and hear rather than see the Lapwing and Golden Plover also come in to roost. To see the great hosts of gulls come flighting in as silent as the geese are noisy and in the spring to hear the songs of Curlew, Lapwing, Golden Plover and Snipe, the after dusk song and calling of the Skylark; the explosive calls and answering yaps of the cock and hen Red Grouse and possibly in the distance the rikkity cooing of a Blackcock lek or at the coast to have the different

pattern of the tides and the winter flocks of waders and duck with all their varied noises and lastly, as departure draws near, to hear the noise of the geese at the roost splashing in the water and the new range of notes telling that the third and most important pillar of goose psychology, that of spring fever and mating, is on the way; there lies the true draw of goose watching and anyone who avoids it is missing one of the finest parts of bird watching and with it the opportunity of obtaining information about a whole number of species at one particular portion of their daily life which probably otherwise would hardly be touched upon. 'But tae oor Geese!'

The position before 1939 and changes during the 1939-45 War

Before proceeding to consider the years covered by the review it is necessary to look briefly at the position in the Lothians and Berwickshire in the period before the 1939-45 War.

The main roost each winter in the Lothians proper was on the coast of East Lothian at Aberlady Bay. The whole level of the goose population in the area was then much lower than at present, with a peak autumn figure estimated at 1,500 to 2,500 for Aberlady (mainly Pinkfeet, but with small numbers of Greylag). At Tynninghame, the other coastal roost in East Lothian, geese were apparently occasional visitors, no more than a score at a time. There were also two smaller inland roosts one gauged at 200–300 birds at Fala Flow at the south-east corner of Midlothian and one of about 100 birds at Cobbinshaw at the south-west of Midlothian. In Berwickshire the only important roost was one at Hule Moss, with up to 2,000 birds at peak. There is also said to have been a roost at Coldingham Moor (J. Berry *The Status and Distribution of Wild Geese and Wild Duck in Scotland.* 1939, p. 38) but from local evidence this was certainly not in use immediately before 1939 and had not been used for at least 20 years before that. As Coldingham Moor was drained and ploughed up around 1946 and part of it has now been planted with trees, it seems certain that it will never be used in the future.

There does not appear to have been any regular use of any of the various reservoirs covered by these watches for roosting purposes in the decade before the 1939-45 War apart from the small use of Cobbinshaw. There had, however, for very many years – at least going back to 1910 and probably long before that – been a large scale migration of geese south through the Moorfoots each autumn. Mr. Robert Anderson, retired shepherd aged 65, who spent his whole boyhood and early and middle manhood in Leithen Water has said that: 'There was aye a big run through of geese each backend – at the time we were howkin' tatties. They cam' doon Leithen Water – as mony as there are noo. Ye couldnae aye see them ye ken.' He, however, has no memory of any noticeable past migration in the spring. According to Mr. John Douglas, a retired farmworker who lived for 77 years always in sight and sound of Fala Flow, 'There had aye been geese at Fala in the hunner's but we didna' pay the attention tae them then that they dae nooadays'. From other remarks by these two it looks as if there was an autumn passage from Aberlady and the Forth to the Solway, with few settling at Fala in the autumn but larger numbers settling in the area on their return passage, from February to April. So at this pre-War stage even if the geese never or rarely used all the present inland roosts these roosts were lying right beneath or near to an accustomed migration route of which all the landmarks were well known.

J. Kirke Nash (*The Birds of Midlothian,* 1935, pp. 151–152) gives specimen records from the notes of that outstanding field naturalist William Evans giving sightings of Pinkfeet passing over Edinburgh and area between the years 1884 and 1912. Six are records of hard weather passage, five of them eastward or westward presumably to and from the sea-coast roost of Aberlady and 'the Lanark moors'. There is only one record of autumn passage and two for spring.

Then during the 1939-45 War the whole coastline of the Firth of Forth became an armed camp with guns, searchlights and sirens along its entire length and on the islands, and the geese appear to have largely deserted the coastal roosts and gone inland, building up at Hule Moss and Fala, from Fala spilling over to Gladhouse and building up at Cobbinshaw and also taking up quarters at Threipmuir, Harperrig and Baddinsgill. Exact dates for this occupation have not been obtained but there seems no doubt that the large scale transfer of the Aberlady roost to Fala/Gladhouse must have taken place quite early in the War period.

In addition to the disturbance at the actual coastal roosts, the area around Drem and East Fortune which had previously been a usual feeding ground of the geese was usurped for use as aerodromes: and as is well known the aeroplane, particularly in its slow-flying forms, is one of the chief abominations of all geese. At the same time there was a decrease of disturbance at many inland sites. For example, some reservoirs were protected places and grouse moors were less shot.

Another result of the War was a revolution in the agriculture of the upland farms in the area, leading to a major increase in goose food supply. With the financial help of subsidies and good prices coupled with the ever greater use of mechanised implements land that had been under grass for long years was brought back to profitable and regular cultivation resulting in greatly increased acreages under oats and then, in the post-War period particularly, barley also. (In 1939 the area under crops and fallow in the counties of Berwick, East Lothian and Midlothian was 147,900 acres. This had risen to 172,500 acres in 1962, despite a slight reduction in Midlothian from 39,500 to 39,250 acres, due to losses of good land for building purposes.) In addition more use was made of fertiliser so that the corn crop obtained from any given area was much heavier. Grass also was turned over and became a regular crop in the rotation in a fashion that had not been thought of before the War. The result was that during the War years the geese had stubbles and fresh grass close to their much expanded or new inland roosts: and as in the post-War years the changed use of the upland farms has largely continued so has the ready-to-roost supply of suitable feeding for the geese. Here then with little doubt lies a large part of the explanation for the continued use of these inland roosts by the geese on a major scale in the post-War years – the other part lying in the fact that in some of them at least they have found themselves more free from human disturbance by shooting, etc. than at the sea-coast roosts of Aberlady and Tynninghame. The remarkable increase in the popularity of wildfowling since the War, and the increased mobility of foreshore shooters are relevant.

Because of the dearth of information about the pre-1939 period one can only speculate on the source of the great increase in population from the pre-1939 surmised peak arrival level of about 5,000 to the 1955-1963 average level of 11,000-12,000. From the figures for 1955 to 1963, natural increase would not by itself appear to be anything like a sufficient cause for this rise during the 1939-45 period. A partial shift from the Tay area caused by the same War-time disturbance and a partial stay behind of birds that had previously flown over direct to the Solway, which was also disturbed by aerodromes, seem the likeliest explanations.

History of the watches

By 1950 regular wildfowl counts were being carried out at most of the recognised habitats with in particular D. G. Andrew and R. W. J. Smith making those at Gladhouse and Gavin Mills those at Fala. My own observations in 1951 and 1952 led to the conviction that the two goose stations of Fala Flow and Gladhouse were related and interdependent and that the figure for the roosting population at each had to be noted side by side and together to enable any accurate consideration as to numbers or trends to be arrived at. When this point of view was put to fellow members of the Scottish Ornithologists Club and in particular to the watchers at Gladhouse and Fala there was at once whole-hearted support for the project of a simultaneous watch at Fala and Gladhouse with further watch stations at suitable points on the usual flight line between the two and the first such watch was held on 1st November, 1952 (with supplementary watches on 8th and 9th November), and repeat watches limited to Fala and Gladhouse and in between were held on 31st October, 1953 and 27th November, 1954.

The success of these watches led to expansion of the watch to cover all the known major roosts of the Lothians area including Berwickshire. The first general watch was held on 12th November, 1955. In 1956 the Watch Reservoir near Longformacus in Berwickshire which had been completed in 1955 was added in, and in 1960 the area at Libberton/Carnwath (which is a daytime feeding area probably based on a number of roosts and not a true roosting station like the others) was brought in because it was thought that it might possibly derive from and be linked to the by this time much decreased Cobbinshaw roost. When the first National Goose Check was held on 12th-13th November, 1960, the Lothians area check was by pre-arrangement held on the evening of 12th November and the results fitted in to the wider check. This arrangement has been repeated in each subsequent November, with a preliminary check in the Lothians area in October to try and get the distribution of the Pinkfeet population at its peak after first arrival and before more general dispersal.

All who have attempted goose counting will appreciate that a measure of discrepancy must be expected but all practical care has been taken by the counters involved in the series discussed in this review. As a result the accuracy of the picture put forward is considered to be sound.

The population of the Pink-footed Goose (*Anser brachyrhynchus* Baillon)

The two species of geese making up the winter population of the Lothians area are Pinkfeet and Greylag, with the latter species making up rather less than 10% of the

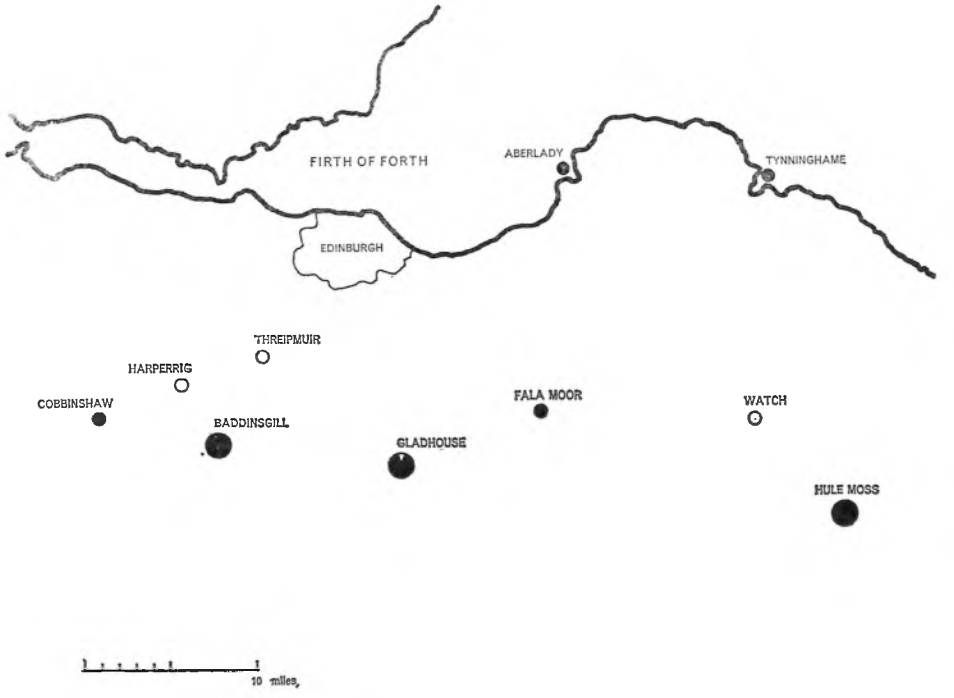

Figure 1. Goose roosts in the Lothians and Berwickshire.
Large circles – roosts with over 1,000 geese in autumn; small circles – fewer than 1,000. Solid circles – roosts used almost exclusively by Pink-footed Geese; open circles – Greylag roosts. Both species regularly occur at Gladhouse Reservoir.

total. The arrival dates of the two species are different, the roosting stations more often than not are different and, whilst they do feed together in the same fields, even there they very much tend to group separately with very seldom true admixture on the ground and never (if one can use that word of geese) in flight. Because of the overwhelming preponderance of Pinkfeet the main part of the remarks that follow relate to that species. The Greylag population is dealt with separately.

The pattern of arrival

While there are variations in detail from year to year, the broad pattern of arrival in the Lothians area each autumn remains the same (Table I). The first few small parties are seen around 14th to 18th September flying in from the north over the Moorfoot Lammermuir range. Almost none stop and some, if not most, head south for the Solway marshes. About the last week of September there is larger scale traffic with the majority again passing on to the south but an 'advance guard' of a few hundred settling in to roost and feed at Fala/Gladhouse in Midlothian with a similar 'advance guard' at Hule Moss in Berwickshire. Finally, around the second week of October comes the big arrival and invasion with an equal number or more passing on to the south. Again the main passing-through traffic in the Lothians heads on for the Solway. The general build-up at Hule Moss takes place earlier than at Fala/Gladhouse and it is thought to be linked with the Humber estuary rather than the Solway.

On more than one occasion I have been fortunate enough to be present in the Fala/Gladhouse area when the big arrival from the north was taking place in clear weather. Under these conditions the geese come in on a fairly broad front at around the 2,000 to 2,500 foot level or in parties of 30, 40, 70 or more flying in loose changing V formation, obviously orientating themselves on the landmarks of Caerketton, Gladhouse Reservoir (particularly) and Fala Moor in the case of those parties which pass on and through to the south. Even although Aberlady Bay is not much used at the first main arrival period it appears to form a visual landmark in the southward movement.

Population changes from October to May

It is at this stage at mid-October that within a week or so the hill stations of Fala/Gladhouse and Hule Moss reach their peak population and the other hill stations of Baddinsgill and Cobbinshaw/Libberton /Carnwath get occupied in force. Then,

Table I. Notes on the arrivals and population build-up of Pink-footed Geese in the Lothians area, 1952-63

	first seen	*first seen at roost*	*major flights through*	*main arrival*	*peak*
1952	17 Sep.	21 Sep.	27 Sep.	28 Sep.	5 Oct.
1953	28 Jul. (sp.?)	27-30 Sep.	3-4 Oct.	10 Oct.	18 Oct.
1954	17 Sep.	18 Sep.	26 Sep.	2 Oct.	14 Oct.
1955	13 Sep.	23 Sep.	27-28 Sep.	29 Sep.	mid-Oct.
1956	8 Sep.	29 Sep.	4-5 Oct.	6 Oct.	6-13 Oct.
1957	3 Sep.	26 Sep.	29-30 Sep.	3 Oct.	19 Oct.
1958	23 Sep.	27 Sep.	11-12 Oct.	12-13 Oct.	26 Oct.
1959	10 Sep.	3 Oct.	17-18 Oct.	18 Oct.	25 Oct.
1960	18 Sep.	25 Sep.	7-9 Oct.	11-12 Oct.	15 Oct.
1961	17 Sep.	30 Sep.	12-13 Oct.	13 Oct.	21 Oct. (11 Nov.)
1962	11 Sep.	17 Sep.	8-9 Oct.	10-13 Oct.	13 Oct.
1963	17 Sep.	26 Sep.	27-28 Sep. (very small)	27-28 Sep.	5 Oct.

Table II. Numbers of Pink-footed Geese in autumn at Fala Flow and Gladhouse Reservoir, 1950-54

		Fala Flow	*Gladhouse*	*total*
1950	28-29 Oct.	700	1,200	1,900
	11-12 Nov.	250	2,000	2,250
1951	21 Oct.	1,500	450	1,950
	28 Oct.	530	2,500	3,030
	7 Nov.	?	about 5,000	
	11 Nov.	1,750	1,300	3,050
	18 Nov.	200	1,300	1,500
	autumn peak possibly over 6,000			
1952	19 Oct.	?	4,000	
	26 Oct.	1,500	2,700	4,200
	1 Nov.	100	4,700	4,800
	8 Nov.	3,100	1,220	4,320
	9 Nov.	1,000	3,320	4,320
	10 Oct.	2,850	?	
1953	31 Oct.	1,500	4,000	5,500
1954	26 Sep.	500-1,000		
	2 Oct.	*c.* 2,500		
	14 Oct.		4,000	
	16 Oct.		1,500	
	24 Oct.	1,250	50	1,300
	6 Nov.		2,500+	
	21 Nov.	*c.* 5,000		
	27 Nov.	2,800	2,200	5,000

unless the food supply situation in the hill areas is particularly abundant – as it was in 1961 when a gale in September shook the standing barley – after a bare fortnight to three weeks at the most, the population at the main hill stations dips sharply at first and then more or less slowly, the rate without much doubt depending on the comparative plenty of food. Some of the loss in the Midlothian area would appear to be from the high upland stations of Fala/Gladhouse to Aberlady and perhaps also to Baddinsgill and Cobbinshaw/Libberton/Carnwath but the main loss is by onward movement to the south. A similar sharp fall within the same few days is usually experienced at Hule Moss.

By the middle or end of December there is usually another sharp decline in the population of the upland areas – that of the Fala/Gladhouse area usually being reduced in January to 700-800; though this figure has shown a tendency to increase in the last year or two. If real hard weather comes this basic flock moves down to the coastal stations of Aberlady and Tynninghame, coming back to the upland area as soon as the weather eases up.

The situation at Hule Moss is similar but the decline to a winter population of 1,500 to 2,500 is less steep no doubt because of the 'fatter' arable areas accessible from that roost. It is however apparently much more liable to be 'shut down' by frost and for longer periods than Fala/Gladhouse. No synchronised count of the roosting stations has been attempted for the bottom population period around mid-January but it might be put at 3,500 to 5,000 birds.

Then, depending on the severity of the winter, a gradual upward trend in population commences in February and continues with or without weather setbacks through March into April, about the middle of which the spring peak population is reached. Again overall figures are not available to give an accurate picture but it is a reasonable guess that the population is both considerably lessened, with a spring peak of around 8,000 birds, and is mainly centred in the upland hill stations. In contrast with the autumn, Fala is used much more than Gladhouse in the spring.

Unless specially good food conditions due to a plenitude of young grass prevail, the peak population at Fala/Gladhouse (4500 to 5000+) is reached and passed very rapidly, even within a week. The numbers then diminish to around 2,000 strong, which departs for the north about the very end of April or first few days of May. Small detachments of up to 100 or so pass through the hill stations for the next week or two, obviously using the known routes and 'transit camps'. And then the calls of the geese are not heard again until the next September – only four months away.

The numbers of Pinkfeet in October and November, 1950-63

With this background it is possible to review the figures contained in Tables II to V. As from 1950 to 1954 the figures available are confined to Fala and Gladhouse (Table II) it is not possible to assess with accuracy the peak population figures for the whole area for these years. Nevertheless from the fact that the Fala/Gladhouse peak Pinkfoot population figures remained around the 5,000 mark from 1951 to 1958 it is possible legitimately to surmise that peak population figures for the whole area in 1952, 1953 and 1954 were very similar to those in the years 1955, 1957, and 1958. Indeed it can also be said that 1953 was a better than average year as 5,500 Pinkfeet were counted at Fala/Gladhouse on 31st October and 6,000 at Hule Moss on 24th October. The significance of the low numbers in 1950 is uncertain because, although there were only 150 Pinkfeet at Hule Moss on 12th November, there had been as many as 10,000 at that roost on 8th October.

Turning to a review of the figures for the whole area for the years from 1955 to 1963 (Tables II and IV), with the requisite additions incorporated to arrive at the peak population figures (Table V) the remarkable fact appears that, although the distribution of the population differed from year to year and the actual date of the peak also varied slightly, the Pinkfoot population remained fairly constant at about 11-12,000.

1956, the first of three years in this series to differ materially, showed a temporary drop in the peak Pinkfoot population to around 9,600. One possible explanation lies in the fact that 1956 was apparently a bad breeding season. Another that is perhaps more likely in the light of the lack of variation between the peak population of 1955 and 1957 is that the peak at Fala/Gladhouse was over so quickly that it was not recorded properly, as apparently happened in 1951. In this connection it should be noted that the actual count of 9,030 on 3rd November was higher than counts in some of the other years made at about the same date.

The autumn of 1961 was unusual in that for the only time in the series the area population showed an increase from its peak arrival level of 12,100 at the watch on 21st October to 14,000 at the watch on 11th November due to the specially good food supply position in that year.

The last year, 1963, was the third to differ materially. During the quite exceptionally hard winter of 1962-63 the Pinkfoot population which remained in the area in January and February was centered at Aberlady where it varied from 200 up to over 2,000 and at Tynninghame where 700-800 were seen on one occasion. But as soon as the weather opened up at the beginning of March the Pinkfeet showed remarkable speed in returning to their upland haunts and resuming their normal pre-migration spring ways.

In the autumn of 1963 there was a quite unusual arrival pattern in the area with heavy in-come from the east or north-east direction following the great gale on Thursday 26th September, and after almost none of the usual flight-through from the north to the Solway and preliminary build-up – the primary reason apparently being a blizzard in Iceland on 24th-25th September. The peak arrival population was then assessed at some 10,000 comparing with the 1962 peak arrival figure of 12,200 or over, the difference being reasonably attributable to casualties resulting from the 1962-63 winter.

Table III. Counts of Pink-footed Geese in the Lothians area in November, 1955-63

roost	*1955 12th*	*1956 3rd*	*1957 16th*	*1958 8th*	*1959 14th*	*1960 12th*	*1961 11th*	*1962 10th*	*1963 9th*	*mean*
Fala Flow	750	–	900	10	270	600	50	2,430	450	600
Gladhouse	2,700	3,750	2,550	3,450	2,000	680	4,670	2,200	4,850	2,980
Aberlady	380	100	10	700	2,360	1,400	250	680	1,380	810
Tynninghame	700	–	150	–	1,000	–	–	–	–	–
Watch Res.	(†)	–	–	–	150	–	–	–	–	–
Hule Moss	1,410	3,200	5,130	4,370	1,100	3,700	3,800	3,500	200	2,930
Harperrig	–	–	–	–	–	–	–	–	10	–
Cobbinshaw	2,120	1,500	1,050	500	2	–	270	130	–	620
Baddinsgill	510	480	900	1,000	530	300	5,000	1,450	1,600	1,530
total (to nearest hundred)	8,600	9,000	10,700	10,000	7,400	6,700	14,000	10,400	8,500	9,500
Libberton/Carnwath	–	–	–	–	–	1,700	580	4,150	1,850	–

none seen at Threipmuir reservoir.
† reservoir completed 1955.

At the watch held on 19th October the population had reduced to 4,750 the lowest autumn level yet recorded in the area, although there was plenty of food available. But by 9th November when the National Watch was held the area population had increased again to 8,500, i.e. a not abnormal figure for the time of year indicating again a resumption of their more usual ways.

An explanation of the steady increase in the peak Pinkfoot arrival figures at Fala/Gladhouse from 1957 to 1961, viz.: 1957 5,000+; 1958, 5,760; 1959, 6,880; 1960, 8,100; and 1961, 8,600, is needed. From the fact that the area population remained comparatively constant during these years it appears likely that the increase was due to changed distribution within the area rather than 'drawing' from another area, the possible conclusion being that Fala/Gladhouse was becoming the main centre for first arrival and subsequent dispersal in the area as a whole, that is to say, serving a function very similar to what Loch Leven used apparently to do on an even larger scale for many years. In 1962, the peak of very brief duration, was again 8,600 but in 1963, already noted as an abnormnal year, it fell to 5,000.

Table IV. Counts of Pink-footed Geese in the Lothians area in late October, 1961-63.

roost	*1961 21st*	*1962 20th*	*1963 19th*
Fala Flow	2,300	170	250
Gladhouse	4,500	5,200	1,560
Aberlady	4	40	630
Hule Moss	4,200	3,500	250
Cobbinshaw	150	40	60
Baddinsgill	950	1,850	2,000
total	12,100	10,800	4,700
Libberton/ Carnwath	700	480	810

none seen at Watch, Harperrig and Threipmuir reservoirs or at Tynninghame.

In contrast with the comparatively small range of variation in the peak population figures during the period of these watches, there is a larger range of variation in the numbers counted at the various November watches (Table III). As will be seen the range is of over 7,000 with a low of 6,700 in 1960 contrasting with a high of 14,000 in the immediate next year of 1961. There is practically no doubt but that these wide variations in population level are related to the food supply available in the area at the time of the watch. It is of course obvious that in a year of quite good food supplies in the area one or more of the major Pinkfoot feeding areas elsewhere in Britain may be even better and so attract more of the total goose population. So also in a year of comparatively poor food supply this area could be relatively better than others and con-

Table V. Estimated size of arrival peak population of Pink-footed Geese in autumn in the Lothians area, 1955-63

		autumn peak in Lothians
1955		12,100
1956		9,600
1957		12,100
1958		11,400
1959		11,300
1960		12,600
1961		12,100*
1962		12,200
1963		10,000
	mean	11,500

* increased to 14,000 on 11th November, 1961.

tinue to hold the geese. It should be remarked that there is no close correlation between the numbers of Pinkfeet counted in the Lothians area in autumn and the total numbers in Britain in November reported by Boyd (1963, *Wildfowl Trust 14th A.R.*, p. 88).

Amongst the ebb and flow of numbers at the various roosts several trends can be made out. The recent increase in the number of Pinkfeet found at Aberlady Bay (to as many as 5,000 resident in late November and early December, 1962) is a welcome vindication of the declaration of a Local Nature Reserve here in 1952. At that time the Bay had almost ceased to be used by geese. The other coastal roost, at Tynninghame, continues to be used only infrequently during the shooting season, presumably because it is so much disturbed.

Another roost that has greatly increased in importance is that at Baddinsgill reservoir. At first sight the increase at Baddinsgill seems likely to be associated with the decline, almost to nothing, at the heavily-disturbed Cobbinshaw reservoir but recent evidence suggests that this is also closely related to events in Lanarkshire.

Roosting and feeding

The twin foundations of goose living, in the winter period, are roosting and feeding. When reasonably undisturbed in their uneasy co-existence with the human and in particular the agricultural community round about, the geese fly to roost either from their feeding grounds or from their resting stations any time from near sunset until an hour or so after it but more usually within the period from half an hour to an hour after sunset when the daylight is fading to a minimum. This must be of choice and not of necessity because geese can on occasion be found flying to roost in conditions of practically total darkness so far as the human eye is concerned. Almost the only times when this ability appears to be used are when the particular roost concerned has become dangerous through extensive shooting. At such times they might navigate by the stars if visible, although sheets of water and silhouetted landmarks must be better seen with what fractional light is available from the vantage point of a goose in flight than from on the ground.

The only time when the navigating ability of the geese breaks down is in mist and this seems fully as much due to confusion of their system of flock call communication as to loss of sight. It follows that in misty weather the geese prefer to feed close to their roosting station. Also when heavy rain or hail comes on when they are ready to fly in they will postpone their flight, or even come down at an in-between rest station, and resume when the blast is over.

At periods when the moon is of any extent and is riding in the night-time sky geese are to be heard flying to and from the roost throughout the night. At such times, either when there has been interference by shooting at the roost or the geese are hungry, they are liable to stay out at the rest station or fields until all hours of the night and only come in to the roost when it pleases them. At Fala and also apparently at Hule Moss the geese from time to time do not come into the roosting water but stay out on the moor all or most of the night, apart from the periods of full moon. As found at Fala this happens, except during special disturbed conditions, first when the small advance guard has just arrived in late September or early October and second, at times when the pond is about to freeze over – a fact that the geese can apparently sense accurately beforehand.

The actual method of flight into the roost varies slightly according to the locality but in the upland roosts it is frequently prefaced by the arrival and flight over the roosting water of one or two separate single geese. On occasion these may fly right in and settle on the water. More often they may return to the direction from whence they came. Then, if there is no disturbing element to be seen near the roost, after a short pause there is a babble of geese to be heard from the rest stations or fields where the goose flocks are located, followed by the chorus of those in flight. According to the spread of the rest-stations or feeding fields in come the geese in loose formation in sections and flocks small and large, the larger the flock the bigger the clamour. These fly in over the water turning upwind

if necessary to do so and then as often as not whiffle down to the pond or loch beneath. If the pond is small and the flock large it is on occasion necessary for a large part of them to circle round 'waiting on' until the first part of the flock has settled before they too can come in. After the first geese are in, the later flocks and sections fly in without any of the hesitation that may have been displayed by the first arrivals. On the other hand if there is some interference at or near the roosting water (such as a human seen near it) at the time the single geese have flown over the area, then after their withdrawal there is a delay of half an hour or more so that the geese come in in very much poorer visibility than normal. At first when the geese come in to roost there is usually a great clamour, redoubled whenever a fresh detachment comes in, with greeting calls from the new arrivals and in answer from the water beneath. Then some time after the last detachment comes in the noise settles down to a constant 'chimmer' or great hum broken only by occasional strident calls (which sound as if coming from the commanders of the flock) varied by occasional squeaks or grunts.

R. W. J. Smith points out that at larger sheets of water, such as Gladhouse, scouting by single birds before the main arrival is unusual, while a moving human body at the edge does not usually deter the birds from alighting well out in the centre of the water.

When the water is frozen over, the geese will quite normally roost standing upon the ice. Under suitable conditions the treading of their feet upon the ice to keep them from freezing to it can be heard, with a sound rather like rain falling on a corrugated iron roof. At such times it has been found possible to arrive at a roughly accurate estimate of the roosting goose population of the night before by counting the castles of fresh goose dirt left behind on the ice. That these are usually the product of one pile per bird has been shown by the accompanying single hollow in the ice (lying in suitable anatomical proximity) caused by the tramping or resting feet of the bird, the appearance of which also has been noted under the special conditions of air temperature which allow the ice to be melted by the feet of the bird. These observations apply to a roost on a comparatively small area of frozen water in the centre of an open moor. Dr. J. Berry remarks that it is unusual for geese to sleep for long periods 'on their feet', particularly on ice or snow. As observed by him under more secure conditions when geese settle down to sleep their feet are tucked up into their flank feathers and the bird rests on its well insulated 'tummy'.

At daybreak or before there is renewed babble and with first light out the geese fly in sections small or large to the fields chosen as feeding grounds. There, if the field is known and conditions are undisturbed, the first section or flock settles usually as near the centre as possible after circling round several times and several 'failed' attempts to settle before they actually do so. Thereafter if the field supplies good feeding the build-up is rapid with the succeeding flocks or detachments settling in much more rapidly. If, however, the initial section is making a first approach to a new field or conditions at the known field have already been disturbed, the approach is even more cautious and scary. On a field that one day has only a few geese, say 50, the next day there may be many more, 500 to 1,000, and by the next 2,000 to 3,000, and there seems no doubt that they are able to communicate the news that there is a good food supply in a certain field to their brethren. That this knowledge can be spread over a wider area than that served by the immediate roosting station is the only legitimate deduction from the incursion of geese into the area in seasons such as the autumn of 1961 when the food supply was specially good. (Incidentally this habit of rapid build-up in an approved feeding field gives a very ready parallel for rapid build-up at an approved roost.)

While the advance guard of geese may feed on such young grass as is available until the oat and barely fields are free of stooks and standing corn, as soon as such fields are in stubble the geese take to feeding upon them. In the main the food obtained is the shaken ears and heads of oats and barley but with the short stemmed barley grown specially for cutting with the combine harvester, and also with oats, has now come the practice of 'under sowing' a clover grass mixture to follow for use as soon as the cutting has been completed. To some extent this green crop is also eaten, and the risk of damage to it whether by eating or trampling is one of the main causes of complaints from the farmer. At times of peak population before the harvest has been generally cleared or at times of late harvest with the oats still uncut, geese will come down in fields which still are covered partly or mostly with stooks and even perch on the stooks, although this is most unusual.

Eating of frosted potatoes on cleared fields is unusual in the upland country and more usual in the coastal area, probably because potato-growing in the upland country is on a small scale.

From January onwards feeding is almost entirely on grass and in the upland area the rapidity of the growth of the return popu-

lation and its existence at a higher level for a longer or shorter period before the late April decline depends on the coming and continued growth of young grass. So the geese come into direct competition with park sheep for the supply of grass at just that period of the year when the park lambing in the upland area is coming or has begun, the usual dates for its commencement being 14th to 21st March. In a year when the grass supply is short there may well be considerable inroads by the geese into the fields visited by the flocks – usually the best – and it is at such a time in my opinion that there is the biggest danger of real damage to the farmers whose fields are affected and the greatest cause for legitimate complaint by them.

In the upland part of the area the question of possible damage to young winter wheat after 'brairding' does not arise as almost no winter wheat is grown. If the geese are feeding in the low-lying part of the area at the appropriate period it can, however, be quite a serious matter.

Rest stations and parking-out stations

The simplest relationship of roosting station to feeding ground is when the food supply field is located within short range of a roosting station which is a comparatively large and undisturbed sheet of water, such as Gladhouse. Then if the feeding birds have had enough or are scared off the supply field they simply fly back to the loch and rest upon its waters or shores. More often in this area the geese are feeding two or three miles or more away from the roost or alternatively the latter is a comparatively small sheet of water, such as Fala Pond or Hule Moss. In such cases the geese in the uplands adopt areas of moor or rough ground as resting stations from which to fly to and from the food supply fields, and at the end of a day they may just as often fly to the roost from these resting stations as from the feeding fields. The siting of these rest stations appears to be a marriage of convenience between proximity to the food supply field and security from interference – this last leading to the choice of a site in the centre of a wide stretch of moor or near the summit of one of the rounded hills in the area.

Geese engaged in what had appeared to be perfectly normal evening roost-bound flight may drop down and settle to rest on a piece of moor ground lying beneath their route to the roosting station. Then after a pause they resume their flight and so arrive at the roosting station in much poorer (and safer) light than would have been the case if they had gone straight on.

The special resting stations for want of a better term I have called 'Parking Out Stations' and in one form or another they have been a feature of the behaviour pattern in the Fala/Gladhouse area ever since their existence was discovered as a result of the first goose watch in 1952. Indeed Fala Moor and the hills near it may often function during the autumn more as a large scale rest station and parking-out station for Gladhouse roost-bound geese than as a night roost on Fala Pond. This has been especially true of the later years covered by these watches.

Similar resting stations are regularly used in Lanarkshire and in most parts of Scotland where Pinkfeet feed at long distances from their roosts.

Linkage of goose roosting stations

The linkage which clearly exists among the various goose roosting stations falls to be considered both as it affects those within this area and also those outside. The special case of Fala/Gladhouse has already been noted. As already seen they apparently derived in their present form from Aberlady Bay and there is frequent flighting, particularly from Fala, to Aberlady Bay to be seen, apart from the transfer of the 'basic flock' to the coast in hard weather already referred to. Interchange between Fala and Hule Moss has been noted on a number of occasions, particularly among arrivals in spring, and in 1961-62 movement was clearly observed as between Baddinsgill and Gladhouse. The roosting flight to Baddinsgill several times has taken place from part of the Libberton/Carnwath feeding area. That there must be a definite connection between Aberlady and Tynninghame is evident from their juxtaposition. Perhaps also there is a connection between Tynninghame and Hule Moss, though this has not been directly noted, perhaps because of the present disuse of Tynninghame.

As regards wider linkage, the southbound flight from Gladhouse/Fala evidently making straight for the Solway marshes has already been referred to. Northbound traffic along the same route in reverse is also often clearly visible, not only in spring but also sometimes in autumn, as at the time of the Solway storm in 1961 and when there is an easing up of hard weather in the winter months.

From Fala also geese can quite frequently be seen, usually in the spring, setting out from nearby hills and making direct for Loch Leven with just comfortable time for them to flip in there about the half hour after sunset. Similarly geese can sometimes be seen setting out taking a line that would bring them to the lower Tay estuary.

Even without the more positive proof supplied by the Wildfowl Trust ringing and colouring of geese there would appear to be little doubt of the constant comings and goings of some part of the goose population both between roosting stations that are near to one another and those that are more distant.

That geese can convey to one another news of food as well as of disturbance appears a legitimate deduction from their local behaviour; coupled with the constant interchange this appears to be the probable explanation of their build-up in an area with a specially favourable food supply.

The Greylag population

Greylags form very much the minor part of the goose population in the area and because of that fact the considerable differences between their behaviour and that of the Pinkfeet tend to get overlooked.

In the pre-1939 period it seems clear that the only population of Greylag wintering in the area was that of say 200-300 roosting at Aberlady Bay with the Pinkfeet. During the War a removal inland and increase parallel to that of the Pinkfeet evidently took place with a population appearing at Gladhouse which can reasonably be surmised to have been the successor to that which had previously wintered at Aberlady. R. W. J. Smith notes that 'by 1948 at least 600 Greylag were firmly established at Gladhouse and in the next two seasons big numbers started to appear first at Threipmuir and then at Harperrig'.

Greylags arrive much later than Pinkfeet in the area, the first few usually being seen about the middle of October and it is not until about the end of that month or the first few days of November that they are fully in. It is fortunate that these watches were almost always held at a time when the Greylag were fully in, except in 1960 when they did not all arrive until after the check on 12th November.

In the years from 1955 to 1963 the total count of the autumn population for the area (Table VI) as found in the November watches has varied between 400 in 1960 and 1,750 in 1957 but has generally been in the region of 1,000 to 1,300. From the figures for Gladhouse in 1948-54 (Table VII) it seems likely that the area total was of the same order in that region in 1951, 1952 and 1953 and below it in 1948-50 and in 1954. The variation in the numbers of Greylags throughout the winter has not so far been studied in detail but there would appear to be a possible pattern of some further increase in late November/early December and of decline thereafter. Greylags depart from the area about a month before the Pinkfeet, the final leaving taking place around the beginning of April.

A rise in the late autumn population which took place in 1962 and 1963 should be noted. In 1962, after the first winter storm on 17th November, the flock at Threipmuir and Harperrig, as usual mainly based on Threipmuir, built up to some 1,200.

Then in 1963 after the watch on 9th

Table VI. Numbers of Greylag Geese in November in the Lothians area, 1955-63

roost	*1955 12th*	*1956 3rd*	*1957 16th*	*1958 8th*	*1959 14th*	*1960 12th*	*1961 11th*	*1962 10th*	*1963 9th*	*mean*
Fala Flow	50	–	–	–	–	–	–	2	–	–
Gladhouse	430	500	800	300	300	25	240	280	280	350
Watch Res.	?	16	40	69	23	95	210	290	180	115
Hule Moss	50	–	8	–	–	–	–	–	–	–
Harperrig	420	200[a]	–	400	650[b]	30	–	45[d] +700	440	240
Threipmuir	200	240[a]	900	250	185	250[c]	420	150	400	390
Cobbinshaw	30	15	–	–	–	–	–	–	–	–
Baddinsgill	–	20	–	–	–	–	–	–	–	–
total (to nearest ten)	1,180	990	1,750	1,020	1,160	400	870	1,470	1,300	1,120

none recorded from Aberlady Bay or Tynninghame.

(a) 375 at Harperrig and 300 at Threipmuir on 4th November, 1956.
(b) on 15th November, 1959; none reported 14th.
(c) 390 on 13th November, 1960.
(d) evidence obtained later showed that some 700 failed to come in to roost at either Harperrig or Threipmuir at this watch and that the joint population at that data was about 900.

Table VII. Numbers of Greylag Geese at Gladhouse Reservoir in autumn, 1948-54

1948	30 October	350
	28 November	230
1949	23 October	50
	20 November	235
1950	5 November	80
	26 November	150
1951	28 October	450
	11 November	450
	18 November	500
1952	25 October	200 (at Fala)
	1 November	650
	9 November	500
	16 November	500
1953	31 October	500
	8 November	500
1954	24 October	400
	21 November	300
	27 November	100

November the number of Greylag at Threipmuir built up to an even higher level than in 1962 and Craigie Tait assessed them at 1,700-1,800 on Saturday, 14th December. The number then based on Gladhouse was about 500 making together the highest area total yet noted in the period without reference to any other possible populations (e.g. it is known that there were still some at the Watch Reservoir on 14th December, though not how many).

Perhaps also connected with this unusually high population level for the area it is understood that during later November and early December, 1963 up to more than 200 Greylag frequented Portmore Loch some 2½ miles S.W. of Gladhouse and roosted there for at least part of the time, i.e. separately from those at Gladhouse. This was the first year in which this is known to have occurred.

Comparison of Tables III and VI reveals that there is almost complete segregation of the two species so far as roosting is concerned, except at Gladhouse. In Midlothian, Greylags are normally the only geese to be found roosting at Threipmuir and Harperrig and in Berwickshire they have adopted the new Watch Reservoir as their own since it first became available in 1956, segregating out almost entirely for roosting purposes from the Pinkfeet at Hule Moss. When the Pinkfoot population is first at its peak a party of Greylag may rest with the Pinkfeet on the Moor at Fala, yet only three or four times in all the years from 1952 can I remember having seen a small party come down to roost with the Pinkfeet on the pond.

As observed in the Fala/Gladhouse area, Greylag appear to be much more predictable in their behaviour than the Pinkfeet as well as being less 'skittery' and to spend much more time at the reservoir and in the fields near its side. They appear to have a greater preference for feeding on grass as compared with stubble which may account for their tendency to remain near the reservoir side. When feeding beside Pinkfeet they do so at a more leisurely and sedate pace, tending to stay in the one area of ground and not feed forward rapidly a short flight over the heads of the geese in front, in the way the Pinkfeet do. Though they are often to be seen feeding in the same fields as the Pinkfeet, almost invariably they form groups of their own within or at the edge of the large flock of Pinkfeet.

In a general flight Greylags almost always form their own separate section and can be picked out by voice and shape. Under at all reasonable conditions, differentiation between the two species becomes reasonably easy with practice. The difference in the normal call notes is often the easiest and best distinction. After listening through these years I personally would say that I would almost never mistake the 'farmyard' calls of Greylag for Pinkfeet but I still on a few occasions have some difficulty with a certain special 'gangling' call given by Pinkfeet when this species, as does happen at the odd time, does not give itself away by indulging in the variations from its much larger vocabularly.

'Jokers in the pack'

This is the apt name which Sir Robert Erskine-Hill of Quothquhan gives to the odd members of other species which turn up from time to time in the otherwise uniform flocks of Pinkfeet and Greylag, or to the special variations of these species such as leucistic Pinkfeet. Whilst in theory denouncing chasing after rarities as 'scalp collecting', in practice when one of these specialities turns up in a flock of say 1,000 Pinkfeet I find myself paying as much attention to the one as to the other 999, somewhat to the detriment of proper watching of the behaviour of the flock as a whole. Nevertheless these special occurrences are only of value if after a time it is found that there is in fact a regular appearance of small numbers of the particular species or if they can be used to give guidance as to the movements of the flock in which they are caught up.

The outside species that has most frequently been observed with the Pinkfoot flock is the Barnacle Goose (*Branta leucopsis* (Bechstein)) which has been seen practically every year since the general watches began in 1955. Though the majority of observations are of 1 or 2 birds only, parties of 4 to 8 have been seen on several occasions retaining their own grouping

within the Pinkfoot flock. Barnacle Geese are frequently seen passing over the area on their way to the Solway in autumn, and less often returning north in spring, these being the geese that breed in Spitsbergen. Whether the Barnacles living in the area are stragglers from this passage or whether they are Greenland-breeders caught up in Pinkfeet in Greenland or Iceland is not yet clear.

One or two Greenland Whitefronts (*Anser albifrons flavirostris* Dalgety & Scott) have been seen at Gladhouse in a number of years, usually in association with the Greylag and more often juveniles than adults. Isolated records also exist for European Whitefront (*A. a. albifrons* (Scopoli)) and Bean Geese (*A. fabalis*) and on one occasion of a Light-bellied Brent (*Branta bernicla hrota* (O. F. Müller)) inland. Two records for a single Greater Snow Goose (*Anser caerulescens atlanticus* Kennard) and a single Blue Snow Goose (*A. c. caerulescens* (L.)) are referred to below.

With very few exceptions the firm records for Bean Geese are from Tynninghame and from Hule Moss, where small parties have been seen on a few occasions, and it is just possible that there is an annual movement of a small number of this rare species which touches this eastern corner of the area from time to time.

Brent Geese, of the Dark-bellied race (*B.b. bernicla* (L.)) were a regular feature of the Aberlady scene in pre-1939 days until the species was hit by the *Zostera* grass disease which decimated their food supply. In recent years small parties of both races of this species have been seen at Aberlady on several occasions for varying periods and it is to be hoped that it will make a comeback.

In 1954 a dead Snow Goose which had been shot was found at Gladhouse by the Water Keeper Mr. John Watt and after careful examination by Kenneth Williamson was pronounced to just fall within the measurements of the Greater race (*atlanticus*). In the winter of 1959-60 a single bird of large size and outstanding appearance and which would appear to be clearly a Greater Snow showed up with one Pinkfoot flock at Libberton/Carnwath and about the same time that winter there also appeared there a Blue Snow Goose, which however mainly consorted with a separate Pinkfoot flock. In the winters of 1960-61, 1961-62 and 1962-63 the Blue Snow Goose reappeared at Libberton/Carnwath and each time stayed with a Pinkfoot flock throughout the season.

By contrast what was almost certainly the same Greater Snow Goose as had been seen at Libberton/Carnwath the year before appeared at Fala from 15th to 23rd October, 1960, was thereafter seen at Hule Moss on 13th November, was thereafter reported as seen at Dumfries and then early in January, 1961, from the Tay before it appeared at Fala once again where it was based from 9th February to 4th March. The last record was from Loch Spynie in Elgin on 27th March, 1961. On 13th October, 1961, what must again have been the same bird was seen at Ladyside/Heriot flying south with Pinkfeet at 1.15 p.m. and to touch down at Caerlaverock on the Solway at 3.30 that same afternoon. Then it appeared at Gladhouse on 11th November and was based there till 2nd December but on 19th December was seen once more at Libberton/Carnwath in which general area it remained till mid-April. It seems possible that the Blue Snow Goose which has remained faithful to the same area for four entire winters typifies one brand of Pinkfoot behaviour as representing the flock with which it is bound up and that the Greater Snow Goose with its much more roving history typifies another brand of behaviour as representing the section of Pinkfeet to which it is attached.

As reported by R. W. J. Smith, Canada Geese (*Branta canadensis* (L.)) in flocks of 30–40 and single birds have been noted as appearing at Gladhouse, Coldingham and the estuary of the Tyne but only in the summer months. In the absence of any known local colonies apart from 5 pairs lately introduced at Mellerstain it is not known from where they derive, although the recent demonstrations of a 'moult-migration' between Yorkshire and the Beauly Firth (see p. 71) may provide an answer. There is also a record of 3 from Aberlady Bay on 1st January 1952.

One or two leucistic geese are often to be seen in the Pinkfoot flocks in the area and, while these are not always possible to re-identify with certainty because of the existence of several of them, the presence of one in a flock of some 500 Pinkfeet once helped (10th November, 1957) to identify the specific movement of the flock to Aberlady Bay from the Fala area, from which direction it was seen to arrive and join the 300 already at the bay.

A melanistic Pinkfoot was seen in the Wester Middleton/Esperston area in April 1963, which was a member of a flock then roosting at Gladhouse. As this colour variant is much rarer than the leucistic any further sighting of such a bird would be of considerable interest.

Thanks to helpers

The information obtained from these goose watches at the various roosts spread

over 'the Lothians area' as defined for these purposes could not possibly have been obtained without the willing aid of a large number of helpers, drawn in most cases from the ranks of the Scottish Ornithologists' Club. Sometimes the watches were perforce carried out in bad weather conditions and often the watchers at a particular roost or watching site saw few or no geese themselves. It is easy to say on paper that a nil return is as important as to have seen 3,000 geese but this is just not true from the point of view of the particular watcher concerned. Nevertheless quite a few of the helpers have shown themselves willing for punishment of this particular brand and it is due to the help of all the watchers concerned and especially to those who have put up with the difficult stations often for several years on end that it has been possible to achieve this very corporate effort. A list of these watchers is appended. The considerable thanks of the S.O.C. and of myself to them all.

List of watchers

D. Anderson, D. R. Anderson, D. G. Andrew, J. Ballantyne, W. Birrell, T. Boyd, Mrs. H. F. Brotherston, A. Bryson, J. W. Cameron, A. Charleston, G. D. Cheyne, S. Clark, A. Cowieson, C. N. Cowper, J. Crawford, W. Douglas, Sir Robert Erskine-Hill, J. N. Fergusson, Miss W. N. Flower, D. R. Grant, F. Hamilton, M. Henderson, Miss N. Henderson, Miss B. C. L. Johnston, M. R. Jones, E. Larkins, Mrs. A. Lister, J. Lister, Col. W. Logan Home, D. Long, A. McCaskie, Miss J. McDiarmid, A. MacDonald, K. S. MacGregor, A. M. Mackenzie, A. Macmillan, J. Malone, A. Miller, G. Mills, Miss A. Munro, J. Munro, W. Murray, D. Pringle, I. Rae, C. P. Rawcliffe, Miss E. Robertson (Mrs. J. Munro), A. Ross, P. Russell, G. L. Sandeman, A. Scott, P. Slater, A. Smith, R. W. J. Smith, J. Stewart, R. S. Craiton, Miss O. T. Thompson, J. Thow, I. Waddington, C. Walker, R. Walker, J. Watt, T. Weir, K. Williamson, J. Young, L. Young.

So far as I know this list is reasonably accurate but it may be that I have omitted one or two names and, if so, my apologies and thanks to those concerned.

This review has been checked over by a number of people who have helped me to fill in various blanks and to rectify some of the mistakes that appeared in the first draft. My special thanks are due to all of them for their assistance in assuring that the review, like the watches, is also very much a corporate production. In particular here I have to thank D. G. Andrew, Dr. J. Berry, H. Boyd, A. Cowieson, Major the Hon. Henry Douglas Home, A. Macdonald, K. S. MacGregor, W. Murray, R. W. J. Smith, G. Waterston, the late Mr. J. Watt.

In addition to thanking all those who have actually taken part in these watches, special thanks are due to all the various landowners upon whose properties they have taken place: the Earl of Stair, Lady Marjorie Dalrymple and Major the Hon. Colin J. Dalrymple (Fala Flow); the Earl of Rosebery (Gladhouse and Carvald Farm); the Dundases of Arniston (Gladhouse and Esperston Moor); A. D. Elliot, Esq., of Kettelshiel (Hule Moss); the Marshalls of Baddinsgill (Baddinsgill); the Berwickshire Water Department (The Watch Reservoir); the Crown Commissioners (Aberlady and Tynninghame); the Edinburgh Corporation Water Department (Gladhouse, Harperrig and Threipmuir); the British Transport Commission (Cobbinshaw).

Our very considerable thanks are also due to the representatives of these landowners on the ground, namely the gamekeepers and water keepers for the courtesy and understanding with which they have always dealt with us when engaged in this 'diversion' and also for their patience on those occasions when by oversight we have not given them as much foreknowledge of our presence as we should have done.

Finally, of the outside helpers I wish to thank in particular Mr. Joseph Dobie Anderson and Mr. Robert Anderson, shepherds at the Garvald Farm, by Heriot, and Mr. Robert Walker, farmer at Middleton Mains, Heriot, whose joint provision of records of autumn flights through and arrival has been of major assistance.

Capture of moulting Canada Geese in the Beauly Firth

R. H. DENNIS

Summary

39 of a flock of 153 flightless Canada Geese were caught near Lentran, Inverness-shire on 3rd and 8th July, 1963. The catching procedures are described. Two of the geese had been ringed as juveniles at Ripley, Yorkshire, 260 SSE, in 1959 and 1962. Four more have been recovered in Yorkshire in October and in December, 1963. This is the first evidence of 'moult migration' by Canada Geese in Great Britain. The average weight of 12 geese was 4·65 kg. (10¼ lbs.), and the average length of the exposed culmen of 21 geese was 53·1 mm., values closely resembling those from a sample of geese caught in Derbyshire in 1957.

In recent years a flock of Canada Geese (*Branta canadensis* (L.)) has visited the western end of the Beauly Firth, Inverness-shire, off Lentran, arriving in June or July and leaving again in the early autumn. There have usually been over a hundred birds. I decided that they were probably non-breeders and that they came to the Firth to undergo their annual wing-moult. I was also fairly certain that there was no unknown breeding population in northern Scotland large enough to account for an influx of this size, so that it would be of considerable interest to catch and mark as many of the geese as possible in order to discover where they were at other times of year.

In the late summer of 1962 I had watched the Canada Goose flocks and noted that they frequently chose to spend their time at the entrance to the Moniack Burn (this and other points to be mentioned are shown on the accompanying sketch map). I decided that the best plan for catching geese would be to erect a V-shaped pen of wire-netting a mile down this stream at one low tide and then drive the flightless geese down the stream into the funnel at the next low tide.

In 1963 I first looked for the geese on 12th June, finding none then nor on the following day. When I returned from Sutherland on the afternoon of 21st June there were three flocks, of 66, 49 and 11, swimming between Lentran Point and Phopachy. I was able to look at them again on the afternoon of 24th June, when high tide was at 3.30 p.m. There were 145 resting on a point of land sticking out into the water. Stalking close to them behind the sea-wall, and using a good telescope, I could see that about two-thirds of the flock had moulted their flight feathers. Some had odd feathers sticking out of the wings and as they flapped feathers fell out. The birds which had moulted could be picked out in the flock by the amount of white under-tail coverts which could be seen. Those that had not moulted appeared black-sterned, because their old flight feathers hid the white coverts. As soon as the tide started to fall the geese moved with it. The tide runs out very rapidly over the shallows; if the tide line got ahead of them, the geese made a mad dash to get back into the water. They followed the tide line down to the low water mark. After they had gone we went out to the point where they had been resting and found lots of flight feathers, and also flushed two Greylags (*Anser anser* (L.)), probably pricked birds.

At my next visit, on 30th June, there were 153 Canada Geese, all apparently flightless. We also saw two Greylags, two Pink-footed Geese (*A. brachyrhynchus* Baillon) four Whooper Swans (*Cygnus cygnus* (L.)) and several hundred Shelduck (*Tadorna tadorna* (L.)).

I decided that Wednesday, 3rd July, would be a suitable day to try a round-up. High tide was to be at 10.30 a.m. which would give us all day to catch them. By this stage my plan of campaign had changed. I thought we needed eight to ten people and at least two boats. I planned to take the boats up from Inverness and shepherd the goose flock into the bay at Moniack Burn at high tide, keeping them there with the help of people wading out at Lentran Point and to the west of the burn. When the tide had fallen the boats could be anchored, a netting pen erected on the burn and the geese driven seawards into the enclosure.

Four of us made a final reconnaissance at low tide on the afternoon of 2nd July. We found the four Whoopers. All were partly moulted and we just failed to catch three of them. The fourth when finally cornered proved to be an adult female (Z 10603) which I had ringed at Bunchrew on 11th December, 1962. One of its wings seemed to be damaged at the carpal joint. We surveyed the area. The part unshaded on the map is sand, suitable for running over. The shaded area is mud, very hard work to walk over, but it will always bear people. This mud is covered with *Zostera angustifolia* (= *hornemanniana*) in plenty and also with *Z. noltii* (= *nana*) and *Salicornia*, making ideal feeding for the geese. The area is cut by small channels and it is easier to walk in the bottoms of the streams.

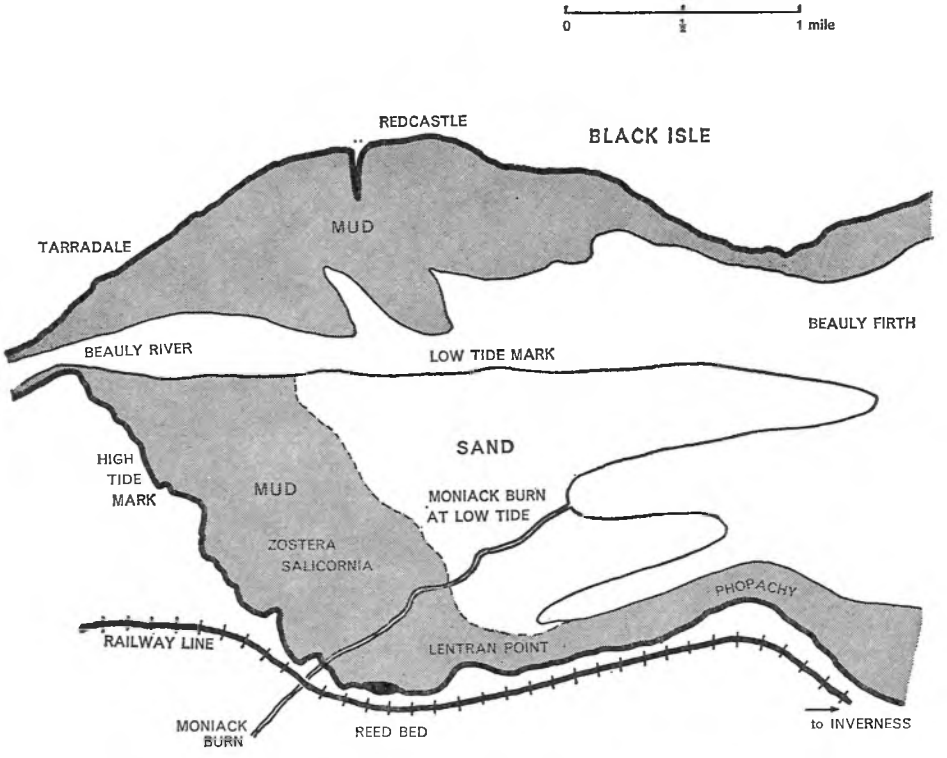

Figure 1. The Beauly Firth. The moulting Canada Geese live in the vicinity of the Moniack Burn.

About two hours after high tide it is possible to walk out from Lentran Point, though in some places the water is up to your waist. Saltings fringe this area and there is a thick reed bed east of the burn which we found full of moulting drake Mallard (*Anas platyrhynchos* (L.)). We caught one and ringed it.

We tried to borrow two boats with outboard motors but all we could get was a highly unstable but light fibre-glass pram dinghy. After this setback I thought we had no chance of getting the Canadas. But our plans were made so I decided to carry on with this dinghy and one of Dick Fursman's canoes.

Wednesday, 3rd July was a miserable day, wind east force 2-3, co'd and foggy. Five of us met at the Lentran lay-by: Dick Fursman, Douglas Weir, Charles Cowper, Jean Spriggs and myself. We took several rolls of wire-netting with us, some rope, rings and various other tools. To our amazement, the 133 geese were in an ideal position, all feeding along the shore between Lentran Point and Phopachy. High tide was at 10.30 a.m., so I decided to start the drive at noon. In the meantime we tried to drive some ducks out of the reed bed but only caught one. The reeds were too thick and it was impossible to find the ducks when they hid. The geese continued to feed off Lentran Point so I launched the dinghy just west of Phopachy by taking it over the railway line. I rowed out into the firth and let the wind and the waves take me towards the geese. They drove very well and went towards the bay. By this time the tide was going down rapidly and people from the shore ran out and cut off their retreat. After much herding, in which they tried to escape by running across the flats to the west, we managed to cut them off. To my amazement they flocked up and went up the stream – ideal – but then we made our mistake. I was still uncertain how close they would let us get before panicking, so I let them rest in the stream at a distance of 400 yards, with us ringed to the seaward side of them. We moved the netting out on to the mud and detoured to drive them into it – instead everything went wrong – the whole flock went up Moniack Burn and hid, some of them even going on up and hiding in the fields of corn. We trapped about twenty by netting this stream and driving them down under the railway bridge. This operation had taken a considerable time and it was decided that we would have to go and get the boat off the

mud because the tide was turning. It was now that we were glad that we did not have two outboard motor boats because two of us had to carry the light! fibre-glass dinghy three-quarters of a mile across the mud flats to the car. We returned to ring the geese. On our way we found that twenty more had been herded into a corner of a field by some inquisitive bullocks. But once we appeared the geese panicked and ran off into the ditches and fields.

We finally ringed seventeen and had two already ringed (137791 and 5011462). The weather conditions were fearful, pouring rain and cold, and all of us were soaked in sea water up to our chests. I found it impossible to sex the geese properly in these conditions because my hands were so cold, the rings were tricky to put on and the method of sticking them in sequence with sellotape was hopeless, because it got wet and the rings fell out of order. While ringing we found that the flimsy fencing we had made was not strong enough because the geese all panicked at once and some escaped by climbing over the backs of the others. We finished at 8 p.m. and all of us were soaked and exhausted. All the geese except a small flock of six were completely moulted and they were excellent at running, hiding and diving underwater.

After this episode, I decided to make a few adjustments to my catching plan and to try another round-up on Monday, 8th July. Our needs were: (1) only the one boat, but it must have two or three people in it, one to look after the boat; (2) more people to keep the geese in one flock; (3) to build a solid enclosure before the drive; (4) to keep some people hidden behind the railway embankment ready to stop the geese going into the reeds and fields. I decided to build the enclosure in the Moniack Burn, just inside the saltings, where the steep banks of the burn would act as sides.

I returned to the area at noon on Sunday, 7th July and found about 130 Canadas feeding in flocks one mile north of Lentran Point.

Monday, 8th, was again cold, with some drizzle and low cloud and unfortunately the wind was west 2-3. High tide was at 2.30 p.m. We started out at 3 p.m., built the trap in the burn and left Dick Fursman, Tim Woods, Jean Spriggs and Daphne Corr spaced out along the saltings. But the geese were on the edge of the saltings well to the west and they started to move north. Derek Mills, David Payne and John Mitchell went to Lentran Point ready to cut off the geese. Douglas Weir took myself, Billy Muir, Nicholas Brown and Norman Storie to Wester Lovat farm which is about one mile up the Beauly River on the south bank. We launched the boat and rowed downstream, whilst Nicholas and Norman walked along the sea wall, keeping pace with us. We rounded the point of the Beauly River. The Greylags, Pinkfeet and Whoopers were on the point of the saltings. We found the Canadas just offshore and they swam very quickly south. Unfortunately the two people on the shore found the going too difficult and they could not keep up with the flock, whilst we in the boat found ourselves being blown out to sea. The geese actually cut the corner at Lentran and I only just overtook them midway between Lentran and Phopachy. I disembarked Billy and, with the shore group, we moved them up towards Moniack Bay; but I found it very difficult to row against wind and tide. Once I had crossed the channel off Lentran Point, I was able to get out of the boat into two feet of water. By running and towing the boat behind me, I managed to cut them off once more and turned them into the Moniack Burn. Once here they moved upstream quite well but suddenly a group of them broke away and ran off to the north. The two people were so tired after walking from Wester Lovat that they were unable to stop this escape. Unfortunately many of the geese had their flight feathers half grown which, although they could not fly, enabled them to flap across the mud at a good speed. We herded up what was left and finally drove 22 into the Moniack trap. Some of them hid in the saltings and some even tried to hide on the open mud flats. Body, neck and head laid flat along the mud made them look quite like a large boulder.

Once more by the time we had them into the trap we were all so wet and cold that we found it hard work to ring and examine them. We weighed twelve birds but we found that the wet sack was a bit hard on their plumage. We measured length of bill from feathers of all of them. Two of them had been ringed the previous trip. As we finished with each one, I dyed its chin and cheeks with purple dye, and then put it back with the rest in the pen. We released them in a herd and they all ran off out to sea. We dismantled the trap and took it back to the car; then we carried the boat across the mud flats to Lentran Point, where we loaded it into the Land-Rover.

I was next in the area on 18th July and by this time most of the flock of 140 were sitting up on the saltings at the entrance to the Beauly River. As the tide went out they never bothered to follow it, so they must have been flying again. Thus the length of the flightless period must have been less than thirty days.

Measurements of moulting full-grown Canada Geese

	weight (kg.)			*bill, from feathers (mm.)*		
	number measured	*mean*	*range*	*number measured*	*mean*	*range*
Beauly Firth, 8 July, 1963						
females	5	4·36	3·9–4·8	5	51·4	49–55
not sexed	7	4·86	4·5–5·3	16	53·7	45–59
Derbyshire, 21 June, 1957						
males	36	4·88	4·17–5·41	36	56·5	50–63
females	36	4·39	3·67–4·95	41	53·7	49–58

Weights and bill measurements

Few measurements of British Canada Geese appear to have been published, so that it seems worth recording those of the small number of birds we were able to study, even though the sex of most of them was not successfully determined. Hugh Boyd has provided some comparative data from flightless geese caught at Osmaston, Derbyshire, on 21st June, 1957.

James Fisher (*Bird Recognition* vol. 2, p. 104. 1951) quotes weights for males of 6¼ to 13½ lbs., average 8½, and for females of 5¼ to 13 lbs., average 7 lbs. The corresponding metric equivalents are males 2·84-6·12 kg., average 3·85; females 2·38-5·90 kg., average 3·18. The source of Fisher's material is not stated. If all British, it is exceptionally variable, so that the considerable differences between his mean weights and ours are of uncertain significance.

The two samples do not differ importantly in the lengths of the bill (exposed culmen), either from each other or from a small number of eastern North American *B. c. canadensis* measured by J. W. Aldrich (*Wilson Bulletin* 58: 94-103. 1946), for which the means and ranges were 56 (53-58) for males and 53·9 (51·5-56·5) for females.

Recoveries

The combined catch, of 39 individuals in all, has already produced valuable results. 137791 and 5011462, caught by us at Lentran on 3rd July, had both been ringed as juveniles at Ripley, near Harrogate, Yorkshire, the former on 30th June, 1959 and the latter on 30th June, 1962. The remains of 137791 (with ringed 5002852 added by us) were later found at the Bay of Nigg, near Aberdeen, on 5th October 1963. Lentran is about 260 miles NNW of Ripley, and the Bay of Nigg is 86 miles ESE of Lentran.

5002856 and 5002865, ringed at Lentran on 3rd July, were both shot at Little Ribston, near Wetherby, Yorkshire in October 1963 (on or about 8th, and on 2nd respectively). Little Ribston is about 270 miles SSE of Lentran and 8 miles SE of Ripley. 5002854 and 5002860, ringed at the same time, were both shot on 26th December, 1963 at Flaxby, near Knaresborough, 265 miles SE of Lentran.

Thus the supposition that the geese moulting on the Beauly Firth are not solely of local origin has now been proved, by the demonstration of journeys from Yorkshire and back to it. How regular this moult-migration may be and whether geese from other areas are involved remains to be found out. Many Canada Geese moult at or near Ripley so that not all the geese from there move to the Beauly Firth. Moreover, the capture of a four-year-old bird at Lentran shows that the moulting flock did not consist only of pre-breeders but contained some mature birds, though presumably none that had bred successfully in 1963.

It is to be hoped that further attempts to catch Canada Geese can be made on the Beauly Firth, which should profit by the experience gained in 1963.

Barnacle Geese caught in Dumfriesshire in February 1963

HUGH BOYD

Summary

A Wildfowl Trust rocket-netting team caught 316 Barnacle Geese at Caerlaverock, Dumfries on 2nd February 1963. These included 94 of 685 ringed in Spitsbergen in the summer of 1962, but none of 609 ringed in East Greenland in 1961, nor any ringed in the Netherlands.

3,000 (2,800-3,200) Barnacle Geese were in the vicinity. Estimates of the total Spitsbergen population in August 1962 from the proportion of recaptures give a most probable value of 2,300, with limits of 1,900-2,900. It seems likely that earlier estimates, based on field observations of rings on 26th October, 1962, were too high because some rings went unseen.

There were 106 males and 82 females in a sample of 188 geese, which included only 5 first-winter birds. Weights of 20 males averaged 1·87 kg. (4 lb. 2 oz.); 15 females averaged 1·69 kg. (3 lb. 12 oz.). These weights suggest that the geese had not been adversely affected by the cold weather.

An Oslo University expedition to Spitsbergen ringed 685 Barnacle Geese in the Hornsund area in the summer of 1962 (T. Larsen and M. Norderhaug, *Wildfowl Trust 14th A.R.*: 98-104, 1963). At least 46 of these ringed geese were believed to have been seen by H. Boyd at Caerlaverock National Nature Reserve, Dumfries, on 26th October, 1962. It was desirable to verify those observations by catching a large sample of the geese frequenting the Reserve. Permission to use rocket-nets for trapping was given by the Nature Conservancy, subject to the restriction that the geese must not be caught on the Reserve itself but only when feeding outside it. The Barnacles began to feed on grass land outside the Reserve boundary early in January 1963 but because of bad weather it was not possible for a rocket-netting team to operate until 1st February. The nets were set that night and 316 geese were caught on 2nd February. The catch included 94 of the geese marked in Spitsbergen in 1962. A British monel-metal ring was added to each of the geese already ringed. Previously unmarked geese were given a British monel ring on the left leg and a white plastic spiral ring on the right leg. After ringing, the geese were released and flew off to the Reserve. The catch had no lasting effect on the behaviour of the geese, which fed in an adjacent field the next morning.

None of 609 Danish rings put on Barnacle Geese in East Greenland in 1961 (R. Marris and M. A. Ogilvie, *Wildfowl Trust 13th A.R.*: 53-64, 1962) nor of the rather larger number used in the Netherlands since 1957 (J. A. Eygenraam, *Wildfowl Trust 11th A.R.*: 77-79, 1960) was found. In conjunction with the very large number of Spitsbergen-ringed birds captured this negative evidence strongly supports the hypothesis that the Solway-wintering flock comprises only geese from Spitsbergen (H. Boyd, *Wildfowl Trust 12th A.R.*: 116-124, 1960). The recoveries so far obtained are also consistent with the supposition that virtually all Barnacles from Spitsbergen winter in the Solway area. Recoveries of Hornsund-ringed birds outside Spitsbergen have come from Norway, 23 October, 1962; Fair Isle, Shetland, 12 November 1962; Coquet Island, Northumberland, 17 October, 1962; Rockcliffe Marsh, Cumberland, January 1963; the grounds of the Crichton Royal Hospital, Dumfries, where a goose (also carrying a Caerlaverock ring) joined the captive collection of waterfowl on 17 November, 1963; and another 'Solway Firth' 7 December, 1963. Geese ringed at Caerlaverock in February have been found dead at Blaydon-on-Tyne, Co. Durham 17 October, 1963 and on the Solway Firth, probably in Cumberland, 1 December, 1963.

The geese marked in Spitsbergen had all been adults. An estimate of the adult population at the beginning of August 1962 can be obtained from the equation $N = M(C+1)/(R+1)$ where N is the size of the population at that time, M the number marked (685), C the sample inspected (308, $= 316 - (316 \times 5/188$ juveniles); see below for explanation of this ratio) and R the number of marked geese recaptured (94), whence $N = 685 \times 309/95 = 2{,}230$ adults (to the nearest ten birds), together with about 60 juveniles, a total of 2,290, say 2,300 birds in all. The 95% confidence limits, based on the normal distribution for the ratio R/C and on the Poisson distribution for the ratio of juveniles to adults, suggest that the total Spitsbergen population in early August 1962 was probably within the limits 1,870-2,910.

Counts and estimates by the rocket-netting party put the number of Barnacle Geese at Caerlaverock on 2nd February, 1963 at 3,000 (2,800-3,200), a figure slightly higher than the largest estimates earlier in the autumn and winter. It is not known whether any substantial numbers were present at the same time in the two other areas on the shores of the Solway Firth that are frequented by Barnacles, but there were

probably few elsewhere, since this was a Saturday at the height of the shore-shooting season, so that those other places were likely to be disturbed.

Even though the Barnacle Goose is legally protected on the mainland of Scotland and in England and is especially guarded on the Caerlaverock Reserve it is quite certain that the Spitsbergen population must have been larger in August 1962 than in February 1963, because of losses during the intervening six months. Thus the visual estimate in February (2,800-3,200) is barely compatible with the capture-recapture estimate for August (1,900-2,900). This is a reversal of the situation which emerged from the observations of October 1962 when 46 Spitsbergen rings were seen in 250 Caerlaverock geese, leading to an estimate for August 1962 of 3,860 (limits 2,960-5,240), compared with a maximum count in October of 2,700 (E. L. Roberts). The discrepancy between the proportion of rings in the geese handled in February and in those seen in October is considerable. A difference as great or greater would be unlikely to occur by chance more than once in 500 comparisons if the two samples were drawn from a single population. The two most likely sources of discrepancy seem to be: (1) failure to detect all the rings present in the sample inspected in October, or (2) non-random mixing of ringed and unringed geese within the Caerlaverock flock. It seems likely that some rings were not seen in October, but also that the mixing of ringed and unringed geese was incomplete, even though the frequency of Spitsbergen rings within sub-samples of the February catch corresponded well to a binomial distribution with a mean of 7·5 rings per 25 geese handled: and the observations in October similarly indicated thorough mixing within the group inspected. However, this does not rule out the possibility of important variations in the proportion of ringed geese in different parts of the entire Solway flock.

Sex- and age-ratios

The geese were not caught until late afternoon and many of them had to be dealt with after dark. This restricted the amount of information that could be obtained about each individual. 188 geese were sexed by cloacal examination: 106 were found to be males and 82 females. Only 5 of these 188 (2·7%) were recorded as in first-winter plumage. It is doubtful whether the recognition of young birds was complete even in this sample, because it was difficult to examine them adequately in the poor light. This is regrettable, as it increases the uncertainty of population estimates based on capture-recapture procedures. It is however unlikely that the proportion of first-winter birds was as high as 5·3%, the proportion observed in October, 1962.

Weight

A few of the first geese to be handled were weighed. 20 adult males averaged 1·87 ± 0·032 kg. (4 lb. 2 ozs.), ranging from 1·59 to 2·10 kg. 15 females averaged 1·69 ± 0·033 kg. (3 lb. 12 ozs.) ranging from 1·42 to 1·87 kg. The females included two first-winter birds, weighing 1·59 and 1·64 kg. According to the *Handbook of British Birds* (vol. III: 210. 1939) H. L. Popham recorded the average weight of 55 Barnacles as 4 lb. (1·81 kg.) with limits of 2½ – 5 lb. (1·13 – 2·26 kg.). R. Marris weighed a small group of flightless adults in Reindalen, Spitsbergen in July 1954: 12 males had a mean weight of 1·91 kg. (range 1·65 – 2·05 kg.); 11 females had a mean weight of 1·68 kg. (range 1·55 – 1·95 kg.). Thus it seems as if the weights of the geese caught at Caerlaverock were in no way abnormal. The Solway area had been experiencing unusually low air temperatures in January 1963, as had most parts of Britain, but the vicinity of the Caerlaverock Reserve had had very little snow, so that plenty of grass was available despite extensive patches of ice on the salt-marsh within the Reserve itself.

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Recoveries of ducks ringed in Aberdeenshire by Miss E. A. Garden

HUGH BOYD

Between February, 1958, and March, 1963, the late Miss E. A. Garden ringed nearly 500 ducks and swans in Aberdeenshire: 135 Mallard, 14 Teal, 21 Wigeon, 64 Eider, 1 Pochard, 126 Tufted Duck, 27 Scaup, 13 Goldeneye, 63 Mute and 7 Whooper Swans. Most of the birds were caught in traps on the estuary of the River Ythan at Newburgh, though many of the dabbling ducks were trapped at the Meikle Loch, Cotehill Loch and a small loch on Forvie Moor, 2½ to 4 miles north-east of Newburgh. All the recoveries of these ducks reported by 31st January, 1964, are listed in Table I.

Table I. Recoveries of ducks ringed in Aberdeenshire by Miss E. A. Garden, 1958-63

ring	*age*	*sex*	*where ringed*	*ringing date*	*recovered*	*recovery date*
Teal						
300.7401	ad.	♀	Meikle Loch	25.9.58	shot nr. Downpatrick, Co. Down, N. Ireland, 355m. SW	15.1.59
300.7402	ad.	♂	Collieston	29.10.58	killed Grande Couronne, Seine-Maritime, France. (49°21′N, 1°01′E)	21.2.59
300.7404	ad.	♀	Collieston	12.11.58	shot Castlerea, Roscommon, Eire, 350m. SW	(22.2.60)
300.7418	ad.	♂	Newburgh	14.2.62	shot Tyholland, Monaghan, Eire, 280m. SW	26.12.63
300.7421	ad.	♀	Forvie	1.3.62	killed Vetka, Gomelsk, U.S.S.R. (52°17′N, 31°11′E)	18.8.62
SS 02501	ad.	♀	L. Strathbeg	17.2.63	shot Luunja, Tartu, Estonian S.S.R. (58°21′N, 26°53′E)	31.8.63
Mallard						
942.943	ad.	♀	Cotehill Loch	29.11.58	local	*c.*10.12.58
942.945	ad.	♀	Cotehill Loch	3.12.58	shot Ringkobing Fjord, Jutland, Denmark. (56°00′N, 8°10′E)	23.9.59
942.949	ad.	♂	Meikle Loch	9.11.59	shot Sjöbotjärn, Gävleborg, Sweden. (61°50′N, 16°15′E)	11.8.61
942.956	fg	♀	Collieston	3.12.59	local	27.1.61
942.957	fg	♂	Meikle Loch	4.12.59	local	8.12.59
942.958	fg	♂	Meikle Loch	5.12.59	near St. Combs, Aberdeenshire, 20m. N	12.12.59
942.964	fg	♀	Meikle Loch	1.1.60	local	7.1.60
942.981	fg	♂	Collieston	15.1.60	local	(7.1.61)
AJ 26301	fg	♂	Meikle Loch	13.10.60	Haddo, Aberdeenshire, 10m. WNW	4.9.62
AJ 26313	fg	♂	Meikle Loch	9.2.61	local	30.1.62
AJ 26326	fg	♀	Forvie Moor	20.2.61	local	end-1.62
AJ 26338	fg	♂	Meikle Loch	3.3.61	shot Gruns, Värmland, Sweden (59°20′N, 13°05′E)	11.8.61
AJ 26339	fg	♂	Forvie Moor	3.3.61	shot Stadil Fjord, Jutland, Denmark (56°12′N, 8°13′E)	26.12.61
AJ 26344	fg	♀	Forvie Moor	23.3.61	shot Gammelstrup, Jutland, Denmark (56°29′N, 9°10′E)	20.11.61
AJ 26345	fg	♂	Forvie Moor	24.3.61	shot near Amsterdam, Netherlands (52°20′N, 4°55′E)	*c.*15.10.61
AJ 36358	ad.	♀	Forvie Moor	21.2.62	local	31.1.63
AJ 36404	ad.	♂	Newburgh	22.11.62	Floors Bay, Arbroath, Angus	21.1.63

continued

ring	*age*	*sex*	*where ringed*	*ringing date*	*recovered*	*recovery date*
Wigeon						
300.7413	fg	♂	Collieston	5.2.62	shot Agerø, Jutland, Denmark (56°43′N, 8°35′E)	26.11.62
AT 95925	ad.	♀	Newburgh	18.1.63	shot R. Pechora, Komi A.S.S.R. (65°58′N, 56°55′E)	20.8.63
Eider						
928.826	ad.	♀	Forvie Moor	22.5.59	controlled on nest, Forvie Moor	2.5.63
942.925	ad.	♀	Newburgh	6.10.58	found dead, local	1.7.59
942.927	ad.	♀	Newburgh	6.10.58	found dying St. Cyrus, Kincardineshire, 40m. SSW	7.7.63
942.935	ad.	♀	Newburgh	6.10.58	found dying Lucky Scaup, Tayport, Fife, 70m. SSW	2.1.63
AJ 13002	ad.	♀	on nest, Forvie Moor	20.5.58	found dead, oiled, Peterhead, Aberdeens. 15m. NNE	22.11.59
Tufted Duck						
AJ 26445	1st W	♀	Newburgh	7.1.63	shot Skjern, Jutland, Denmark. (55°57′N, 8°30′E)	30.10.63
AJ 26455	1st W	♀	Newburgh	8.1.63	shot Lainio, Norrbotten, Sweden. (67°47′N, 22°20′E)	22.9.63
AT 95915	ad.	♀	Newburgh	12.1.63	shot Iholmen, Fyn, Denmark (55°02′N, 10°31′E)	8.1.64
AT 95918	ad.	♀	Newburgh	13.1.63	previously ringed (H 22819) as juvenile, Skanslandet, Helsinki, Finland. (60°08′N, 25°01′E)	5.7.60
					controlled Vallisaari, Finland. (60°08′N, 25°00′E)	29.5.63
AT 95959	ad.	♀	Newburgh	26.1.63	Balgone, Oldmeldrum, Aberdeens., 12m. WNW	*c.*19.3.63
AT 95961	ad.	♂	Newburgh	26.1.63	Ellon, Aberdeens., 4m. NW	(18.3.63)
AT 95971	1st W	♂	Newburgh	27.1.63	shot Toomebridge, Co. Antrim, N. Ireland, 245m. SW	1.9.63
Scaup						
AJ 26369	ad.	♀	Newburgh	25.2.62	drowned in fishing net, Vestmannsvatn, N. Iceland. (65°47′N, 17°25′W)	spring 1962
AJ 26448	1st W	♂	Newburgh	7.1.63	found freshly dead on shore, Nairn, 70m. WNW	1.6.63
Goldeneye						
AT 95976	ad.	♀	Newburgh	27.1.63	drowned in fishing net, Norra Sunderbyn, Norrbotten, Sweden. (65°44′N, 21°52′E)	22.7.63

The feature of the Teal recoveries is the occurrence of three in mid-winter in Ireland, showing an unexpectedly strong onward passage to the south-west. Half of the Mallard recoveries are local and there is no indication of onward passage within the British Isles. The recoveries in Scandinavia confirm the picture given by recoveries in this country of Mallard ringed abroad, that birds of Baltic origin are most likely to be found as immigrants in the north and east (G. V. T. Matthews. 1963. *Ibis* 105: 185-197).

The recoveries of Eiders showing movement down the east coast of Scotland as far as Fife confirm the results of ringing in the same great colony on Forvie Moor 30 years ago.

The recoveries of Tufted Ducks in Finland, Sweden and Denmark suggest that immigrants to Aberdeenshire come from the same areas as those found in south-east England, rather than from Iceland, the source of the Scaup.

The Goldeneye found in Sweden is the first British-ringed Goldeneye to be recovered abroad. More importantly it was found in the lowlands near the Gulf of Bothnia rather than in the mountains further west. Marking in Sweden had hitherto suggested that the Goldeneye of east Sweden travelled no further than Denmark and Germany in winter.

Wildfowl on hydro-electric reservoirs in the Scottish Highlands

DEREK MILLS and DUNCAN MACIVER

Summary

The value of hydro-electric reservoirs as wildfowl habitats is discussed, on the basis of a large number of counts made from April, 1962 to March, 1964 at Meig reservoir, Ross-shire. This was formed by the construction of a concrete dam across the River Meig by the North of Scotland Hydro-electric Board in 1956. The numbers of wildfowl were small, though above the average to be found on many neighbouring natural lochs and other reservoirs. Possible ways of making reservoirs more attractive to ducks include fencing stretches of shore to stop grazing, planting with semi-aquatic herbage, and the use of artificial islands.

Introduction

The recent trend in British wildfowl management has been towards the awareness of the need for conserving present wildfowl habitats, protecting existing wetlands (Olney, 1963) and making use of areas of water resulting from the activities of man (Atkinson-Willes, 1961; Harrison, Harrison and Olney, 1962; Atkinson-Willes, 1963). Developments of this kind have, however, mainly taken place in England and Wales.

In Scotland many reservoirs have appeared and existing bodies of water have been increased in area in the last decade as a result of the construction of dams by the North of Scotland Hydro-electric Board. The value of these waters as wildfowl habitats has not been assessed hitherto. This paper discusses their value in the light of intensive observations of the wildfowl using Meig reservoir in Ross-shire.

Meig reservoir lies in Strathconon and was formed after the completion of a dam 52 ft. high on the River Meig, a tributary of the River Conon, in September, 1956. The bed of the reservoir lies at a little over 240 ft. above sea level in a narrow valley with hills rising to a height of 1,176 ft. from the north shore and to 2,199 ft. from the south shore and is 12 miles from the sea. The reservoir, which is approximately $2\frac{1}{2}$ miles long, has an average area of 117 acres (47 hectares) increased to 165 acres (67 hectares) when filled to capacity. The water level is subject to frequent fluctuations and during heavy rainfall may rise at the rate of a foot an hour. The average annual rainfall at this point is 50 in. but a few miles to the north west, in the same watershed, it reaches over 80 in.

The surrounding terrain consists, on the high ground, of heather moor, *Molinia-Myrica* swamp and *Sphagnum* bog lying over peat and morainic deposits with outcrops of pelitic gneiss and siliceous schists. Reafforestation with spruce and larch has been carried out by the Forestry Commission on the hill slopes on the north side of the reservoir. Along the shores at the west end of the reservoir the terrain is alluvial pasture with *Juncus effusus* in the damper areas. This pasture was previously cultivated from a number of crofts which were demolished immediately prior to impoundment. Some of the pasture is permanently submerged, other parts are temporarily flooded while the remainder is permanently above water level. Sheep graze over the latter and also move on to the pasture which is exposed at average water level. Only this western end of the reservoir provides feeding for surface and diving ducks. The water has a pH of 6·6 and an alkalinity of only 6·2 parts per million (expressed as calcium carbonate). The fish present in the reservoir are salmon (*Salmo salar*), brown trout (*S. trutta*) and eels (*Anguilla anguilla*). The effects of impoundment on the growth of brown trout and on the invertebrate fauna in Highland lochs are described by Campbell (1957, 1963). Post-impoundment shore line development was similar to that described by Campbell (1963) for similar lochs and reservoirs in the Highlands. At the west end of the reservoir permanently submerged clumps of *Juncus effusus* were intact throughout 1957 but by 1959 only decayed stumps remained. In 1959 *Elodea canadensis* had established itself but only in small amounts and only isolated plants occur at the west end of the loch. In the shallow water, part of which is stagnant at certain water levels, *Lemna* spp. occur.

Results

Counts of wildfowl were made practically each day, and on many occasions twice daily, during the period April, 1962, to March, 1964. Where there were two counts on the same day one was made in the morning and the other in the late afternoon. The numbers of ducks seen and the number of days in each month on which counts were made are given in Table I. The counts are almost certainly affected by the presence of

Table I. Average numbers of ducks on Meig reservoir each month from April, 1962, to March, 1964

Number of days on which counts were made shown in parenthesis after each month. Figures in parenthesis after averages record number of days on which birds were seen.

month		*Mallard*	*Wigeon*	*Teal*	*Goldeneye*	*Goosander*
1962						
April	(25)	1·5 (7)	2 (2)	2·3 (3)	16 (12)	2·4 (10)
May	(30)	4·3 (17)	1 (1)	1 (1)	0	2 (13)
June	(24)	3 (5)	0	0	0	0
July	(31)	0	0	0	0	0
August	(19)	30·5 (3)	0	0	0	0
September	(26)	50·7 (26)	8·5 (2)	0	0	0
October	(31)	45·1 (31)	7 (1)	0	1·3 (3)	3·5 (13)
November	(27)	17·2 (23)	0	8·3 (3)	7·3 (20)	2·4 (7)
December	(20)	10·2 (17)	0	4 (2)	12·5 (17)	5 (1)
1963						
January – wholly frozen, no ducks						
February – wholly frozen, no ducks						
March	(24)	4·8 (16)	8 (11)	0	13·3 (21)	3·2 (12)
April	(27)	1·7 (15)	3·2 (16)	0	10·4 (22)	2·5 (6)
May	(23)	3·6 (14)	3·5 (2)	0	1 (1)	0
June	(23)	3·5 (2)	2 (1)	0	0	0
July	(31)	2·5 (2)	8 (1)	0	0	0
August	(15)	0	0	0	0	0
September	(17)	30 (14)	8·6 (8)	0	0	0
October	(29)	25 (11)	9·7 (8)	0	3 (9)	2 (1)
November	(27)	13 (18)	8 (9)	0	7 (26)	1·5 (2)
December	(25)[a]	6·1 (9)	0	0	5·8 (10)	0
1964						
January	(22)[b]	9·6 (13)	0	0	9·4 (15)	1 (1)
February	(23)	10·7 (19)	6·5 (15)	0	14·4 (22)	1·7 (4)
March	(18)	1·6 (3)	5·3 (15)	0	12·8 (18)	0

[a] complete ice cover on 13 days.

[b] complete ice cover on 5 days.

anglers during the period 1st June to 30th September. In January and February, 1963, the reservoir and all other lochs and reservoirs in the area were completely frozen over and the only open waters near at hand were the neighbouring rivers on which Mallard and Goldeneye were seen over the whole of this time in small numbers. Both Mallard and Goldeneye returned with the first appearance of open water on 6th March. Similarly, in December, 1963, wildfowl reappeared as soon as there was a small amount of open water.

Matthews (1960) discusses the value of daily counts and states that 'when a near daily count has been made, the mean value of these counts gives a good measure of the population level within the month'. In discussing the time of day on which counts are made he found that only Mallard and Wigeon showed any noticeable effects, both giving rather fewer birds and more variation in the afternoon. On Meig reservoir it was found that fewer Mallard were recorded in afternoon counts than morning counts in the spring but that the reverse was the case in the autumn (Table II), while Goldeneye showed the opposite tendency, more birds being present in the afternoon in the spring and fewer in the afternoon in the autumn.

Mallard (*Anas platyrhynchos* L.). The Mallard is the commonest duck occurring on the reservoir. In the spring practically all Mallard seen are drakes and the largest number seen at one time was 14. This is the only duck which has been recorded nesting by the reservoir: one nest with nine eggs was found in a clump of *Juncus* but was later found destroyed. There is very little nesting cover at the west end, but the southern shore along the eastern half of the reservoir has heather and birch scrub. However, no young ducklings have ever been seen and most nesting Mallard are recorded on the neighbouring hill lochs. The

Table IL Variations in numbers of Mallard and Goldeneye on Meig reservoir in twice-daily counts, 1962 and 1963

	number of pairs of counts	days with more or less ducks seen in afternoon than in morning		
		more	less	no difference
Mallard				
spring	24	8	12	4
autumn	24	13	9	2
Goldeneye				
spring	24	14	5	5
autumn	12	2	5	5

numbers of Mallard increase in August and September, presumably being family parties coming down from the hill lochs, and the maximum number recorded is 70. The birds appear to use the water more as a roost than a feeding area and visit the neighbouring cornfields in Strathconon. The corn is not gathered in usually until late in the season and in 1963 some of it was not off the fields until the end of October. Mallard occasionally feed in some of the smaller bays, usually after the reservoir has risen and some of the neighbouring pasture has been flooded. After October the numbers of Mallard on the reservoir drop and probably many have moved further down the valley to the low-lying arable country around the Cromarty Firth.

Wigeon (*Anas penelope* L.). Few Wigeon were seen in spring in 1962, but rather more in 1963. Those present in autumn in each year probably represented one family party. Wigeon are known to nest at the west end of Strathconon and also in Strathbran to the north.

Teal (*Anas crecca* L.). A few Teal were seen in spring 1962 and a small flock was present that autumn, feeding in the shallow water and on the mud at the west end of the reservoir.

Goldeneye (*Bucephala clangula* (L.)). Goldeneye are present throughout the winter and spring with maximum numbers of up to 30 in the spring. The latest spring records were on 28th April, 1962 and 17th May, 1963. They were first seen in autumn on 20th October, 1962, and on 17th October, 1963. They feed mainly at the shallow, west end of the reservoir. Because these birds are continually diving there is the likelihood that fewer birds were counted than were actually present.

Goosander (*Mergus merganser* L.). The Goosander occurs in spring when flocks of up to seven have been seen. Birds shot on the reservoir at this time were found to have been eating salmon parr and smolts. None is seen from May until October when flocks of up to eight, which include young birds, have been counted. In 1959 Goosanders were seen on Meig reservoir in September (Mills, 1962). He also gave de-details of their density on the River Meig itself.

The Tufted Duck (*Aythya fuligula* (L.)), although it nests locally, has only been recorded on the reservoir occasionally. The Pochard (*Aythya ferina* (L.)) has never been seen on the reservoir although it occurs in the spring on Loch a' Chuilinn only a few miles to the north. The Red-breasted Merganser (*Mergus serrator* L.) has been seen on the reservoir once and in 1963 a nest was found a few miles further up Strathconon at Strathanmore. The eggs were sent to the Wildfowl Trust, where they duly hatched.

In 1962 Whooper Swans (*Cygnus cygnus* (L.)) were on the reservoir from October to December, averaging six in October with a maximum of eight; and five in November and December with maxima of six.

Flocks of up to 50 Greylags (*Anser anser* (L.)) have been known to rest for a few hours at the west end of the reservoir on two occasions, once in the spring and once in the autumn.

Other waterfowl occurring on the reservoir include the Black-throated and Red-throated Divers (*Colymbus arcticus* L.) and (*C. stellatus* Pontoppidan) which are frequently seen in the spring; the Cormorant (*Phalacrocorax carbo* (L.)), which is present singly or in twos and threes, in the spring and autumn; and the Heron (*Ardea cinerea* (L.)). The Common Sandpiper (*Tringa hypoleucos* (L.)) and Oystercatcher (*Haematopus ostralegus* (L.)) nest close to the reservoir and the Greenshank (*Tringa nebularia* (Gunnerus)), present in the spring, nests only by the hill lochs. The Common and Black-headed Gulls (*Larus canus* (L.) and *L. ridibundus* (L.)) are frequently on the reservoir and nest locally.

The value to wildfowl of natural lochs and of hydro-electric reservoirs in the Highlands

The factors governing the suitability of lochs and reservoirs in the Highlands for wildfowl appear to be far more complex than would at first appear to be the case. One explanation for the presence and absence of certain species on stretches of water may be the availability of certain foods. For example, the presence of up to 10 Pochard on Loch a' Chuilinn, a natural loch the area of which was increased by the construction of Achanalt Barrage at its foot, and not on Meig reservoir, might be explained by the presence in Loch a' Chuilinn of Horned

Pondweed, *Zannichellia palustris*, which Atkinson-Willes (1963, p. 312) quotes as being one of its foods. Similarly the Tufted Duck is rarely seen on Meig reservoir but occurs more often on Loch Achilty, a natural loch, where one of its known food organisms, the freshwater shrimp, *Gammarus lacustris* is plentiful, and also on Loch a' Chuilinn and Loch Achanalt (a natural loch joined to Loch a' Chuilinn by a 100 yd. stretch of river) where the related organism *G. pulex* occurs. The Goldeneye occurs in smaller numbers on Loch a' Chuilinn and Loch Achilty than on Meig reservoir, although on an assessment of available food more might have been expected on Loch Achilty, particularly as the clarity of its water is locally unique and the bed of the loch is chiefly gravel and stones. Furthermore, the tree line comes down to the shore and extends around the whole of the loch. Another natural water similar to Loch Achilty is Loch Ussie which has clear, rather than the more normal peaty, water and probably a big *Gammarus* population. Loch Ussie, which is frequented by Goldeneye in some numbers, lies above Dingwall and close to the Cromarty Firth and appears to serve chiefly as a roost during the winter for Mallard and Wigeon. Those species using lochs chiefly as roosts will not occur on the more inland waters in the Highlands in winter where arable land, to which they are likely to flight, is some distance away. From observations of a general nature, the numbers of wildfowl occurring on Meig reservoir appear to be slightly above those to be found on many of the natural lochs in the district.

It remains to compare Meig reservoir as a wildfowl habitat with other hydro-electric reservoirs, including natural lochs whose waters have been dammed, in Ross-shire and other parts of the Highlands. These reservoirs can be divided into two categories: (a) those with steep, heavily eroded and frequently rocky shore lines running directly into deep water and with little in the way of shallow water at the head of the impoundment; and (b) those with a more gently sloping shore line and consequently more shallow water and exposed areas of grassland or mud at certain water levels. Those in category (a) are generally main storage reservoirs, usually situated in the upper reaches of the river system and consequently at a higher altitude than those in category (b), which are temporary storage or balancing reservoirs where the drawdown, instead of being roughly seasonal in pattern as in the main storage reservoirs, is short term and the water levels may fluctuate rapidly, depending on generation demands from the associated power stations. Some of the reservoirs coming into category (a) are listed in Table III. Casual observations indicate that these are less frequently used by wildfowl, partly due presumably to lack of shelter and food, than those in category (b). From Table III it can be seen that Meig compares favourably with the others in this category as a wildfowl habitat. The general impression gained is that reservoirs in category (b) are better wildfowl habitats but further investigation is merited, particularly as data on wildfowl on a large number of hydro-electric reservoirs are completely lacking.

Habitat improvements would seem to be most worthwhile on waters with gently sloping shores. Some of the more obvious and practicable improvements are: (1) increasing the cover along the shore by marginal planting and (2) the provision of artificial islands. (1) Increased cover could be produced by fencing off the shore for several yards back to prevent grazing by sheep and allow natural regeneration of the birch scrub and heather. This has already been done, for amenity reasons, by the North of Scotland Hydro-electric Board, on Glascarnoch reservoir. As the seasonal draw-down on this reservoir exposes a large expanse of mud at its upper end they have fenced off this portion of the southern shore and planted with a mixture of coniferous and deciduous trees. Berry (1955) in discussing shore erosion suggests the planting of margins of reservoirs with alders, some kinds of willows and poplars and some of the larger rushes, sedges and reeds as these would also withstand a considerable range of fluctuation in water level. He suggests, however, that they should be transplanted when well grown, otherwise wave action may prevent such plants gaining a roothold on a bare shore. (2) The provision of artificial islands in the form of rafts described by Harrison and Harrison, (1959), might provide useful nesting or roosting sites safe from flooding should the water levels in the reservoirs rise during the nesting season and wickerwork nesting baskers (Harrison and Harrison, 1961, pp. 223-228) might also be of value. Nesting boxes have already been set up near a small number of reservoirs and lochs with a view to encouraging Goldeneye to breed in this country. Even if this proves unsuccessful the nest boxes may be occupied by Goosanders and other birds (Grenquist, 1962). The introduction of certain wildfowl might also be considered on selected reservoirs. Three Greylag and two Canada Geese have already been released on Loch Faskally. Though the introduction of some wildfowl is desirable, due regard must be paid to other interests and the introduction

Table III. Wildfowl reported on some Highland hydro-electric reservoirs

Former natural lochs shown in italic. I = Inverness-shire.
P = Perthshire, RC = Ross and Cromarty. ms = main storage.
bal. = balancing, bar. = barrage, d = diversion.

reservoir	*Mallard*	*Wigeon*	*Teal*	*Tufted Duck*	*Pochard*	*Goldeneye*	*Goosander*	
(a) reservoirs with steep, heavily-eroded sides								
L. Fannich (RC, ms)							occ.	
Glascarnoch (RC, ms)	few wildfowl seen							
L. Luichart (RC, bal.)	occ.					few	few	
Achonachie (RC, bal.)	up to 50					occ.	occ.	[1]
(b) reservoirs with gently sloping sides								
L. a' Chuilinn (RC, bar.)	up to 20	15	5	20	10	4	4	[2]
Meig (RC, d) maxima	70	14	10			25	7	[1, 3]
L. Garry (I, bal.)	up to 20					occ.	occ.	
L. Tummel (P, bal.)	150	80						[3]
Faskally (P, bal.)	max. 75	10	40	145	5	65	5	[3]

([1]) Red-breasted Merganser occasional.
([2]) also up to 5 Mute and 5 Whooper Swans.
([3]) data from Atkinson-Willes (1963).

of fish-eating birds might have serious disadvantages.

The presence of increased numbers of wildfowl on some reservoirs might help to fertilize these waters. Fraser Darling (1947, p. 237) refers to a loch on Priest Island, Wester Ross, where the accumulated effects of Greylag Geese, Cormorants and gulls defecating in the water raised the pH from 6·0 to 7·6 in spring and early summer. However, Kear (1963) has shown that to add the equivalent of 10 pounds of nitrogen per acre per annum, the amount required to produce a significant effect, calls for use by roosting wildfowl at the annual rate of 10,000 goose-nights per acre. This level of usage is known to be achieved at some major goose roosts on shallow permanent lochs but is far in excess of that at present prevailing on the hydro-electric reservoirs.

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A nesting study of Mallard in Berkeley New Decoy, Slimbridge

M. A. OGILVIE

Summary

Mallard nesting in the Decoy wood were studied in 1961-63. 224 nest-sites used are discussed in relation to available habitat. There is some evidence that individual females have traditional sites. The onset of laying was 3 weeks later in 1962 and 1963 than in 1961, when it began in mid-February. The average size of early clutches was 12·6 eggs and that of later ones 9·9 eggs. Though one egg was usually laid each day, there was often a gap of a day during the laying of the first seven eggs. The average incubation period of 51 clutches was 27·6 days, the range 24-32 days. 88·7% of 180 nests were successful and 82·4% of eggs hatched. The association of first laying with spring temperatures is examined and compared with Continental studies.

During the three breeding seasons of 1961-63, a study was made of the Mallard (*Anas platyrhynchos* L.) nesting in the wood surrounding the pool of Berkeley New Decoy at Slimbridge, Gloucestershire. The wood is four acres in extent and encloses the decoy pool of 0·85 acre. It is divided into many small parts by the four pipes leading off the pool, and by numerous connecting paths. The trees are mostly deciduous with a few large oaks, elms and in particular willows, with dense thickets of hawthorn and bramble, and considerable areas with nettle and rush undergrowth. Two rhines, or drainage ditches, run along most of the perimeter.

Once a nest was found it was visited daily while laying was in progress and then only occasionally until hatching was due. If laying had been completed before the nest was discovered it was visited every second day so that the hatching date was not missed. Table I gives the number of nests found in the three years, distributed in seven categories of nest-site. Nests that for some reason were not completed are included here, but re-nestings in the same site in one year are not.

The drop in the number of nests in 1962 is mostly due to the removal from the area of some of the breeding birds at the end of the previous summer. This was part of the campaign to reduce the number of Mallard living in the Wildfowl Trust's pens adjoining the Decoy wood. The effect was short-lived, as will be seen from the total for 1963.

Differences in site-preference between the three years are not great. The major variation, that of an increased proportion of nests in thick cover in 1963, was due to the only noticeable habitat change in the period which was the compressing of areas of rather straggly bush cover into thicker scrub by the heavy snowfalls of the previous winter. The first four categories show a remarkably consistent use of the constant quantity of available sites. There did not appear to be a directional preference in the positioning of nests at the foot of trees or fences.

Table I. Distribution of nest sites used by Mallard in 1961-63

description of site	*1961*	*1962*	*1963*	*total*
crown of pollarded willow	5	5	4	14
inside base of tree or stump	11	6	9	26
foot of tree	12	8	10	30
foot of board fence	4	2	2	8
thick cover: brambles, shrubs	29	15	33	77
thin cover: nettles, rushes	25	16	17	58
open	3	4	4	11
	89	56	79	224

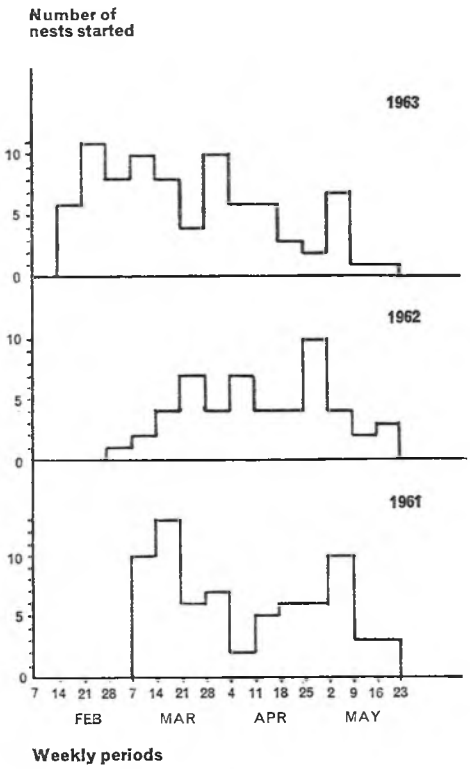

Figure 1. Dates of laying of first eggs in Mallard clutches at Slimbridge in 1961-63. Records grouped in weekly intervals.

In 1962 seven females were caught by hand on the nest and ringed. Five of these were re-caught the following year, three in exactly the same nest-site, one within five yards, and one a considerable distance away, though still on the same side of the pool. This last bird nested both years on the ground in thick cover. The other four were all in clearly-defined sites, inside a hollow tree or on the ground at the foot of a tree. A further thirteen birds were caught on the nest in 1963 and this study of tradition in site-selection will continue.

The dates of laying of the first egg in each clutch in the three years are compared in the histograms of Figure 1. Few nests were located when containing only one egg and extrapolation has been used to discover the date, based on an average laying-rate derived from those nests found before the completion of laying. Just over 40 nests were found sufficiently early in the laying period for the information to be useful.

The birds studied here quite often missed a day early in the laying period. Of 16 nests found with five eggs or fewer, 10 missed a day, and 3 missed two days during the laying of the first seven eggs. This is at variance with the generally accepted laying rate of one egg per day (Eygenraam 1957, Hochbaum 1944, Sowls 1955). A possible cause is the disturbance involved in locating the nest, but on only two occasions was the female present when the nest was found, and over half the nests were in situations which it was possible to reach without leaving a trail.

The histograms record the number of nests started in seven-day periods. There is a three-week difference between the onset of breeding in 1961 and in the two subsequent seasons. Evidence from previous years suggests that the second half of February is the normal starting period for the population of Mallard at Slimbridge following a mild winter. 1961 is therefore taken as an average season. In 1963 nesting was delayed by the hard weather, but, within one week of the cessation of the continuous frosts at the beginning of March, the first birds were laying. In 1962 the picture is less clear-cut with periods of ground frost in the second week of February and in early March when the birds might have been laying and temperatures remaining below average until late March. This probably accounts for the slow start to the season compared with the other years. The timing of the breeding season at Slimbridge is compared with other European studies in a later section.

A well-marked reduction in the number of clutches started occurs about five weeks after the onset of breeding but is soon followed by an increase. This increase can be attributed to the laying of second (repeat) clutches by the early nesters. Collecting eggs has also been undertaken in recent years to try and reduce the number of Mallard in the enclosures of the Wildfowl Trust. The eggs from the nests in the Decoy in the three years of the study were collected at the pipping stage and hatched in an incubator. The ducklings were subsequently reared by hand away from Slimbridge. Thus the female Mallard were relieved of their maternal duties to their first brood and free to make a second attempt. The occurrence of second clutches produces a slight lowering of the mean size between clutches laid in the first five weeks of the season and those laid subsequently (Table II). The average size of 95 early clutches is $12 \cdot 60 \pm 0 \cdot 220$ eggs and that of 114 later ones $9 \cdot 88 \pm 0 \cdot 203$ eggs. The means for the three seasons are very similar. The largest clutch for which only one female was believed responsible was 18. Five nests were found with clutches of 18 to 20, which could definitely be attributed to two females. In four of them eggs were laid at two

Table II. Clutch size and date of laying of Mallard. Completed clutches only

maximum clutch size	*1961 begun*			*1962 begun*			*1963 begun*		
	before 20 Mar	*after 20 Mar*	*total*	*before 5 Apr*	*after 5 Apr*	*total*	*before 7 Apr*	*after 7 Apr*	*total*
4								1	1
5		2	2		1	1			
6				1	1	2			
7		2	2	1	2	3		3	3
8	1	3	4		4	4	2	3	5
9		12	12		5	5		10	10
10	3	3	6		8	8	4	10	14
11	5	12	17	2	7	9	10	3	13
12	12	3	15	5	6	11	5	2	7
13	7	1	8	3	1	4	5	3	8
14	5	1	6				7	1	8
15	3	2	5	3		3	3		3
16	2		2	3		3	1	1	2
17							1	1	2
18	1		1						
total	39	41	80	18	35	53	38	38	76
mean	12·6	10·0	11·3	12·6	9·8	10·8	12·3	10·1	11·2

a day for at least part of the laying period, and in the other some of the eggs were of a markedly different colour and size from the rest. At no nest was more than one female seen at a time. In one nest with 19 eggs the female was clearly unable to cover all the eggs properly and only 9 hatched, though the rest had developed partly before dying. All the other females on large clutches brooded them successfully, usually by arranging the eggs in two layers.

The incubation period of a clutch was measured from the day the last egg was laid (Day 1) to the day the last egg hatched. The spread of hatching was usually about 24 hours, extending in a few cases to as long as 36 hours. Of the 51 clutches for which these data were available the incubation period varied from 24 days to 32 days with a mean of 27·6 $\pm$ 0·23 days, a figure in close agreement with other results (Witherby *et al.* 1939). The proportion of successful nests was high; 180 nests (88·7%) of the 203 completed nests recorded in the three years. (A successful nest is one in which at least one egg of the clutch hatches.) Of the 23 completed nests that failed entirely, 12 (5·9%) were deserted by the female and 11 (5·4%) suffered predation.

A more detailed analysis of hatching success is given in Table III. Here the figures used refer to the eggs rather than nests. Percentages are used to allow direct comparison between seasons. Eggs that failed to hatch were opened to determine whether or not they were fertile and if possible to learn why hatching did not take place. In 1961 (but only in that year) a number of congenital deformities was found in embryos from unhatched eggs (Harrison and Kear, 1962; Napier, 1963; Kear, 1964). Included in the losses to predators is a small number of eggs that disappeared from nests in circumstances where predation was not the cause. Some of the tree-top sites had room for only a small clutch of eggs and one or two instances were recorded of females knocking an egg out of an overfull nest.

The outstanding feature of Table III is the constant hatching success. 1963 shows the most variation with a marked decrease in the infertility rate and an increase in the amount of predation. In the previous two seasons there were females which laid com-

Table III. Fates of eggs in Mallard nests, 1961-63

fate	*1961* %	*1962* %	*1963* %	*total frequency* %
hatched	81·2	83·3	83·1	82·4
failed to hatch	4·1	3·4	3·0	3·5
infertile	4·7	6·3	1·4	3·8
predation	6·0	4·5	10·0	7·1
desertion	4·0	2·5	2·5	3·1
total eggs in sample	959	527	806	2,292

plete clutches of infertile eggs and the drop may be because these particular birds had failed to breed at all in the third year. However, the number of nests with one or two infertile eggs, which are not uncommon, was also reduced. Predation increased in 1963 in both the number of nests completely robbed and in the number that lost part of their clutches. The Decoy wood is trapped for rats, stoats, etc., and crows and magpies are actively discouraged from the area. There was no direct evidence for an increase in predators but this would appear to be the explanation. In two cases eggs disappeared from the nest at the rate of one a day for seven successive days. This was probably the work of a mammalian rather than an avian predator.

This study of nesting Mallard shows a close agreement in the proportion of successful nests and eggs with two American studies (Tables IV and V).

The success of females rearing broods has not been studied because very few clutches have been left to hatch in the nest. However, there is probably a very high mortality of newly-hatched ducklings in the Decoy due to the obstacles in the way of the female leading her brood from the nest to the pool. As well as the fences shown on the map, the outside curves of all four pipes are lined with overlapping straw or reed screens and there is no access to the water at ground level. If a brood does reach the pond, survival is again small which may well be partly blamed on the steep banks with a shortage of places where the ducklings can be brooded on dry land. The broods that find their way into the two rhines are more often reared successfully.

Comparable material from Europe for any part of this study is slight. The start of nesting is the only subject given any widespread attention. Bezzel (1962), working near Munich, found that the first nests appeared from the third week in March to the third week in April. He correlates first laying dates with the occurrence of above average spring temperatures seven to nine days before laying. This is evidence of a slower reaction to temperature than that shown by the birds at Slimbridge. Using the grass temperatures measured at the nearest Meteorological Station, 15 miles away near Bristol, laying began in 1961 five days after the end of a week of near zero readings. In 1963 the time interval was just four days after the last ground frost which ended a nearly continuous spell of ten weeks. In both years subsequent single nights of frost

Table IV. Success of Mallard nests at Slimbridge and in Idaho and California

	Gray's Lake, Idaho 1949-51 (Steel et al. *1956)*	*Tule Lake, California 1952 (Miller & Collins, 1954)*	*Slimbridge, Glos. 1961-63*
successful	85 (*68·6%*)	178 (*85·1%*)	180 (*88·7%*)
predation		8	11
destroyed (flood, cattle)	39	7	–
deserted		16	12
total	124	209	203

Table V. Fate of eggs in successful nests of Mallard at Slimbridge and in Idaho and California

	Gray's Lake, Idaho 1949-51 (Steel et al. *1956)*	*Tule Lake, California 1952 (Miller & Collins, 1954)*	*Slimbridge, Glos. 1961-63*
	%	%	%
hatched	89·8	91·4	92·6
failed to hatch	5·2	4·9	2·9
infertile	3·0	1·6	2·2
predation	1·9	2·1	2·3
total number of eggs	689	1,622	2,039

produced a corresponding gap in the appearance of first eggs. The picture is less clear in 1962 when there was a very gradual start of laying with the first seven nests appearing over a fortnight compared with under a week in the other two seasons. Temperatures were below average throughout February and most of March, 1962, though with few extremes recorded. Eygenraam (1957) gives hatching dates in Holland for the years 1950-54, and laying dates estimated from his results indicate that nesting was nearly a fortnight later than average in 1954, when there was a cold spell over much of Europe in February. The normal appearance of nests in Holland is in the last week of February and the first of March; a fairly close parallel with Slimbridge. Eygenraam's material was gathered from populations in town parks as well as from more natural areas. He concludes that there is little difference between the two.

In England there is a need for further work concerning the variation in different years of the onset of laying and into the factors which govern it. A closer understanding is required of the relationship of the nesting bird to its environment.

I wish to thank Dr. Janet Kear and Miss Susan Loader for ensuring continuity in the nest-records during my brief absences from Slimbridge in each of the three seasons.

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Birds at Borough Fen Decoy in 1963

W. A. COOK

In the Fourteenth Annual Report (at pp. 150-152) an account was given of the habitats provided by Borough Fen Decoy and of the birds other than ducks which occur there. The progress of ringing in 1960-62 was also described. Counting and ringing was continued in 1963. Though these activities remain secondary to the main activity of the decoy, which is to catch ducks, they provide information which is of general interest, particularly in respect of the effects of the cold winter of 1962-63 on the small birds of the area.

Seven new species were recorded for the first time in 1963: Bewick's Swan[1] (an adult, 2nd-3rd April); Common Sandpiper and Greenshank (both irregularly during August); Nightjar (10th-18th September); Icterine Warbler (trapped and ringed 10th July); Siskin (trapped and ringed 19th October); and a Little Bunting, seen 4th-5th April.

[1] scientific names of species mentioned are listed at the end of the paper.

The cold spell

The pond was frozen from 18th December, 1962, and most of the duck had left by 22nd, though two Teal appeared on 27th and flocks of 4 to 10 flew over the pond up to 8th January. The Wash area was more fortunate than most of the rest of the country in that there was little snow. At no time during the winter was the top of the stubble covered in the fields surrounding the Decoy. The

lowest temperature recorded was 7°F (–13·9°C) on the night of 22nd-23rd January, 1963.

The frosty weather ended on 22nd February and 11 Teal returned on 6th March, 15 the following day with 5 Mallard. There was at this time a few inches of water on the ice, which finally thawed by 19th March. The highest number of ducks recorded from 6th March to the end of the catching season in mid-April was 40 Mallard and 28 Teal.

Moorhen counts remained constant at about 40 until mid-January when the population had fallen below 30. Only 12 were seen on 21st and 5 on 31st; there was an average of 5 in February. Five dead Moorhens were picked up in February, two of them ringed. As the pond opened, the population built up to 20, remaining constant through the breeding season. December 1963 counts vary from 37 to 42 birds.

Woodpeckers disappeared on 21st December. A Green Woodpecker was found dead at Deeping on 22nd. This may have been too early for the weather to have been responsible. A Greater Spotted Woodpecker returned on 16th February and one or more has been present since: an adult female ringed 28th September, 1962, has been re-trapped twice in the autumn of 1963.

Tits fed regularly in the area near the trap and were frequently re-trapped. Detailed records were not kept as I handled birds as little as possible, and any carrying rings were allowed to fly out of the door. Fat and nuts were also provided, no doubt ensuring their survival.

Blue Tits numbered between 5 and 10 from mid-December to March, increasing to 15 in April. Great Tits completely disappeared between 20th January and 17th February, having declined from 10+ to 3 or 4. A Coal Tit appeared on the fat on 17th February but was not seen again: two were again recorded in the Decoy on 11th October. Two Willow Tits fed regularly until 22nd March. No more were seen until a juvenile appeared in a mist net on 10th July. Two were seen the next day, including the ringed one. One or two were present until 2nd August, when 8 appeared for one day only. Since that date the population has been constant at 2 or 3. Long-tailed Tits used to breed and winter in the Decoy wood but a flock of nine disappeared at the end of October, 1962 and this species has been unrecorded since.

Wrens on the other hand were present right through the hard weather. There is no doubt they declined more than any other species. There were 10 probable breeding pairs in 1962, but only 2 nests were found in 1963 and no other Wrens could be seen so it is more than likely that only these 2 pairs survived.

Through December, 1962, about 25 Blackbirds could be seen feeding daily and a mixed Turdidae roost in a Sloe thicket held 250-300 birds. By the end of January only 6 Blackbirds could be seen feeding and these were all in the trap area. The roost had diminished to about 40, half the birds being Fieldfares. Several dead Blackbirds were picked up towards the middle of February. By the end of February, 10 were feeding regularly, increasing to 25 by 6th March. Song Thrushes left early in the winter: 7 on 22nd December decreased to 4 on 28th, 2 on 31st, and the last one on 1st January. The first to re-appear after the hard spell was on 6th March, two more on 7th, building up to 8 by 31st. Although none of the thrushes ringed in the Decoy in summer was recovered in this period, two Song Thrushes and a Blackbird ringed locally were recovered in Devon, Cornwall and the Cherbourg Peninsula respectively. This indicates a general SW movement and is rather ironic, as had they stayed in this area they would have probably survived the winter.

Robins appeared to hold their own, counts varying between 3 and 6. The normal Decoy population of 20 Dunnocks rose suddenly to 42 on 26th November, receding to 18-20 by 17th December, 7 on 9th January and 6 on 30th. The lowest recorded number was 4 from 4th to 25th February. They increased to a peak of 30 on 19th March, then dwindled to about a dozen which remained through the breeding season.

Most of the finches and buntings increased at the onset of the cold spell, Greenfinches going up from 4 on 4th December to a peak of 35 during the last week in January. Goldfinches were up and down between 5 and 30 but disappeared altogether from 13th January until 3 returned on 13th March. Linnets behaved similarly, the effective dates being 9th January and 27th March. In the latter species the breeding population was the highest since records were started in 1961. Bullfinches were absent from 1st February (1 female), to 26th (2 females). Chaffinch numbers fluctuated between 8 and 50, their appearance or non-appearance probably depending on where the flock first found food. Bramblings also fluctuated, but their changes did not coincide. No Yellowhammers were observed in the Decoy or the surrounding fields from 27th December until 27th February. Reed Buntings were seen throughout the cold period, nearly all the birds present being males. The ubiquitous House Sparrows were present all the

time in their impudent hundreds, many drawn from the farm by the scattered tail corn. Tree Sparrows are the most difficult species to count at any time and are usually shown on the daily census sheet by a tick only. Some were present all through the winter but the ringing totals of one each in January and February, with none in March suggest there were fewer than usual. They were certainly more abundant in April, when they topped the ringing totals.

Reviewing the situation in December, 1963, it appears that only two species were seriously affected by the winter of 1962-63, Long-tailed Tits and Wrens. The tits had left the wood before the frosts started, but I have no doubt that the continued low temperatures caused their demise. 5 or 6 Wrens are being regularly seen now, this being about half of the 1962 population.

Whilst clearing debris from fallen trees on 14th May, a Starling's foot was observed protruding from a hole, 8 cm. in diameter and 20 cm. deep, in the main trunk of a fallen Poplar. Closer examination showed the hole to be full of bodies. There were 7 birds and 5 Field Mice (*Apodemus sylvaticus*). The birds were 1 Starling, 1 Song Thrush, 2 Blackbirds, 1 Chaffinch, 1 Tree Sparrow and a ringed Willow Tit. The bodies were completely dried out and there was no sign of any of them having been eaten. Could these birds have been roosting in the hole, and succumbed to the extreme cold or had they sought the sanctuary of this hole in order to die? Wrens and Tits are known to roost in crevices and holes such as nest boxes, but this is such an odd mixture that I doubt if any two of them were alive at the same time. The mammals could have joined the corpses in this sepulchre at a later date.

Ringing

1,229 birds of 42 species, including 221 pulli, were ringed in or near the Decoy in 1963 (Table I), making the total of small birds ringed since 1960 3,895. Three new species for the Decoy ringing totals were Swifts, Siskin and Corn Bunting. Over 800 retrap records have accumulated since 1960, some birds having been caught as many as 15 times. Ten ringed birds were picked up dead either in the cold period or found decomposed after the thaw: 2 Moorhen, 2 Blackbirds, 2 Song Thrushes, a Willow Tit, 2 Robins and a Wren.

Table I. Birds other than Anatidae ringed at Borough Fen Decoy in 1963

species	*month* *Jan*	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*	*total*
Moorhen	3	1	5	3		1	1	8		10	5	5	42
Wood Pigeon	59	16		1				3		3			82
Swallow					2	10	10	5	2				29
Great Tit		1		3		7		1	1	5		4	22
Blue Tit	6					3	1	6	3	9	4	6	38
Song Thrush				18	6	1	9	1	1	2	4		42
Blackbird	10		2	17	29	8	3	8	3	33	8	7	128
Robin	1	2		2	6	3	1	3		5			23
Whitethroat					2	12	1	1					16
Spotted Flycatcher					3	8	1	1					13
Dunnock	5	3	1	9	6	1	1	5		4	1	4	40
Starling	36			15						1		2	54
Greenfinch	45	24		14	1	3		2	1	6	3		99
Goldfinch				7	2	2	8	7	2	4	3		35
Linnet	2			4	19	17	4	6	1	2	7	9	70
Bullfinch			1	3	1	4		6	3	15	6	5	44
Chaffinch	13	7		8	1	5	2		3	6		6	51
Brambling	45	74		1						1			121
Yellowhammer			1	12	1			1	1	5			21
Reed Bunting		2		6						2	2		12
House Sparrow							50			10	8		68
Tree Sparrow	1	1		30	2			10	3	40	24	16	137
others	2	1		4	2	14	17	5	1	4		2	52
total	228	132	10	157	83	99	109	79	25	167	75	65	1,229

species of which fewer than 10 were ringed: Heron (1), Water Rail (1), Turtle Dove (2), Cuckoo (2), Swift (2), Great Spotted Woodpecker (2), Willow Tit (3), Tree-creeper (3), Wren (1), Mistle Thrush (4), Fieldfare (2), Redwing (1), Reed Warbler (4), Sedge Warbler (9), Icterine Warbler (1), Blackcap (5), Garden Warbler (2), Lesser Whitethroat (5), Siskin (1), Corn Bunting (1).

Two migrants ringed in 1961 were retrapped in 1963: a Spotted Flycatcher ringed as an adult on 30th May 1961, trapped on 23rd April and an adult female Whitethroat ringed on 13th May 1961, retrapped on 3rd June.

Trapping was done in mist-nets and a crow-trap, except in January and February, when mist-nets were not used.

Most of the April catch was taken in mist-nets at Easter. The July total was boosted by the sample of 50 juvenile House Sparrows that are taken annually. This species is providing some interesting recoveries (see below), and a similar sample will be ringed in 1964.

The Swallow total is low and includes 17 pulli ringed in farm buildings 200 yards outside the Decoy. In 1963 the roost in the reed bed was established too late for exploitation, when in accordance with a tradition handed down from the days when the Decoy was a commercial undertaking the pond area was kept quiet.

Blackbird, Bullfinch and Tree Sparrow furnished over half the October catch. The two latter are the most incomprehensible of all birds recorded and ringed in the Decoy. 139 Bullfinches ringed since 1960 have provided only 1 local recovery, and retraps are confined to less than 10 individuals. Tree Sparrows have produced 1 recovery from 434 ringed.

Table II records the more interesting recoveries reported during 1963.

Breeding birds and nests in 1963

Nests were recorded for the third consecutive year, 106 British Trust for Ornithology cards being completed. Of the nests studied 31 were completely successful and 23 partly so, the remaining 52 failing for various reasons (see Table III). Defining a successful nest raised a problem as the nests were only visited every third or fourth day.

A decision had to be made regarding nests in thick undergrowth, nettle-beds or reed-beds, where a trail to a nest would probably destroy other potential sites. Time was also limited and only nests found within three feet of an established path were visited regularly. A number of territories revealed by displaying males were not followed up as it was felt that an unrecorded success was preferable to a recorded failure. Note was made of singing males and of food carrying and faeces removal, in an attempt to estimate the number of birds breeding in the Decoy in 1963. The figure finally arrived at was 300 pairs, though this is little more than a wild guess. For example, 20 male Linnets appeared to have established definite territories, and I was quite proud of the fact that I had found fifteen nests of this species. However, when the leaves fell in October at least another 37 Linnet-type nests were exposed, mostly on the outer branches of hazel. Allowing for nests that had disintegrated, or are still unfound, for a few that may be wrongly identified and for second broods, the number of breeding Linnets must have been at least 30 and was probably nearer 40.

The land area in the Decoy is shown as fourteen and a half acres. With half an acre for the reed-bed, making 15 acres of suitable breeding habitat, this gives a density of

Table II. Recoveries in 1963 at more than 5 miles of birds ringed at Borough Fen Decoy

ring no.	*age*	*date ringed*	*where found*	*date recovered*	*movement*
Snipe					
40976 S	FG	20.12.61	Par, St. Austell, Cornwall	0.1.63	245m. SW
Wood Pigeon					
3080606	FG	13.11.63	Burwell, Cambs.	19.1.63	35m. SE
3080674	FG	22.1.63	Ryhall, Rutland	5.3.63	8m. W
3092545	FG	25.2.63	Swaffam Prior, Cambs.	28.9.63	36m. SE
Swallow					
AE 51057	Ad.	6.9.62	Douglas, Cape Province, South Africa (killed in a thunderstorm)	4.2.63	
Song Thrush					
59084 R	FG	21.10.62	La Rochelle, (Charente Maritime) France	31.1.63	
Blackbird					
28194 S	Ad.♂	24.5.61	Blatherwycke, Northants.	25.7.63	14m. WSW
Greenfinch					
47752 S	Ad.♀	2.1.62	Gainsborough, Lincs.	14.2.63	55m. NW
House Sparrow					
AA 30060	Pull.1	3.6.60	Swineshead, Boston, Lincs.	23.2.63	23m. N
AA 67413	FG	2.2.61	Whittlesey, Cambs.	24.4.63	8m. SE
Tree Sparrow					
AK 21428	FG	4.4.63	Saffron Walden, Essex	27.10.63	47m. SE

Table III. Nests found in use in Borough Fen Decoy, 1963

species	number of nests found	unsuccessful nests: deserted	unsuccessful nests: eggs lost	unsuccessful nests: young lost or died	successful nests: some reared	successful nests: complete success
Mallard	1				1	
Moorhen	15		11			4
Wood Pigeon	6	2	4			
Turtle Dove	7	2	3			2
Great Tit	1				1	
Wren	2				2	
Song Thrush	9	1	2	1	2	3
Blackbird	24	1	9	3	3	8
Robin	1					1
Reed Warbler	3				1	2[a]
Sedge Warbler	2				2	
Whitethroat	3				2	1
Lesser Whitethroat	1					1
Spotted Flycatcher	2		1			1
Dunnock	5	1	1		3	
Greenfinch	1	1				
Goldfinch	2				1	1
Linnet	15	2	4		3	6
Bullfinch	3			1	1	1
Chaffinch	1				1	
Yellowhammer	1			1		
Tree Sparrow	1	1				
Total	106	11	35	6	23	31

[a] 2 Reed Warblers successfully reared Cuckoos

20 nests (or should it be breeding pairs?) an acre. No doubt this high density is due to the lack of suitable habitat in the fens, with an unlimited amount of food available.

During the winter a further dozen nest boxes have been placed in the Decoy, in the hope of recording more of the tit's nests. At the present they mostly breed in hollow elder stumps and are in too deep to see eggs or young.

Scientific names of birds mentioned in the text

Heron *Ardea cinerea* L.
Bewick's Swan *Cygnus columbianus bewickii* Yarrell
Teal *Anas crecca* L.
Mallard *Anas platyrhynchos* L.
Water-Rail *Rallus aquaticus* L.
Moorhen *Gallinula chloropus* (L.)
Snipe *Capella gallinago* (L.)
Common Sandpiper *Tringa hypoleucos* L.
Greenshank *Tringa nebularia* (Gunnerus)
Wood Pigeon *Columba palumbus* L.
Turtle Dove *Streptopelia turtur* (L.)
Cuckoo *Cuculus canorus* L.
Tawny Owl *Strix aluco* L.
Nightjar *Caprimulgus europaeus* L.
Swift *Apus apus* (L.)
Green Woodpecker *Picus viridis* L.
Greater Spotted Woodpecker *Dendrocopus major* (L.)
Swallow *Hirundo rustica* L.
Great Tit *Parus major* L.
Blue Tit *Parus caeruleus* L.
Coal Tit *Parus ater* L.
Willow Tit *Parus atricapillus* L.
Long tailed Tit *Aegithalos caudatus* (L.)
Tree-creeper *Certhia familiaris* L.
Wren *Troglodytes troglodytes* (L.)
Mistle Thrush *Turdus viscivorus* L.
Fieldfare *Turdus pilaris* L.
Song Thrush *Turdus ericetorum* Turton
Redwing *Turdus musicus* L.
Blackbird *Turdus merula* L.
Robin *Erithacus rubecula* (L.)
Reed Warbler *Acrocephalus scirpaceus* (Hermann)
Sedge Warbler *Acrocephalus schoenobaenus* (L.)
Icterine Warbler *Hippolais icterina* (Vieillot)
Blackcap *Sylvia atricapilla* (L.)
Garden Warbler *Sylvia borin* (Boddaert)
Whitethroat *Sylvia communis* Latham
Lesser Whitethroat *Sylvia curruca* (L.)
Spotted Flycatcher *Muscicapa striata* (Pallas)
Dunnock *Prunella modularis* (L.)
Starling *Sturnus vulgaris* L.
Greenfinch *Chloris chloris* (L.)
Goldfinch *Carduelis carduelis* (L.)
Siskin *Carduelis spinus* (L.)
Linnet *Carduelis cannabina* (L.)
Bullfinch *Pyrrhula pyrrhula* (L.)
Chaffinch *Fringilla coelebs* L.
Brambling *Fringilla montifringilla* L.
Yellowhammer *Emberiza citrinella* L.
Corn Bunting *Emberiza calandra* L.
Little Bunting *Emberiza pusilla* Pallas
Reed Bunting *Emberiza schoeniclus* (L.)
House Sparrow *Passer domesticus* (L.)
Tree Sparrow *Passer montanus* (L.)

Duck-trapping methods

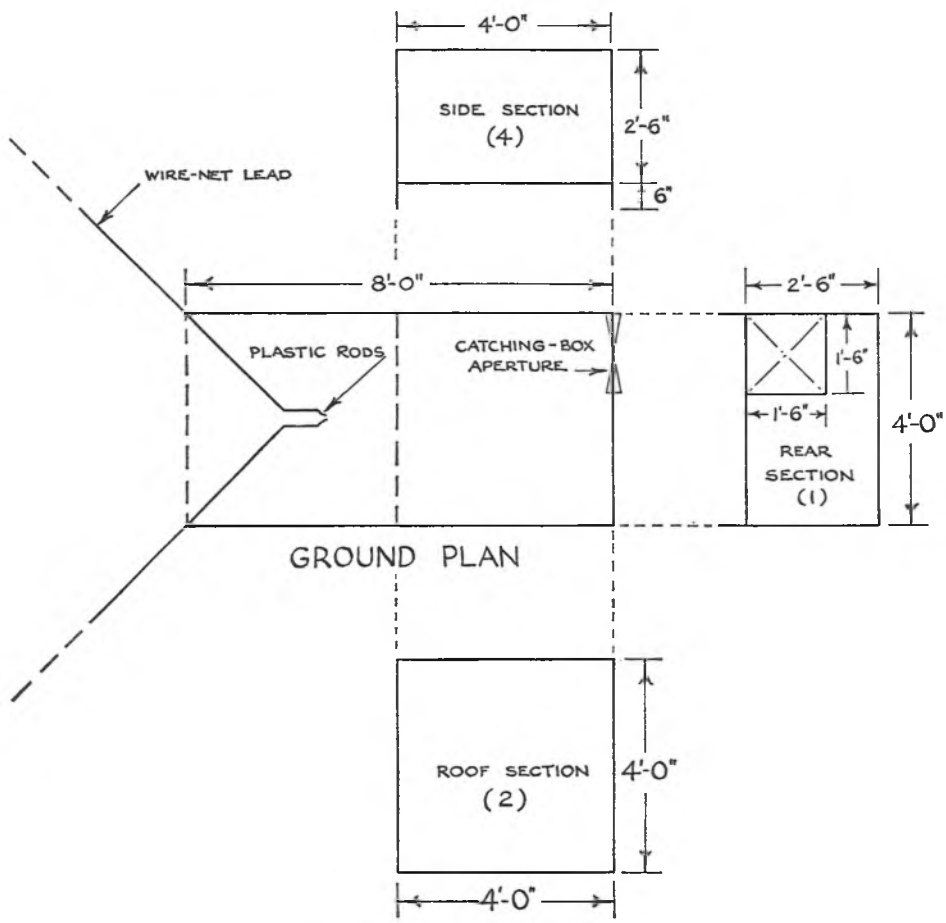
MISS E. A. GARDEN

Introduction

Under the conditions prevailing on the Ythan estuary, Aberdeenshire and on the local lochs, 'Abberton' cage-traps (described by Major General C. B. Wainweight in *Wildfowl Trust 8th Annual Report*: 44–47. 1957) have not proved very successful for catching ducks. This has led to various modifications and new designs being tried in the course of the last six years. Three patterns found successful in the prevailing conditions are described here. All traps must be sited on feeding grounds and not in roosting areas.

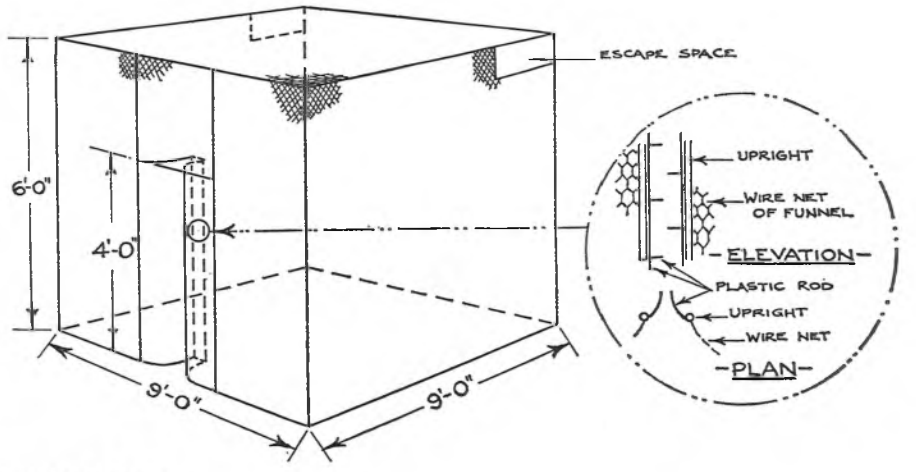
The 'Garden' trap

A small, portable trap for use on fresh waters. The dimensions of this trap are shown in Figure 1. The funnel entrance should either face dry land or be parallel to it as ducks swim towards deeper water once they are in the trap and so tend to find their way out of funnels facing offshore. Guide wires or leads, consisting of 10-12 ft. lengths of wire netting 24-30 ins. high attached to the outer corners of the traps and angled outwards at about 45° are effective. A small catching box at one corner is essential.



GARDEN'S PORTABLE TRAP

Figure 1. Plan and dimensions of a small, portable duck-trap.

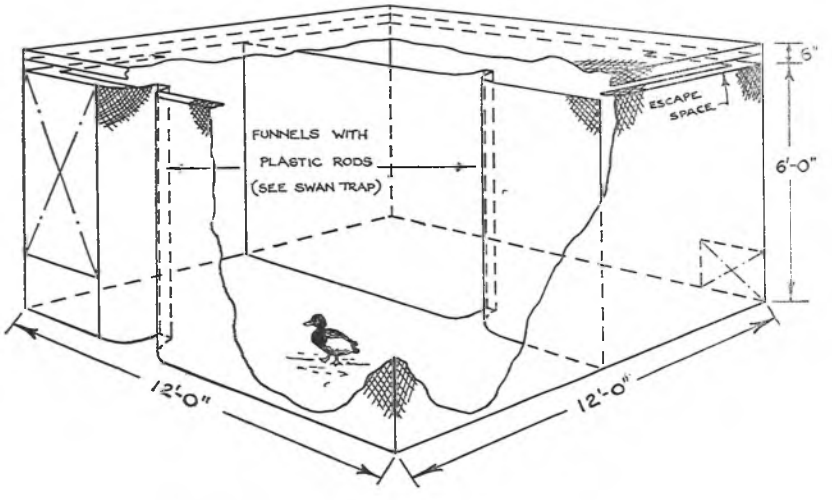


SWAN TRAP

Figure 2. A trap for ducks and swans which can be used in tidal water.

The Swan trap

For use on tidal water, to catch sea and diving-ducks and swans (Figure 2). Traps 9 ft. square and 6 ft. high, with a single funnel at least 4 ft. high, will catch both eiders and swans. The funnel should be about 3 ft. deep, with an entrance 9-12 ins. wide. The trap should be set with the entrance facing shorewards, well below the high tide line. Ducks seem more inclined to enter the trap when it is sited so as to become almost wholly immersed at high tide than when only part of the trap floor is then under water. On the Ythan the trap is set about 25 yds. below high water mark and floods to well over 3 ft. It is, of course, necessary to allow for the possibility of unexpectedly high tides by providing an escape device. A gap of about 1 ft. should be left between the tops of the netting walls and the roof of the trap. Experience has shown that in windy conditions the smaller diving ducks, such as Goldeneye, will climb the wire and scramble out through the gap. This can be prevented by fitting a 6 in. baffle strip of netting pointing inwards at the top of the wall. To prevent waders and other non-swimming birds from being drowned the bottom



MODIFIED ABBERTON TRAP

Figure 3. Modifications of the 'Abberton' trap for use in tidal water.

of the walls should be made of 3 in. chain-link netting, through which they can escape.

This type of trap has caught Eider, Mute and Whooper Swans, Tufted Duck, Scaup, Goldeneye, Mallard and a Pochard.

Goldeneye are extremely difficult to retain in a trap for any length of time. Plastic rods, of $\frac{1}{8}$ in. diameter, protruding at an angle into the funnel (see sketch) greatly decrease the proportion of escapes. These rods are also valuable in the other types of traps described here.

The Ythan-Abberton trap (Figure 3)

The basic 12 ft. Abberton trap has been modified to catch Tufted Duck, Scaup and Goldeneye in the estuary. The major changes are: (1) elimination of all funnels except those pointing landwards; (2) bisection of the trap with an internal wall parallel to the entrance side, this wall being provided with one funnel not directly opposite the outer entrance; (3) provision of an escape space, as in the Swan trap.

Bait

In Aberdeenshire by far the most effective bait for all traps is barley, with wheat as second choice.

Acknowledgements

I am very grateful to Mr. A. Anderson for preparing the drawings and to Miss V. M. Thom for her help with the notes.

Shelduck trapping methods

COLIN YOUNG

On the Ythan estuary in Aberdeenshire, Common Shelducks (*Tadorna tadorna* (L.)) are trapped for ringing in a specially designed baited trap as they return from the wintering grounds in the early spring. During the last two years over 200 Shelducks have been successfully ringed in this area. The techniques used in trapping Shelducks are slightly different from the usual duck trapping methods. In the first place, Shelducks are usually found in large numbers only on tidal water so that special 'anti-drowning' modifications are required on the traps; and secondly, the extreme wariness of the birds makes it necessary to work well out on the tidal mud flats, often in extreme current and ice conditions.

On the Ythan the trap is situated near the outer edge of a very broad mud flat (Sleek of Tarty) where it has to withstand complete submergence in 13 ft. tides and, as was the case during the recent severe winters, the ravages of ice floes. The actual position of the trap is extremely important. It must be placed where the birds congregate naturally to feed but preferably not in a spot which will ultimately be occupied as a feeding territory.

The trap itself is illustrated in the accompanying diagram. The special features are: the extra wide outer funnel (Shelducks abhore narrow funnels), the chain link mesh on the inner chamber which prevents the Shelducks from damaging their bills and also allows the smaller waders to escape, and most important of all, the 'anti-drowning' modification in the roof. The last feature prevents the birds from flying out but does provide an emergency escape hatch in the event of very high tides. Barley is used as bait.

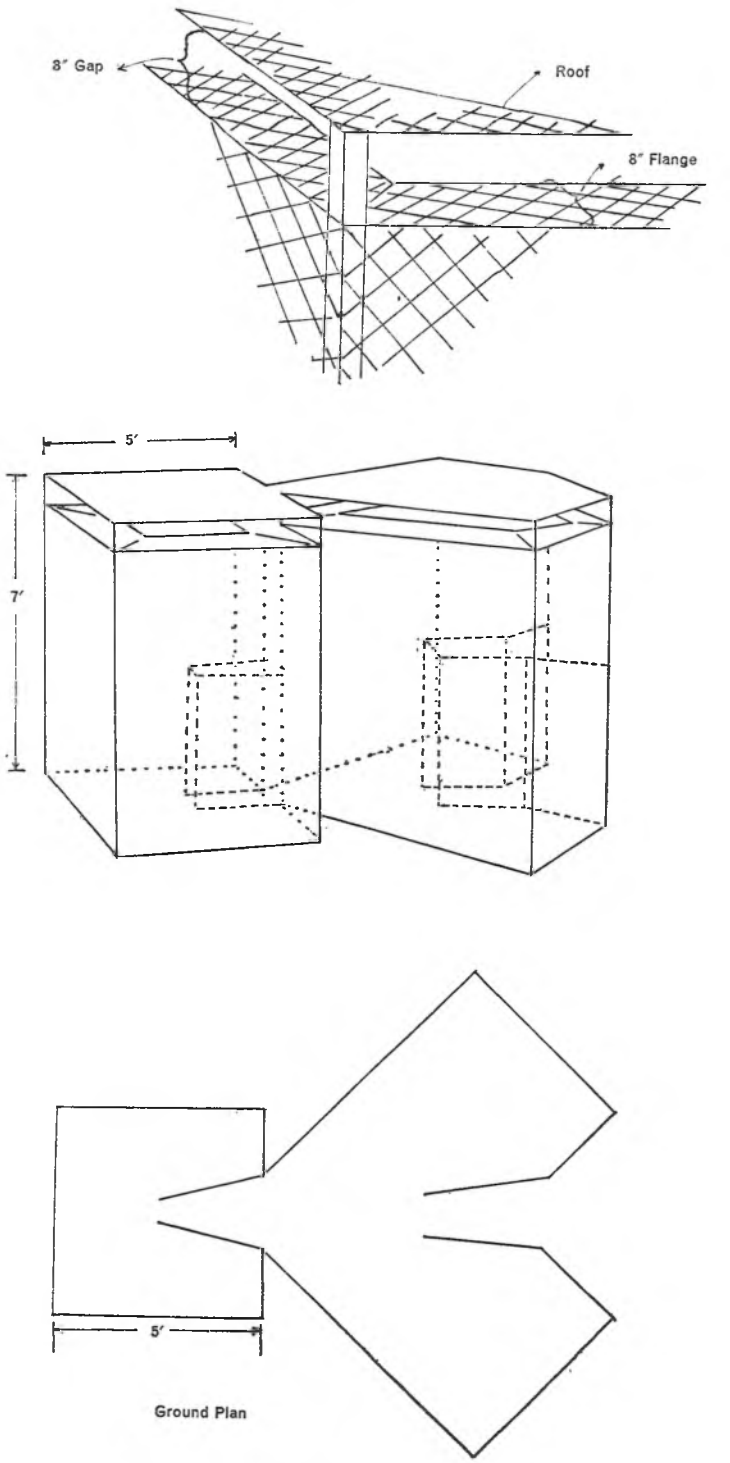


Figure 1. Plan and dimensions of a trap for Shelducks.

An automatic incubation recorder for wildfowl

JOHN HORI

Automatic recording devices which can be buried under ducks' nests to provide records of incubation rhythms have been developed by workers in North America, though no detailed accounts of their construction and use seem to have been published. Such equipment appeared to have obvious application to the nests of Shelduck (*Tadorna tadorna* (L.)), where it could be easily disguised. During the winter of 1962-63 various prototype equipments were constructed and eventually a crude but effective working apparatus was used in North Kent during the 1963 breeding season.

Apart from a wide variety of miscellaneous sites the principal Shelduck nesting places in the area under observation were in rabbit burrows, trees, or hay and straw; all were of roughly equal importance. Hay and straw sites seemed most suitable for recorder experiments and the co-operation of farmers was obtained in arranging interiors of barns and sheds to make them more suitable. Farm buildings chosen all had a previous tradition as breeding sites, and artificial nesting places were constructed in them with bales of straw, meal bags, corrugated iron and other miscellany. Five of these sites were subsequently occupied.

Description of equipment

Basically the equipment comprised three parts : (1) a detecting component in which a contact-making device varied the condition of an electrical circuit according to the female's presence or absence; (2) an electrically operated graphic recorder which responded to the contact; and (3) an interconnecting cable system. In practice none of the components was quite so simple and refinement was necessary to cover other variables.

The simplest system for the detecting component would have been a weight-responsive one in which a sitting bird closed a contact against spring pressure, the spring restoring the contact to its opposite position when the bird left the nest. This would have had obvious disadvantages in matching springs to hypothetical weight conditions and in making running adjustments in the field. It was found that the best results, within my own economic possibility, were obtained with a domestic beam scale on which the pan was replaced by the bottom of a large plastic bowl. In addition to improved accuracy and consistency, such a scale had two major advantages: (a) the movement of the pan to cause beam deflection was very small and (b) balance conditions were adjustable; making it possible to weigh and balance any reasonable clutch. The scale range was 0-14 lb., with adjustment in 1 oz. steps, so that in practice the limiting factor was the physical size of the clutch, not its weight.

An extension arm was fitted to the beam of the scale to operate a totally enclosed micro-switch which thus changed its contact position when there was a change of weight on the scale. Careful attention was necessary to silence the scale movement and all contact faces were treated with foam rubber. The composite scale, beam switch and bowl were placed in a wooden box suitable for burying beneath nests and a layer of straw was stuck over the whole exterior to obviate the possibility of it becoming completely uncovered.

A portable miniature potentiometric recorder was coupled to the detecting equipment; this was a self-contained instrument comprising slide wire, servo-driven wiper combined with the pointer, servo amplifier, battery supply and chart assembly. The unit was transistorized and its small overall dimensions (10 in. × 8 in. × 6 in.) were admirably suited to concealment near the nest, although the original conception was that it should be remotely housed. Various types of 'range unit' are obtainable and in this case temperature measuring circuits were employed. The range and deflecting circuits gave balance conditions when connected to an external thermo-couple; mid-scale deflection corresponding to approximately 27°C at the external location. The copper-constantan thermo-couple was cemented to the beam scale bowl so that it was in the bottom of the nest; it was thought initially that it would be possible to measure incubation temperatures in this way (see below). External circuit connections were such that the micro-switch on the beam connected the thermo-couple to the recorder whenever the beam was deflected by the weight of a sitting bird. Conversely, when the bird left the nest the beam reset; this operated the micro-switch which 'open-circuited' the thermo-couple loop and unbalanced the recorder 'range circuits' which returned the pointer to zero. The pointer reproduced a continuous graphic record on 3 in. wide waxed paper charts. The absence of ink pens and ink reservoirs was an obvious advantage. A chart length of 65 feet was used and driven

at 1 in. per hour by the eight-day clockwork drive. This gave a record of just over one month's duration.

Recorder and beam scale were interconnected with a twin core copper-constantan cable and the whole system was actuated by dry batteries contained within the recorder.

Application and field results

Five of the artificial nest sites were occupied and the recorder was applied to four of these before correct operation was achieved. The initial conception was that the apparatus would be installed towards the end of the laying period when the duck's attachment to the nest had become strong and when the beam scale could be set with accuracy. Approximate weights of birds and eggs had been previously determined, but the size of each particular clutch had to be found out. Setting-up procedure was therefore to involve waiting until the clutch had been completed, or nearly so, and then weighing it on the beam scale. The latter could then be 'calibrated' by adding approximately half the weight of the bird to that of the clutch so that the scale would not be deflected extraneously. The scale and all associated equipment were then to be buried beneath the straw.

The application histories follow, in chronological order.

At Nest 1, egg laying was watched to apparent conclusion, *i.e.* down lining, and the apparatus was installed on 21st May, 1963. The beam scale was buried beneath the nest and the recorder placed in a remote part of the barn. Unfortunately this nest turned out to be a multiple one, the work of at least two females, and more eggs were laid until the total reached 25. This necessitated repeatedly re-weighing the clutch and re-setting the beam scale, and it was not altogether surprising that the birds ultimately deserted. The photograph on p. 172 shows this nest 'restored' with the scale buried beneath it.

This first attempt showed that the apparatus was generally satisfactory but the repeated weight increases caused by the laying of additional eggs caused the recorder to incorrectly indicate the continuous presence of the bird. This condition obscured battery drain difficulties which were to arise later.

Nest 2 was in a Dutch barn. The beam scale was buried beneath the nest during laying. The recorder was sited in a hole in the side of the stacked straw. This application quickly illustrated a deficiency in the equipment. As previously described, balance conditions in the range circuits were obtained with the thermo-couple in circuit, *i.e.* with the bird on the nest, and under these conditions the capacity of the internal batteries was some 300 hours. However, when the bird was not on the nest the recorder deflected to zero, driving hard against a stop and consuming much more power than in balance conditions. With continuing deflection to zero, batteries were exhausted in approximately two days.

The apparatus had to be removed from this location when the straw was sold and this opportunity was taken to modify it. Alterations were made to the recorder and its external circuit so that the internal batteries were only utilized when a bird was on the nest. Disconnection of the recorder batteries was effected by an interposing relay to which a capacitor discharge circuit was fitted. The relay was actuated by the beam scale micro-switch and at every relay operation the capacitor discharged into the recorder deflecting circuits causing a definite kick in the trace when the bird left. These modifications necessitated addition of a relay box and a further set of batteries to energise the relay, the latter adding greatly to the weight and bulk: to economise in wiring, the recorder was subsequently placed near to the beam scale. After one further unsuccessful application the apparatus was installed in another hay barn. The modified equipment is shown at p. 172.

At the final nest there was no escape tunnel (see also Hori, 1963). Batteries and relay were buried beneath the straw adjacent to the nest. The equipment was installed on the sixth day of incubation and at first operated perfectly. Further difficulties were soon encountered however when it was found that the drag between the straw of the nest and the stationary straw surrounding it could prevent 'throw off' of the beam scale counter-weight system. This happened particularly after long spells of sitting, presumably as a result of turning, re-settling and lengthy compression of the straw. It was the most difficult problem to eradicate since it involved the small differential between approximately half the weight of the bird and the force necessary to overcome drag and interference of straw. The problem was solved by completely separating the straw of the nest from its surroundings and inserting a stiff paper lining to form a cylinder in which the beam scale bowl and nest moved freely. Some eggs were removed from the nest during these adjustments to avoid removing the whole beam scale for adjustment.

Consistent operation was finally obtained on the ninth day of incubation and a continuous record was plotted from then until the ducklings left the nest. Full details

of the results are to be published elsewhere (Hori, in press). The thermo-couple did not give an accurate picture of incubation temperatures and acted merely as a deflecting source for the recorder. This resulted from a decision to 'play safe' by burying the couple beneath a layer of straw and cementing it to the recorder bowl. However, it still seems probable that incubation temperatures could be measured in this way.

This female, AJ87910, was noteworthy as being the first ever to provide such data. Matters were not to end there however; her body was picked up at Niedersachsen on the river Weser near Bremerhaven on 15th October, 1963, so near the Knechtsand as to make it certain that she had been there or intended to go there. She thus went on to prove conclusively that some, if not all, breeding birds from North Kent make the moult migration to Heligoland (Goethe, 1961).

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Congenital malformation in birds bred at Slimbridge

JANET KEAR

As in two previous breeding seasons, all young birds and eggs that failed to hatch during 1963 were examined for malformation. The high proportion of abnormality (10 out of 1,767 birds examined) in 1961 (Harrison and Kear 1962; Napier 1963) has not recurred (0 out of 934 in 1962 and 0 out of 2,459 in 1963), suggesting some external factor affecting, for one year only, a number of our breeding ducks. Harrison (1963) has supposed that seed-dressings, of which the three most toxic were voluntarily banned for spring use from January, 1962, might be implicated in congenital deformities in corn-eating birds. It is, of course, impossible to know whether grain fed to the collection in spring 1961 was contaminated, but it is recognised that certain drugs can upset normal embryonic development and the effect of agricultural chemicals in this specific situation might be investigated. The abrupt cessation of abnormality after 1961 makes a further suggestion that radioactive fall-out was a prime cause of the high level of congenital deformity seem less likely, since fall-out continues despite a partial test ban treaty.

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Parental care in the Shelduck

JOHN HORI

Summary

The behaviour of Shelduck during the brood season is described and discussed. Attacks by adults on their own broods, and the behaviour of ducklings and of birds assumed to be 'failed breeders' seem to provide a mechanism of crêche formation.

Introduction

The brood behaviour of the Shelduck (*Tadorna tadorna* (L.)) is unlike that of most species of ducks. The crêche system, in which many broods of ducklings gather together under the care of one pair of adults, is well known, as is the fact that this system leaves the majority of adults free to make their moult migration. However, the mechanism of crêche formation is obscure, and observations described in this paper suggest that it may not be as haphazard as previously supposed. All the observations were made in North Kent during 1961-63 inclusive. Other aspects of adults' behaviour with broods are also described and discussed. All times are G.M.T.

Leaving the nest

Both parents lead ducklings from the nest: drakes accompany females back to the nest during incubation and consequently are present at the final visit. At the latter the male waits near the nest, outside a barn or derelict building, at the foot of a tree, or beside a hole. The female leads the brood out and both parents then take them on or close to salt water: traditional nursery areas are used. In North Kent broods generally leave the nest before 0630 hrs. and travel to nursery areas very quickly: they do not pause on the grazing marshes.

In difficult nest locations the female may carry ducklings out in her bill and whilst I have not witnessed this personally it has been reported to me several times by reliable farm workers. A nest under observation in 1962 was in a hollow bough of a tree, approximately 15 feet off the ground, accessible only from inside the hollow trunk. Probably the trunk was hollow to the ground, but it had filled with natural debris to a level about 6 feet below the nest chamber. The interior was quite smooth and had an internal diameter of some 2 ft. 6 in. At 0515 hrs. on 5th June all 10 ducklings were found out of the nest and standing in the bottom of the trunk: because it was anticipated that the parents would have difficulty in getting them out I retired to the nearest cover to watch. The pair returned at 0533 hrs. and the female went into the nest at once. The male was unusually agitated and contrary to usual behaviour remained at the foot of the tree running backwards and forwards and circling it; possibly anticipating the descent of the ducklings. During the next 42 minutes the female went in and out of the nest hole four times, remaining inside for periods up to 16 minutes. Each time she emerged from the nest she would lead the male in running round the base of the tree or in short circling flights. These activities attracted another pair who, in spite of aggression by the brood drake, hung around near the base of the tree. Twice the second female actually flew up to the nest hole and peered down into the trunk whilst the brood female was inside. At 0629 hrs. the birds were disturbed by the commencement of farming activities and flew off towards the grazing marshes; no ducklings had then been removed.

I was unable to return to this nest until 1400 hrs. on 6th June when there were no adults in the vicinity. Five ducklings had been left in the bottom of the trunk and although they were later found to be adept climbers they were unable to scale the smooth interior of the trunk. Three were rescued and one other was recovered by farmworkers late that evening. I consider that the five ducklings which had escaped from the hole could only have been taken out in the female's bill.

Tolling and distraction display

Tolling, as described by Sowls (1955) for surface-feeding ducks, is by far the most common behaviour when family parties are threatened by approaching danger. One or both adults attempt to attract attention away from the brood by flying in circles and calling. The drakes uses a variety of whistling notes and the female a monosyllabic nasal version of the more usual 'ak-ak-ak' which might be rendered 'arrnk, aarnk'. The latter is repeated slowly and regularly and has an anxious quality. The drake's calls appear to vary with the emotional stress. When the threat to a brood is not severe a soft clear whistle is used. Greater danger evokes either an increase in the volume or the number of calls, sometimes both; *e.g.* a double whistling note 'whee-chew, whee-chew' and occasionally long phrases of trilling whistles which have an almost passerine quality.

Rarely, the intensity of tolling increases to a pitch where it borders on or becomes an injury feigning or distraction display. On 24th June, 1962, a close approach was made to a pair with six tiny ducklings. The female began to toll and then settled on the water some 50 yards away. The drake showed much more anxiety than the female and after tolling a few times began to feign. Each time he flew past he would slacken speed, reduce height until only a few inches above the water then drop his body and tail almost to stalling point. With legs dangling he 'wobbled' past as though about to pitch into the water, wing tips alternately touching the surface. Four times the bird did this and each time it dropped its legs into the water several times making a loud splashing sound. A subdued clear whistle, frequently repeated, was uttered the whole time. Even more rarely, distraction display occurs on dry land. I have witnessed it only once, when a female attempted to distract me with a display almost identical to a Mallard's and equally violent.

Brood attacks

The term 'brood attacks' is used here to describe attacks by parents on their own broods. This was first seen on 2nd July, 1962, when a pair were seen with their eight 3- to 6-day-old ducklings on a large fresh water fleet in one of the traditional nursery areas. At this date crêches were beginning to form, but family parties made up the bulk of the 128 ducklings in that area. It was noticed that the drake of the pair in question was making almost non-stop assaults upon his own ducklings, pursuing them incessantly, scattering them and rushing after them with neck stretched over the water in typical aggressive postures. Whenever he got near enough he stabbed the ducklings with his bill, often causing them to dive, but apparently not really hurting them. It was noticeable that he ignored ducklings other than his own brood, even though the former constantly intermingled with the brood. The female floated passively on the water nearby until, after about half an hour, she began to do exactly the same thing and within a short time became more vicious than the male and apparently incited him to more severe attacks. For a further three-quarters of an hour both parents chased and attacked their own ducklings. On several occasions it seemed that the female would drown a duckling when she pecked viciously and repeatedly, waited for it to re-surface after it had dived to escape and then rushed or flew at it again. Once she flew across the water, grabbed a duckling in her bill and 'ducked' it five times in rapid succession. In another case while she was 'ducking' one the male 'stabbed' at it viciously. The female always tried to hold the ducklings in the same way, by grabbing both wings behind their backs. Similar onslaughts may have been responsible for the seven dead ducklings seen floating on the water that day; although there were many large gulls about and a drake Shelduck was seen to mob a Great Black-backed Gull (*Larus marinus* (L.)) which passed over the gathering water. Towards the end of the watching period, attachment of the brood to the parents appeared to weaken and there were periods when only one duckling was anywhere near them. At 1015 hrs. I decided to test the brood attachment by revealing my presence and walking directly towards them. The latter at once gathered together and both parents immediately began tolling (see above). They circled over the brood seven times as I stood beside the water, the female quacking and the male whistling with typical alarm notes.

In 1963, particular attention was paid to this aspect of parental behaviour and four further instances of brood attacks were seen. Two on 7th July were similar to the occurrence described above, but the third and fourth were of even greater interest because they demonstrated conflicting emotions in the parents. On 14th July a female feeding with her brood attacked them twice in half an hour. The ducklings were already giving her a 'wide berth' and it seemed that this was a case where an attack period was ending, or alternatively it was an attack of low intensity. Sporadic attacks continued during the next half hour and one of the young which was caught was repeatedly 'ducked'. After this period the female walked out of the water and stood near her mate; the brood followed. Within a few minutes she was brooding four of the ducklings under her wings, sheltering them from a cold south-west wind! The final case, observed in 1963, has been fully described elsewhere (Hori, in press): in it, parents defeated in their attempts to prevent attacks on their brood by another pair of adults ultimately ended up by themselves attacking their own young.

Discussion

The bond between the parents and brood is strong in Shelduck. However, unlike that of geese, which Shelduck resemble in many ways, the family bond is often broken when the ducklings are at an early age, because most adults make an annual moult migration. The crêche system appears to have definite advantages in connection with the moult migration because females which have spent a month or so incubating

are scarcely in condition to make a migration of some 400 miles. Those broods which reach the nursery areas as early as the first half of June do not necessarily crêche (see also Hori, in press), but later ones do so rapidly. This suggests that as migration time approaches, parents are more likely to desert or otherwise 'lose' their broods. The stimulus to desert is not readily apparent. It may be overcrowding of duckling waters as the season advances or perhaps the visual stimulus of large adult flocks which begin to appear about the third or fourth week in June and gradually move to the open water of the estuary before migrating.

The brood attacks described above lend weight to the hypothesis that in many cases the parents themselves break the family bond by forcing their broods to leave them. This is borne out by observations on adult pairs in the vicinity of duckling broods and crêches in early July. The pairs in question, which tend to remain on the banks of the duckling waters, are distinct from birds assumed to be 'failed breeders' (*i.e.* sexually mature birds which have lost their nests or broods). The females, showing loss of down and breast feathers, have either bred successfully or at least completed most of an incubation. These pairs watch the ducklings from a distance and appear to be in loose contact with them. They are quite passive, unlike 'failed breeders' which follow duckling broods and crêches about, apparently attempting to adopt them (see also Hori, in press). They are considered to be successful breeders which, having driven their own ducklings away, nevertheless remain weakly attached to them for a short time thereafter. Similar conflicting motivation was demonstrated in the field when adults who had been attacking their own brood began distraction display to protect them immediately I appeared.

Other factors probably contribute to crêche formation. One of these is the tendency which ducklings themselves show to join other groups. On 23rd June, 1962, a pair with eleven tiny ducklings was seen to pass close to another pair with four larger ducklings. As they did so, one of the larger ducklings swam towards the brood of eleven. The drake of the latter family attempted to keep the larger duckling away by swimming between it and his brood, whilst the drake who had been with the brood of four swam about nearby. In spite of both the drakes the larger duckling attached itself to the younger brood and the second pair, now with three large ducklings, swam away. On other occasions ducklings were seen to wander away from their parents. Scattering of ducklings also occurs when the parents and sometimes the brood as well are attacked by parents of another brood. This is particularly noticeable when human intrusion causes a dozen or more broods to swim together.

The presence of 'failed breeders' on the duckling waters has already been mentioned. Possibly birds which have laid their eggs in multiple nests come into this category. Such pairs remain in the nesting range, sometimes in contact with the failed nest site. By the third week in June those without nest- or brood-ties withdraw from the nesting areas and territories and gather in flocks on nearby salt water. In the early stages of this withdrawal many failed breeders find their way to the nursery areas, perhaps in loose contact with adult pairs which have bred. Such groups have been discovered to exist within the breeding populations in North Kent and have been called 'communes' (Hori, in press). On the duckling waters birds believed to be 'failed breeders' attempt to join broods and crêches in spite of initial aggression from the adult pairs accompanying them; circumstantial evidence suggests that these are the birds which ultimately assume care of the crêches. Throughout the brood period, particularly before parents part from their young, those adults without broods show considerable interest in ducklings, without being aggressive. Whenever family parties pass near groups of such adults, the latter 'crowd around' as though admiring the young. The latter behaviour and the general atmosphere is reminiscent of a remarkable performance my wife and I once witnessed in our domestic geese. We knew that an egg in one nest was chipping when our attention was drawn to it by a tremendous clamour from the whole flock. We found the parent female astride a newly emerged gosling which was weakly moving; the female and the rest of the flock, which were standing in a close circle round the nest, were trumpeting at the gosling and at each other, stretching their necks over the former and clamouring in each other's faces. This type of behaviour, and that of the assumed 'failed breeders' in general, heavily underlines the strong gregarious tendencies of Shelduck. In this context the 'brood attacks' may not be quite such an anomaly as they appear. Since other adults will readily adopt ducklings there is little danger to the latter if their parents do desert them on the traditional nursery areas and, since adults make a moult migration, the biological advantage of the species may be best served if they force their young to leave them at a time when they themselves can adequately prepare for

the migration. Brood attacks seem to be the only intra-specific behaviour at variance with complete gregariousness within family and other social groupings. I consider that they are not simple aggressive acts and that they serve a group- or population-advantage, as do the mutual stimulation displays between Shelduck pairs which occur in the communes, but which have a superficial resemblance to aggressive displays.

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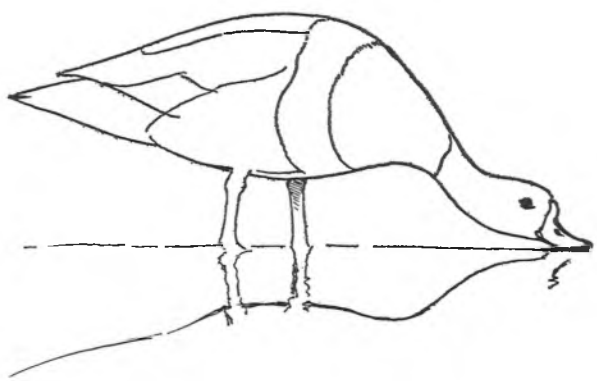

Research and conservation overseas

Observations on the biology of the Spectacled Eider

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Probably no species of North American waterfowl is more poorly known than the Spectacled Eider (*Somateria fischeri* (Brandt)), whose range in North America is limited to the western and northern coasts of Alaska. Even along these coasts the species is evidently common as a breeding bird only in the region around Barrow and between the mouths of the Yukon and Kuskokwim Rivers. In the latter area it occurs as a nesting species from the coastline to perhaps as far as 10 or 15 miles inland throughout the lowland grass and sedge tundra, especially where the tundra is dissected by tidal channels and rivers. Gabrielson and Lincoln (1959) have summarized what is known concerning the breeding and wintering distributions of this bird. Although it has been presumed that the Aleutian Islands comprise the winter range of this species in North America, no observations of it have been made there by Mr. Robert Jones, refuge manager of the Aleutian Islands National Wildlife Refuge (personal communication). Observations of the Spectacled Eider on the breeding grounds are also very few and consist primarily of those obtained by Conover (1926) and Brandt (1943), during their expedition to Hooper Bay in 1924. These authors collected a total of 27 birds, 37 eggs, and provided data on seven nests. Several of the birds, and apparently all of the nests and eggs, were taken at Igiak Bay, which is located just north of Hooper Bay. They first observed the species at Hooper Bay on 5th May, and noted that some of the migrating flocks appeared to arrive from the north. This caused Conover to conclude that the species might winter in the northern Bering Sea, but it would seem more probable to me that they might cross the Bering Strait and winter along the Siberian coastline. In 1924 the first eggs were found at Igiak Bay on 13th June, and young were first observed on 8th July.

In an attempt to observe and film the displays of this species for comparative purposes, and to collect eggs for subsequent hatching and rearing, an expedition was made in June 1963 to the Igiak Bay region by myself and Mr. Glen Smart. A chance meeting with Dr. Brina Kessel and two students from the University of Alaska resulted in the formation of a joint expedition, which proved to be of mutual benefit and enjoyment. Our time of arrival (7th June) was planned in the hope that we would be able to observe late stages of pair formation and obtain unincubated eggs. Unfortunately by this date nests were well under way, and we were able to find only partially incubated eggs, which are far less desirable for transporting than freshly laid eggs would have been. Observations on the displays and relationships of this species have been published elsewhere (Johnsgard, 1964), but many of our experiences and observations exclusive of the strictly behavioural ones seem worth recording here, especially since so little is known about the biology of the Spectacled Eider.

Abundance and composition of Spectacled Eider flocks

During the period from 7th to 14th June the Spectacled Eider was the most abundant breeding duck in the vicinity of our camp which was located at the base of the Askinuk Mountains about five miles directly east of Paimut (an Eskimo site referred to by Brandt as Bimut). Small flocks of Spectacled Eiders were commonly observed on the Kolomak River, a tidal river originating in the Askinuk Mountains and flowing into the Kokechik (or Kakechik) River at the eastern end of Igiak Bay. These flocks, of which the largest observed was 14 birds, consisted almost exclusively of adults. Only one of the males seen was in apparently immature plumage, thus presumably non-breeding males remained at sea off the coast. However, two of the three females collected were immature birds. Conover (1926) noted that except for one immature female, only fully adult birds were recorded by their party. Most of the females seen by me appeared to be paired and breeding birds, which spent most of their time at the nest, flying to the river only when disturbed or for copulation. Females in groups of twos and threes were sometimes

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seen and were judged to be either non-breeding immatures or birds that had lost their clutches. Common predators of the area included the Glaucous Gull (*Larus hyperboreus* (Gunnerus)), the Short-billed Common Gull (*Larus canus brachyrhynchus* (Richardson)) and three species of jaegers (*Stercorarius* spp.). Two nests apparently destroyed by predators were found, and it was a common sight to watch jaegers or gulls swoop down on an exposed nest only moments after a female was flushed from it. Probably for this reason females rarely leave their nests; we never found an untended clutch. The majority of the birds observed on the river were unpaired adult males, which congregated in small groups in search of females, immediately flying to any that came within sight. They would attempt to display to such females, but when these birds were already paired the possessive male usually prevented them from initiating any very active courtship. The most active periods of display occurred when these unpaired males located untended females which I believed to be non-breeders or unsuccessful nesters.

Nesting and Territoriality

Unlike the Common Eider, which is definitely a colonial nester, our observations on the Spectacled Eider suggest that nests tend to be slightly clustered. Of 13 nests which I observed, the closest distance between any two nests was 12 ft. Three of the nests were to my knowledge distinctly isolated from all others, and of the other ten nests the average distance between nearest known nests was somewhat over 50 ft. This certainly indicates a certain degree of nest 'clumping' or incipient colonialism. Around one tundra pond of less than an acre three nests were found, while two other small ponds each had a pair of nests. Only one nest was found that was distinctly placed away from water; it was about 60 ft from the nearest pond. The average distance from water of the remaining nests was 3·3 ft, and some were within a foot of the water's edge. One nest that had recently been destroyed and abandoned was found on a small island (three by four ft), while nearly all others were situated on the periphery of tundra ponds. All of the nests were built in fairly high grass of the past season; not until incubation was well under way was the newly growing grass high enough to afford any significant cover.

Eleven observed clutches ranged from three to six eggs in number, averaging 4·25 eggs. Brandt (1943) observed clutches containing as many as seven eggs, and judged that the eggs were laid every other day. The measurements of 12 eggs averaged 69 by 43·7 mm., the extremes being 66 and 71 mm. by 43 and 45 mm. The weights of 11 eggs which failed to hatch ranged from 57·5 to 65·5 g. and averaged 60·25 g. Since we did not arrive before the onset of incubation we were not able to definitely establish the incubation period of any eggs, but of the eggs brought back one hatched on 28th June and the others on 6th July, indicating a possible minimum incubation period of 22 days. In all likelihood it is closer to the 28 days that has been reported for Common and King Eiders. Brandt (1943) estimated that 10th June might represent the date of maximum nest initiation in the Igiak Bay area, but our experience would indicate that in 1963 most laying began at least two weeks before this date.

No signs of overt hostility were observed between pairs sharing nesting ponds. Frequently a pair would swim within a foot or two of another pair that was sitting by the water's edge, without causing any disturbance. There was thus no indication of a defended area, or territory. At various times males were seen to be accompanied by two or even three females, perhaps birds that had lost their clutches but were still attracted to their general nesting area. When we left in mid-June, most of the males appeared to be still attending their mates (who were a week or more into incubation by then). In the Chevak area not far away, Robert Elgas (*in litt.*) observed that male Spectacled Eiders were common in 1962 until about 21st June when they suddenly disappeared and presumably went to sea to moult.

Appearance and General Behaviour

Since so few persons have observed this species in life, a few comments of a general nature might be in order. One of the most striking and unexpected features of the birds was the bright reddish orange colour of the male's bill, particularly near the base. This is far brighter than is indicated in published paintings. Secondly, the greenish to greenish-gold hood behind the eyes is not smooth and neatly 'trimmed' as in the King Eider, but rather is distinctly 'shaggy'. However, contrary to what Brandt (1943) states, it is not raised during display. Lastly, the black underpart colour of the male is not the rich jet black that occurs in Common and King Eiders, but is of a slightly greyish or silvery cast, exactly as shown in Kortright (1942). In addition, the pale bluish iris of the male is very different from the very dark iris colour found in the males of the other eiders. The appearance of the female is extremely similar to that of the Common Eider, except for the curious pale 'spectacles' that contrast strongly with the

dark brown feathers immediately in front of this area. In fact, we found that birds on nests were most readily found by looking for this conspicuous brown patch that destroyed their otherwise almost perfect concealing coloration.

I observed the birds feeding on the Kolomak River at various times, diving under water in a somewhat awkward fashion. They opened their wings as they submerged, in the same manner as do Common and King Eiders. Spectacled Eiders appear to be remarkably silent birds, for although I observed them as closely as 30 yards away on various occasions, the only calls heard were inciting notes from the females. These calls were much like the corresponding calls of female Common and King Eiders. Again, on one occasion some male Pacific Eiders were displaying in the company of a flock of Spectacled Eiders, and although I could hear the formers' cooing calls very plainly, nothing was heard from the latter[1]. Pre-flight movements consist of lateral head-shakes in an alert, stretched-neck posture.

The photographs of adults accompanying this article (at pp. 170-171) illustrate the general appearance of the birds. The only previously published photographs of living Spectacled Eiders are those by Allen (1951), which were also taken at Igiak Bay.

Rearing of the Young

Of the eider eggs that were brought back from Alaska, only four hatched. The others probably became chilled for too long a period at a critical time in the development, probably after about a week of incubation. Downy Spectacled Eiders have been reared in captivity only once before, by Jack Kiracofe, who brought back 35 ducklings from Chevak, Alaska, in 1962. None, however, had been artificially incubated and reared before. Few Spectacled Eider duckling skins are present in collections, and the published illustrations all have certain shortcomings. The painting by Shortt in Kortright (1942) is particularly poor; the head pattern is entirely inaccurate and lacks any suggestion of 'spectacles'. The plate in Delacour (1959) by Peter Scott is also misleading; instead of being uniformly pale, the spectacle area should be almost the same tone of brown as the back and crown, being outlined in front, behind and below with buffy feathers. The photographs that accompany this article illustrate the extraordinarily grotesque head markings of the downy Spectacled Eider. Except for the head, the bird is a uniform pale brown above with pale grey underparts. The iris is dark brown, the bill is slate grey with a pinkish nail, and the feet are olive grey. The average weight of the four ducklings between 24 and 36 hours after hatching was 46 g., and the extremes were 44 and 49 g.

The young ducklings began to eat well almost immediately, and together with other ducklings of various species were fed boiled eggs and hamburger, Ralston game bird starter mix, and a high protein pellet preparation (Ralston Purina 'Trout Chow'). In addition, fresh green oats were available.

In their behaviour the ducklings were very reminiscent of Common Eider ducklings. Like ducklings of that species, they would frequently lift the bill in a manner much like the chin-lifting display of adult female eiders. Fairly loud cheeping notes, usually uttered in rapid series, were heard from the first day. The first indication of juvenal feathering appeared around the scapulars after 17 days, and the wing feathers first began to break through their sheaths after 21 days. Unfortunately, three of the four ducklings died at ages between 10 and 24 days, apparently as a result of an eye infection. The remaining bird, a female, was raised successfully.

Other species of Anatidae

Surprisingly, other species of eiders were uncommon or rare. We observed a few Pacific Eiders (*Somateria mollissima v-nigra* G. R. Gray) on the Kolomak River, and learned that they were much more common at the head of Igiak Bay near Cape Romanzof. We found only a single Pacific Eider nest. We located no nests of Steller's Eider (*Polysticta stelleri* Pallas), and observed only a single pair of this species. Apparently the Steller's Eider is now far more rare at Igiak Bay then it was during Brandt's expedition, since a young Eskimo from Paimut did not recognise coloured illustrations of Steller's Eiders. Other ducks that we found and determined to be nesting in the area were the following, listed in order of decreasing estimated abundance: Old Squaw (*Clangula hyemalis* (L.)), Pintail (*Anas acuta* L.), Green-winged Teal (*Anas crecca carolinensis* Gmelin), and Greater Scaup (*Aythya marila mariloides* (Vigors)). Whistling Swans (*Cygnus c. columbianus* (Ord)) were present in considerable numbers and nest throughout the region; eight eggs were collected between Igiak Bay and Bethel and were subsequently hatched and reared. Four species of geese nest at Igiak Bay. On the basis of nests found, the White-fronted Goose (*Anser albifrons frontalis* Baird) was the

[1] I have since heard captive males in Jack Kiracofe's collection utter a very faint 'hoo-hoo' during their 'head-forward-rearing' display. This is very similar to, but much weaker than, the call uttered by Common Eiders during 'Cooing movement 3'.

most abundant breeder. The Emperor Goose (*Anser canagicus* (Sewastianow)) was present in much larger numbers, but somewhat fewer nests of it were found. Cackling Geese (*Branta canadensis minima* Ridgway) were abundant and several nests were located. A single pair of a distinctly larger Canada Goose judged to be Taverner's Canada Goose (*B. c. taverneri* Delacour) was found nesting as well. Brandt likewise found a single nest of a 'Lesser' Canada Goose in the Igiak Bay region and believed that the form should be regarded as a species distinct from the Cackling Goose. Several of the Cackling Geese of this area were observed to possess a white band at the base of the black neck, a feature characteristic of the very rare Aleutian Goose (*B. c. leucopareia* (Brandt)) but which is of irregular occurrence in the Cackling Goose. Several small flocks of Black-bellied Brant (*Branta bernicla orientalis* Tougarinov) were observed, and one definite nest of this species was found. This possibly represents the first nesting record for Igiak Bay, for although the Brant is now an extremely abundant nester in the Hazen Bay area not far south of Hooper Bay, Brandt and Conover found no indication of nesting in 1924, and were unaware of a nesting ground to the south of Hooper Bay. We left the area too early to determine whether the Black Scoter (*Melanitta nigra americana* (Swainson)) nested there, but only a single male was observed during our stay.

Acknowledgements

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Spectacled Eiders

Lake Rezaiyeh: a specialised summer habitat for Shelduck and Flamingos

CHRISTOPHER SAVAGE

Summary

Common Shelduck (*Tadorna tadorna*), to a lesser extent the Ruddy Shelduck (*T. ferruginea*), and the Greater Flamingo (*Phoenicopterus ruber roseus*) are summer visitors to Lake Rezaiyeh, in Iranian Azarbaijan, where they remain throughout the breeding season under conditions of extremely high salinity. In 1960 the Common Shelduck nested successfully in numbers but the Flamingo did not. The Common Shelduck were observed to congregate for their moult. The habitat is described in some detail, in particular the relationship between the lake salinity and the sole sources of food, the brine shrimp *Artemia* and the alga *Enteromorpha intestinalis*.

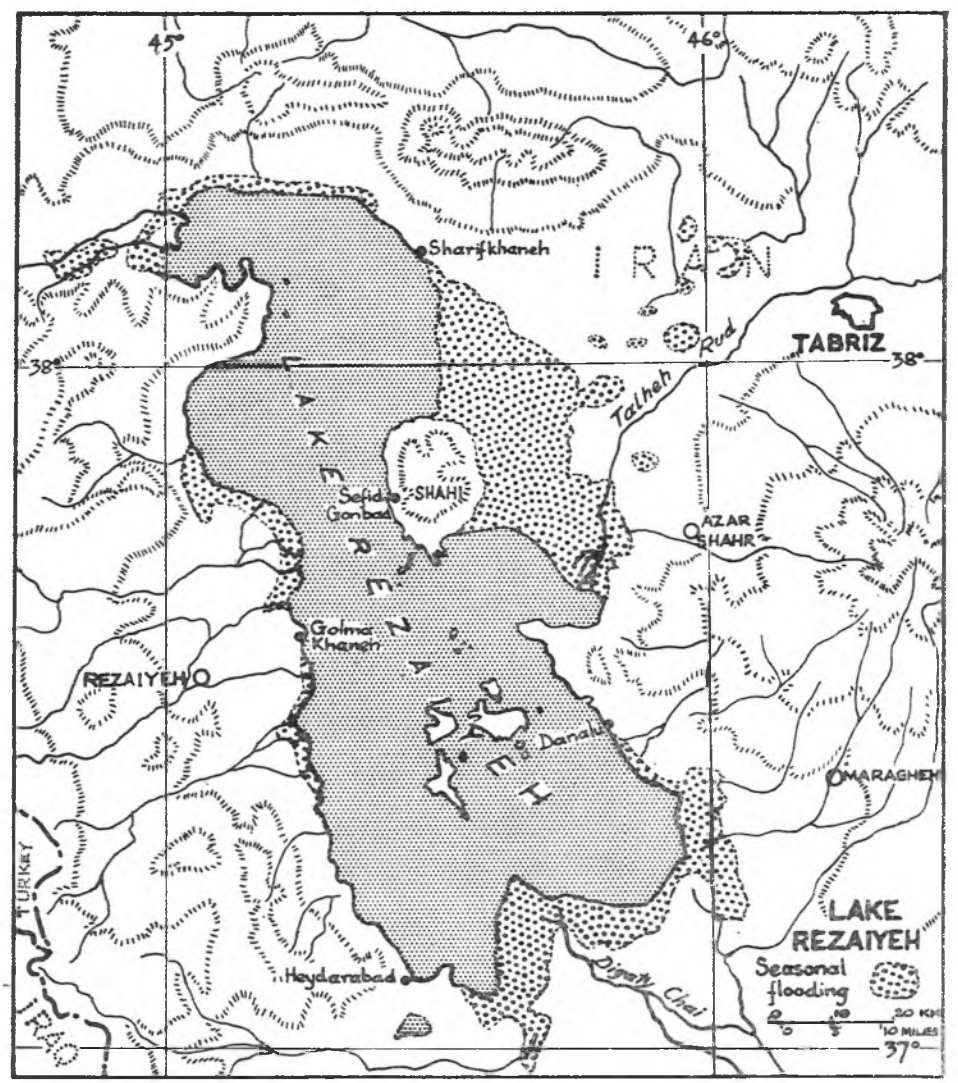

Figure 1. Lake Rezaiyeh and its environs.

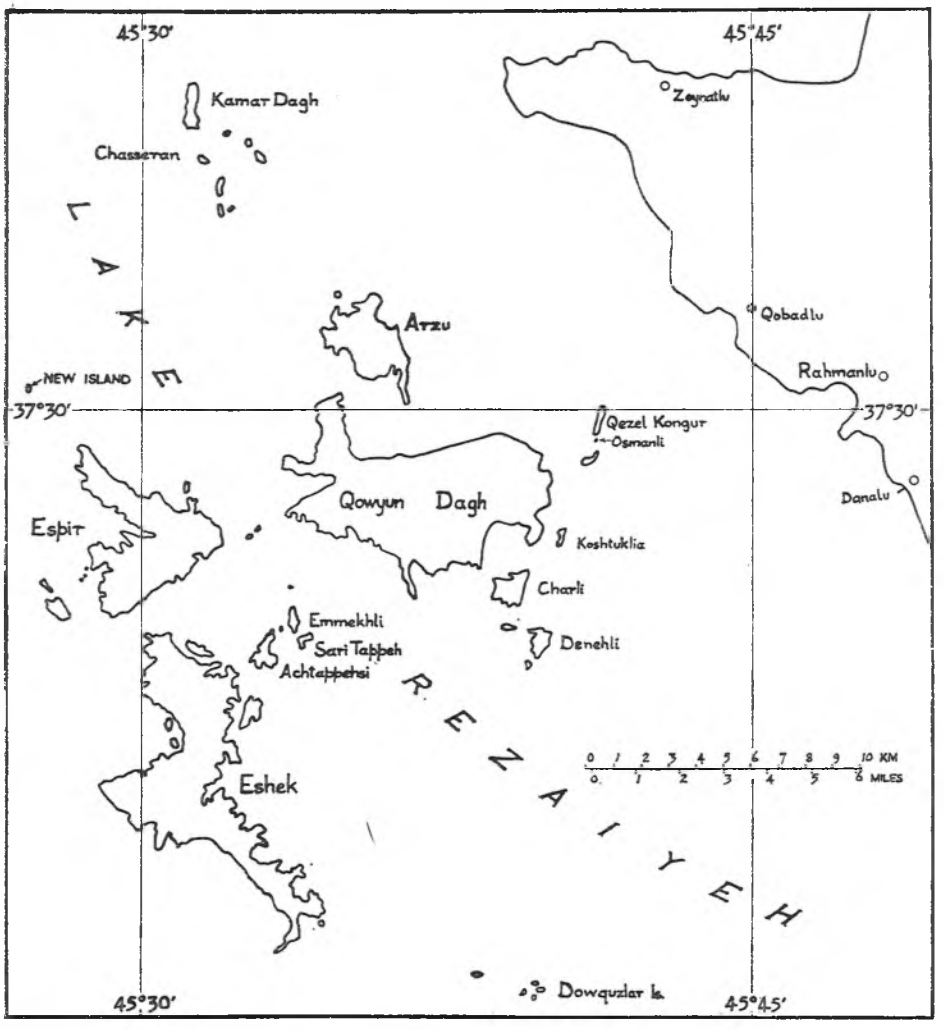

Figure 2. The islands in the southern part of Lake Rezaiyeh.

Lake Rezaiyeh, formerly Lake Urmia, is a great salt lake of nearly two thousand square miles in extent. It is situated in Iranian Azarbaijan, 110 miles south of Mount Ararat and 60 miles west of Tabriz. Although reasonably accessible, it is remarkably little known even locally, except to those who believe in the medicinal properties of the lake-side mud near the town of Rezaiyeh or Sharifkhaneh. There are no fish in the lake and the popular belief is that the lake is 'dead'.

On being posted to Tabriz in the spring of 1960 I was on the lookout for the White-headed Duck (*Oxyura leucocephala* (Scopoli)) and made close enquiries about Lake Rezaiyeh. I soon met Dr. Freidrich Plattner, Professor of Physiology at the University of Tabriz, who had already spent much of his spare time for a number of years canoeing on the lake. I learnt from him that the lake was far from dead, as at certain times of the year there were rich hatches of brine shrimp (*Artemia*), besides a growth of *Enteromorpha intestinalis*, an algal organism belonging to the family Ulvaceae. Moreover these two provided rich food for waterfowl, which seemed well worth looking into. Dr. Plattner's enthusiasm was so infectious that within a few weeks I purchased a second-hand outboard motor boat from Tehran and thenceforward spent every available spare moment exploring the lake.

The lake, its salinity and food resources

Lake Rezaiyeh is shallow throughout, with some fifty-six islands. All these except Shahi, which is now no longer an island, are uninhabited. Besides Shahi, the only island with fresh water is Qowyun Dagh, which has two springs. There are no boats on the lake except for an ancient steam tug which tows a lighter on a weekly service round the lake, mainly for the movement of cattle between the harbours of Sharifkhaneh, Golmakhaneh, Heydarabad, Danalu and Sefid Gonbad for Shahi. My soundings suggested an average depth of 15 feet and no more than 25 feet anywhere in the southern half of the lake. The lake has no outlet so that the seasonal inflow, which is mostly from snow melt, causes the lake to rise in spring up to six feet or more. Evaporation then lowers the level again throughout the summer and autumn. At the same time, the variations in the volume of water cause a range of salt concentration varying from a maximum of more than 28% by weight to as low as 8%. By comparison, the Dead Sea, having a seasonal variation in level of 10 to 15 feet and a mean depth of 1,080 feet, has a range of only 23 to 25% of salts.

The salts of the lake are very similar to those found in the sea, though in greater concentration. Typical analyses are given by Plattner (1955) as follows:

	Abich (*1855*)	*Hitchcock* (*1895*)	*Gunther and Manley* (*1898*)	*Plattner* (*1954*)
Cl'	57·75	58·20	57·33	57·50
SO_4''	5·12	3·75	5·06	4·78
CO_3''	–	–	–	0·08
Na'	34·00	36·40	33·98	34·08
K'	–	–	0·78	0·77
Ca''	0·22	0·24	0·32	0·25
Mg''	2·91	1·41	2·53	2·54
	100·00	100·00	100·00	100·00
Total solids in grams for 100 grams of liquid	22·07	20·55	14·85	20·09

The annual cycle of water levels and salt concentrations is best expressed on the accompanying idealised diagram (Figure 3, after Plattner). The bands for salt concentration and water levels are 'envelopes' for observations taken over a period of nearly ten years. Particularly regular features are the highest water levels in the first half of June and the highest water temperatures in August. The only food resources for waterfowl, *Enteromorpha* and *Artemia*, are closely related to this annual cycle. *Enteromorpha* precedes *Artemia* and disappears earlier, around August.

Enteromorpha grows in dense flat colonies on stony or sandy ground along the shores of the lake and islands wherever the water is shallow. From elevated points the plants can be seen under water as a continuous dark green band. Strong waves and surf will tear it loose, after which it floats at a shallow depth and is distributed by wind and currents over nearly the whole surface of the lake. Plattner (1960) found that whenever there is a year when salt concentrations remain around or below 20% *Enteromorpha* becomes so abundant that the whole lake looks like a vegetable soup. On the basis of random samples, he estimated in these years a production of 200,000 tons wet weight! In years of high salinity, as in 1960 when I made my observations, *Enteromorpha* is relatively scarce.

Artemia begin to appear in April but do not build up in great strength till June. Successive hatches keep numbers up till September when they become noticeably fewer. Dr. Plattner found in the laboratory that they did not hatch out at salt concentrations higher than 11%, from which he deduced that hatching must occur mainly outside the mouths of perennial rivers where salt concentrations are lower. The only rivers of that description are the Tatau Cham and Digati Chai in the south. The Talheh Rud, although an important tributary in winter, dwindles to almost nothing in summer. It is significant that Dr. Plattner also found that salt concentrations sampled in the southern basin always lagged behind those taken simultaneously in the north, at Sharifkhaneh for example.

After hatching *Artemia* appear to be moved northwards and spread over the lake by the winds and currents. In June and July, when there are often storms on the lake with strong winds from the south and south-west it is noticeable that the Flamingos and Shelduck are mostly to be found round the Qowyun Dagh and the neighbouring islands where they can find shelter from the storms yet the winds bring them their food. Conversely, when there is less wind the Shelduck disperse and the Flamingos are to be found more often in the open waters of the southern basin or alongside the southern shore.

Shelduck – their nesting and moult

In early May, 1960, when searching for a suitable beach to make my base of operations, I found a number of pairs of both Common and Ruddy Shelduck (*Tadorna*

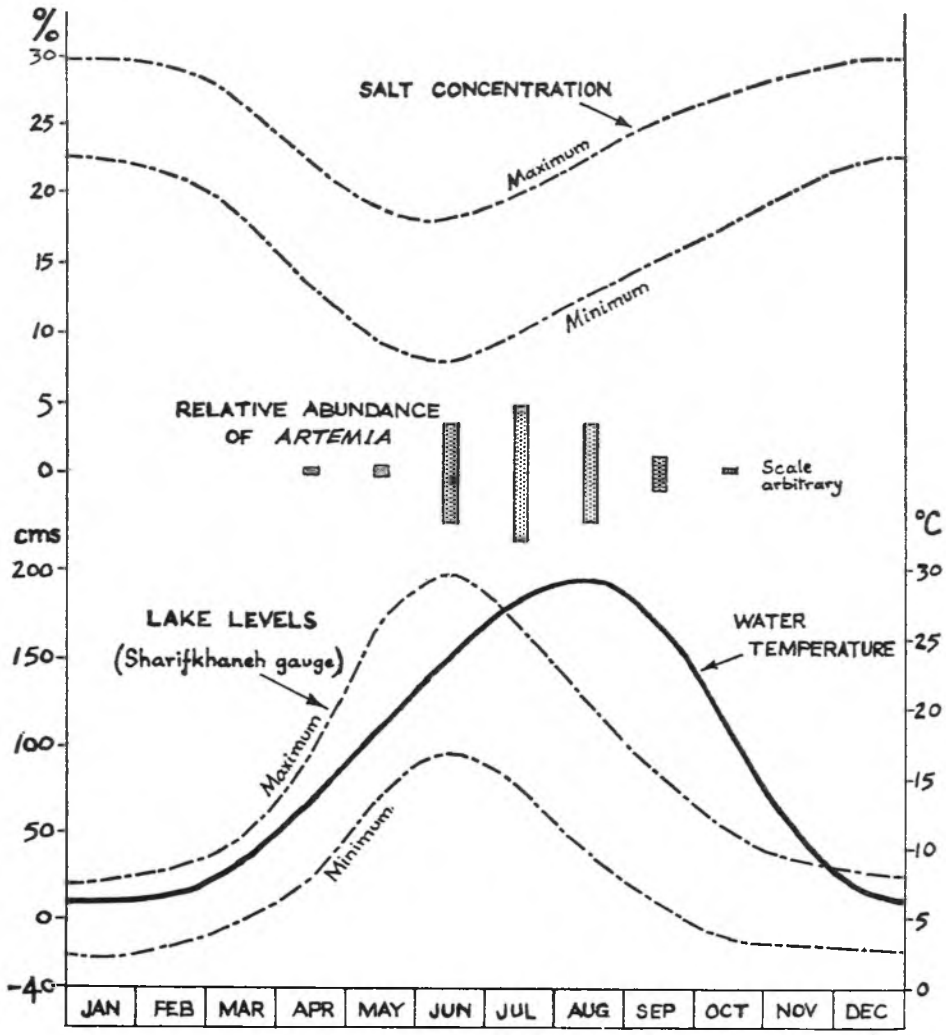

Figure 3. Relationship between relative abundance of *Artemia* (brine shrimp) and the annual cycles of water level, salt concentration and water temperature of Lake Rezaiyeh.

tadorna (L.) and *T. ferruginea* (Pallas)) in the neighbourhood of Rahmanlu. They could often be seen at dawn or dusk visiting some small pools of fresh water near the water's edge. The Ruddy Shelduck spent most of the rest of their time prospecting the gabbro cliffs. I found no signs of nests or young, though the local farmers informed me that they did nest along the tops of the cliffs in some years. This kind of site appears to be popular with *T. ferruginea*, for, about a week earlier, Admiral Furse, who was in the vicinity on a botanical expedition, encountered a pair nesting on a high cliff several miles north of Lake Van. I also heard later that in Azarbaijan these birds are often found several miles from the nearest water.

I saw little more of the Ruddy Shelduck but when I first visited Qowyun Dagh on 26th May there was a number of pairs of Common Shelduck, particularly around the southern side of the island where it has steep limestone cliffs. Three weeks later I found a nest in a crevice some twenty or more feet deep which could only just be crawled into and explored by torchlight. Such nesting sites abound, but are not easily reached, and since the islands are uninhabited they are as safe as a bird could wish.

The following week I made a long circuit of the islands to the south and west of Shahi which I found deserted except for a gullery. On the way back we visited the small island of Kamar Dagh which has

steep cliffs and rocky shores. Numbers of Shelduck were sitting around on the rocks and a little further on, near Chasseran Island, was a brood of twelve very newly hatched ducklings. On moving the boat towards them, the ducklings began diving freely, while the mother put on an impressive performance of the traditional 'broken wing' display. As we left, the mother rejoined them after a short flight round us to make certain all was clear.

At the end of June there were quantities of *Artemia* to be seen and millions of their eggs floated on the surface of the water, often being blown into tight mats several square feet in extent. The Shelduck fed avidly in the open water, on or just below the surface, so it was not possible to say whether they were eating the *Artemia* or their eggs.

At the beginning of July I had my first opportunity of investigating the southern shore of the lake, travelling via Qowyun Dagh to Heydarabad and back via the Dowquzlar Islands. We saw two or three pairs of Shelduck near Denehli but none further south. The only bird-life on the lake was a small party of Flamingos (*Phoenicopterus ruber roseus* (Pallas)) about five miles from land south of Qowyun Dagh. They appeared to have been feeding and seemed reluctant to move as we passed by.

For three weeks in July I was away. On my return on 4th August there were still quantities of *Artemia* but few eggs, and the rising salinity had caused white crusts to have formed on the rocks, sometimes up to eight feet above water level. Near Qezel Kongur (golden rocks) and the fist-like rock of Osman-li we found a flock of nearly three hundred Shelduck. Previously they had taken little notice of a boat till one was within 15 to 20 yards, but this time they swam off quickly; many scuttering over the surface like Steamer Ducks (*Tachyeres* sp.) off Tierra del Fuego. When we approached any individuals too rapidly however, they dived readily, as they do in Bridgwater Bay (King, 1960). Some of the birds were in immature plumage, but the majority were adults in moult. By 18th August the flock had dispersed over a wide area but most were still flightless. By 8th September they had completely dispersed and thereafter I only found small parties around outlying islands.

The Flamingos

The first Flamingo of the season was found in rough water west of Qowyun Dagh on 3rd June. On 5th June there was a party of twenty to thirty in a fjord-like creek on the east of Eshek Island. This particular creek proved to be a favourite haunt of both Flamingo and Shelduck, no doubt because the prevailing winds brought their food supplies from the south and the creek provided still water. It was near here that Dr. Plattner in other years often found the lake 'like vegetable soup'. Numbers soon built up to about a hundred at which they remained throughout the season. They would often be found resting on a sand bank at the southern tip of Arzu or frequenting the numerous little bays and creeks of that island or the neighbouring Qowyun Dagh.

At the beginning of September the lake level had fallen sufficiently to expose a small island about three miles north west of Espir. I had previously heard of the sailors talking of shallows in this area where the Flamingos would often be found. I had also been intrigued by the story that they would sometimes catch young ones in their hands! The place was difficult to find as it was not marked on any map and could only just be discerned from the headland of Espir now that the shallows had become an island. There were nearly thirty Flamingos there as well as a number of Shelduck. On approaching the Flamingos, I found that they were flightless, though some could manage to rise from the water sufficiently to run along the surface to get further away from the boat.

The island itself was almost entirely crystallised in salt but it was interesting to find preserved in the salt the signs of about twenty Flamingo 'nests'. The mounds were unmistakable. It is conceivable therefore that they may have nested there in previous years, though it is possible that the nests may have been only 'dummies' such as described by Brown (1959), and the 'young ones' captured by the boatmen could most likely have been moulting adults.

The same day as we visited the new island we found what were probably the remainder of the flock, numbering about eighty, along the southern shore near Heydarabad. These could all take flight. Some seemed larger than others but I judged them all to have been adults. There were quantities of *Enteromorpha* in the shallow water, where they had been feeding.

At this stage unfortunately I had to cease operations as the salinity was too high for the outboard motor and on more than one occasion I had been almost stranded due to crystallisation in the water circulation system.

Conclusions

It would seem to be no coincidence that the presence of the Shelduck and Flamingos is matched by the abundant seasonal food supply in Lake Rezaiyeh. Judging only from behaviour, it appeared that *Artemia* and

their eggs form the principal item of diet for the Shelduck, and that both *Artemia* and *Enteromorpha* provide the Flamingos with theirs. Both species benefit greatly from lack of human interference. But in spite of these favourable factors how, one may ask, can Shelduck and Flamingos survive in such highly saline conditions? Both species drink the water, with concentrations rising to 28% by weight, and they do not frequent the few fresh springs along the coast or even those on Qowyun Dagh. Brown (1959) describes how Lesser Flamingos living on soda lakes will apparently go to any lengths to drink fresh water, even at near boiling point. Dr. Plattner, being puzzled by this, made some laboratory experiments. A Shelduck which had been brought in winged by one of his staff was fed on *Artemia*, and was provided with lake water to drink. He noticed after a time that it would give a kind of sneeze accompanied by a shake of the head. On collecting the 'sneeze' he found a concentration of salt. This led to his discovery of large lachrymal glands situated above the eyes which are capable of excreting chlorides at a high concentration, thus helping the kidneys, whose capacity for chloride elimination is no higher than average in other animals. Flamingos from Rezaiyeh were found to have similar glands. Although such glands have been found in many marine birds (Schmidt-Nielsen *et al*, 1958) the problem does not appear to have been previously studied in relation to Flamingos.

Final note

No description of Lake Rezaiyeh would be complete without mention of the surprising beauty of the islands in summer. As the concentration of salt increases, the crystals scintillate in the sun as they form on the surface and then drop to the bottom. The water is so clear that one had the feeling of flying high over a vast snow field. The shore lines are encrusted in salt, but in the little pools among the rocks one still finds the *Artemia* which appear golden in the sunlight. From a high point on Qowyun Dagh, as one looks down on the surrounding islands, the colours are unbelievable. Although the only waterfowl on the lake are the Shelduck and Flamingos there are many other sights to delight the eye. I found Avocets nesting in early June on mud flats near Rahmanlu, Red-necked Phalaropes on passage in early September, the Red-billed Chough nesting among the cliffs of Qowyun Dagh, and vast quantities of Rock Doves, many of which made use of a special pigeon tower producing nearly a ton of guano a year for the landlord of Rahmanlu. On Qowyun Dagh there were also wild Moufflon introduced in the time of Mozaferedin Shah during the last century, but this is a story in itself (Savage 1960). Qowyun Dagh was proclaimed a Game Reserve in February, 1960, and in due course may become a National Park, for which it has all the attractions.

Acknowledgements

I most gratefully acknowledge the help of Dr. Freidrich Plattner whose enthusiasm and knowledge have been invaluable in solving some of the mysteries of Lake Rezaiyeh and in overcoming some of the physical difficulties involved.

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Winter appraisals of annual productivity in geese and other water birds

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Summary

Every nesting season stamps a visible record of its success or failure on fall populations of geese, swans, and some other water birds. Thanks to the distinctive first winter colouration of young of some species, and the persistence of broods ('families') and other functional groupings in some of these and other species, comprehensive studies of annual reproductive success and mortality can be made by methodical field scanning of wintering flocks. Winter survey methods developed for Blue, Snow and White-fronted Geese are discussed here in great detail, not only because of their intrinsic importance, but because they may provide clues for probing the vital statistics of other birds. Winter appraisals of productivity have the special advantages of being quick, simple and economical, and of providing information that is timely rather than historical. Their efficacy hinges upon competence of field observers. So long as observers remain afield the appraisals can take cognizance of biological as well as arithmetical aspects of current welfare of populations. By themselves the data from some winter appraisals may be sufficient for routine management of the robust species; used in concert with other surveys they may help solve many intricate problems in those bird populations that require special attention.

Inquiries into the mechanics of bird populations sometimes encounter an informational 'partial vacuum', in which further progress seems to evoke laboured exercises in abstruse mathematics. It is therefore refreshing to learn that populations of many of the geese, swans, and other water birds can be examined directly, and if need be in minute detail, by expedients that are relatively uncomplicated and pleasant. A mildly-sophisticated form of winter bird-watching, that exploits familial and other groupings and/or distinctive coloration of first winter young, serves to monitor annual status, mortality and reproductive success among Blue and Snow Geese, White-fronted Geese, and the other species discussed in this report. With application of simple actuarial arithmetic, the historical record of these winter observations can be made to yield vital statistics for these populations.

History of Development

Information that is reliable and timely is essential to effective conservation of wildfowl. At a bare minimum, this information should afford some idea as to annual status of each species. Management of birds that are heavily hunted requires more precise records of current mortality, increment, and other factors that affect status, so that hunting regulations and other conservation measures can be evaluated and brought up to date. Heroic action may be required to save a rare or endangered species, and such action, to be efficacious, calls for detailed, up-to-the-minute knowledge of ecology of environments, and of biological as well as arithmetical aspects of biotic potential in the species. In the tribe Anserini,[1] almost every genus has species that are robust and some that are not; it is often difficult to get detailed data for those populations that require special attention, unless it be adduced from studies of their more prosperous relatives. Of the investigational techniques formerly in common use, no one method could produce all the information needed for this group of birds. All conventional methods used together have fallen short of providing for some species information that is timely as well as comprehensive.

The first substantive data on numerical standing of various species of waterfowl in North America came from a midwinter 'inventory' or census that was conducted in January each year (Bell, 1937). This inventory was intended to produce numerical indices that would reflect trends in abundance, although its data often invited further interpretation not all of which was warranted. When it registered an increase one winter for a species that previously had been low in numbers, one might infer that mortality in that species had been lessened during the past calendar year, perhaps by protective measures, although it was equally possible that the nesting season just past had produced more than enough young to compensate for annual mortality. When a species showed decrease in numbers one winter, the decline might be thought to reflect high mortality, or poor productivity, or both during the past year. Or the discrepancy may have represented only census error. So long as inventory figures had to stand alone, without benefit of corroborative information from productivity sur-

[1](of Delacour and Mayr, 1945)

veys or other sources, they gave no clue as to the nature of changes in population status, and often left some doubt whether changes had indeed occurred.

Supporting information as to annual status of birds might be adduced from band records (Lincoln, 1930), but the Arctic-nesting geese, swans and brants had not been banded in numbers when our inquiry started in 1937. More recently, large-scale banding programmes are contributing materially to knowledge of distribution of these birds, their survival, and other vital statistics. However, banding data used alone have shortcomings (Boyd, 1959), and are more historical than current. Few band returns can be expected from species whose hunting is greatly curtailed or forbidden.

Nesting ground surveys each summer produce timely information as to breeding population levels and reproductive success, but such surveys of the American Anserini would have to cover each year vast breeding ranges that include much of the topside of the North American mainland and the Arctic Archipelago, and some portions of Asia. Even after 1947, when routine summer surveys were expanded to take in most of the breeding grounds of the American game ducks (Williams, 1948), they did not unearth much data on 'annual arithmetic' of the geese, swans and brants, although their explorations have contributed materially to better understanding of the nesting geography of these birds (Lynch and Smith, 1959).

The prevalence of young of the year in the fall population of a species reflects its annual reproductive success. Fall age-ratio information is important to waterfowl management even if only in subjective or percentage form. When taken together with an estimate of total birds in the fall population, the two types of data become complementary. Census figures make possible the conversion of percentages to total numbers of young and older birds. This information, if obtained for two consecutive years, can serve as a quantitative expression of net annual increment of young and can be made to disclose calendar year mortality of older birds (see later discussion of Population Plot). This record serves in turn to monitor the credibility (if not the absolute accuracy) of census counts, and provides a means of interpreting the trends the latter seem to indicate. Most methods of determining age in waterfowl in fall and winter (Mosby *et al*, 1960) require in-hand examination of specimens furnished by hunters or trapped in the course of banding operations, and so could not be used for species that were difficult to trap in winter, or that were not subject to hunting. Fortunately many of these 'difficult species', especially of the genera *Cygnus* and *Anser*,[1] display external features that may be exploited in winter surveys of annual productivity. The young of many of these have characteristic first-winter plumage by which they can be distinguished from older birds at considerable distance.

Since the Blue Goose (*Anser c. coerulescens* (L.)) is a form whose dark first winter young are conspicuously different from white-headed older birds, the authors began studies in 1937 in an effort to determine its annual productivity via field observations in Louisiana. This work later was expanded to include Continental populations of the Snow Geese (the Lesser Snow or white phase of *A. c. coerulescens* and Greater Snow *A. c. atlanticus* (Kennard)), and the White-fronted Goose (*Anser albifrons*). Somewhat similar studies were undertaken on the Blue Goose by the Canadian Wildlife Service in 1946 at James Bay, Ontario (Hewitt, 1950), and series of observations of this general type have been made in England on the White-fronted Goose (Boyd, 1957) and the Brent Goose (*Branta bernicla* (Burton, 1958)). Greater Snow Goose (*A. c. atlanticus*) observations by Howard (1940), the Whooping Crane (*Grus americana* (L.)) surveys described by Stevenson (1943), and the Trumpeter Swan (*Cygnus cygnus buccinator* (Richardson)) counts reported by Banko (1960) can be considered examples of winter appraisals of productivity. Boyd (1959) summarizes the potentialities and the accomplishments of these surveys. Most of these early studies involved a field sorting of young and older birds on the basis of plumage; in only a few instances were family and other groups considered.

Of additional value in population studies would be annual records of average number of young per brood, the proportion of adults that produced broods, the percentage of broods that had lost parents, and similar details of annual productivity and mortality. All species of the tribe Anserini (and of the Gruidae and some other birds) have strong social organization wherein young remain with parents as families through their first winter of life. This offered the possibility that rather comprehensive 'nesting studies' might be conducted on the wintering grounds of these waterfowl. At first our winter appraisals did not seek to explore fully this possibility, although families were recorded by some observers as a matter of convenience in

[1]Including *Chen*. The nomenclature used in this paper is that of P. Scott *A Coloured Key to the Wildfowl of the World*. Scribner's, New York. 1961.

keeping field notes. Eventually the more experienced observers noted that certain 'non-family' groupings were as conspicuous as the families, not only in the wintering flocks but also in field records. After 1947, the recording of all groups, non-family as well as family, became a standard practice in winter surveys.

That we elected to follow this course of action was due not so much to astute planning, as to the circumstances attending field observations in the Gulf Coast marshes. Geese wintering in this region seldom congregate on open water, or along exposed shores or sand bars where they would offer the observer an unrestricted look at all birds in a flock. They are more apt to be found deep in the vast marshlands or in weedy pastures or rice stubble, where settled birds are screened at least partially by vegetation. Only when these birds take wing can the observer see them clearly, and even then he is apt to be overwhelmed when a great flock of many thousands of birds is suddenly flushed or passes overhead. So we made a practice of seeking out each individual wintering flock when it was 'working' to a feeding or roosting area in a normal undisturbed manner. Thus most of our observations were made of flying birds at times when functional groups would be most conspicuous. Eventually we learned how to exploit the family and other group records, as is explained subsequently in this paper (see 'Population Plot'). Derivation of vital statistics from winter data is illustrated by the Whooping Crane analyses of Allen (1952) and Lynch (1956).

These appraisals are now routine each winter for Blue-, Snow- and White-fronted Geese, but are still exploratory for other birds. Survey data are collated and analysed annually in the Branch of Wildlife Research, Bureau of Sport Fisheries and Wildlife. Annual reports that are prepared for the information of wildlife administrators and survey co-operators are on file at Patuxent Wildlife Research Center, Laurel, Maryland, and at its Lafayette, Louisiana field station; and also at the Wildfowl Trust, Slimbridge.

The present paper describes these winter appraisals as an adjunct to, not a substitute for, other waterfowl fact-finding techniques. Their principal value is that they can produce, quickly and economically, rather precise and timely information on annual productivity for species that are amenable to such survey. When employed in concert with other surveys, they may help develop for some species a whole spectrum of vital knowledge that can be kept up-to-date.

Field Procedure

These appraisals involve direct field observations of living birds. In this regard they differ from some biometry, wherein the investigator remains quite aloof from the birds he is studying and contents himself with maintaining a clearing house to which comes information furnished by hunters or other co-operators. Our appraisals take a more 'personal' approach to the subjects. It must be acknowledged that this requires of field workers a keen interest in and a certain familiarity with wintering birds and their habits. Observers must be able to locate all important segments of wintering populations each year, and to scan them methodically so as to detect and record evidence of productivity. Being thus afield and in intimate contact with birds, they are also able to keep aware of environmental and other factors affecting the welfare of species.

In its simplest form this productivity appraisal would amount only to a tally of all first winter young and all older birds in sample wintering flocks, without reference to groups. The young Blue Goose has a dark head and body during most of its first winter (Bent, 1925), whereas 'yearling' (sub-adult) and adult Blues have white heads. The head and body of young Snow Geese and swans are dull white suffused with slate or dun in the fall, in marked contrast to the gleaming white plumage of adults and sub-adults. Among some other birds that might be candidates for these winter appraisals, first-winter young can be discerned when lighting conditions are favourable. In the case of the White-fronted Goose, for example, the cross barring on lower breast and belly of sub-adults and adults, and the unmarked underparts of first-winter young (Bent, 1925), can be seen when the sun is at a low angle, as in morning or evening, or when the birds pass directly overhead. Burton (1958) uses the presence of white edgings to the wing-coverts to distinguish first-winter Brent Geese (*Branta b. bernicla*).

Young of many of these species have been caught alive during the fall months, and held captive at an aviary in Lafayette, Louisiana to learn the dates when first winter colours gave way to adult-appearing yearling plumage. It was found that most young Blue Geese remain conspicuously different from older Blues as late as March, although care must be exercised in field identification of Blue Geese after January because precocious youngsters show some whitening of cheeks at midwinter. Young Snows become progressively whiter as winter advances, but traces of darker colour persist on dorsal aspect until birds enter midsummer moult. Some young

Whitefronts show individual dark feathers on the underparts by the end of January, but these do not begin to resemble the conspicuous dark blotches of yearling plumage until the month of June.

In the more detailed appraisal, the observer views a flock of wintering birds not as a casual aggregation of individuals, but rather as a congregation of families, mated pairs, 'yearling' (sub-adult) bands, and other meaningful groups of birds. These groups, and the diagnostic features of plumage, are most conspicuous when these birds are in flight and executing some manoeuver. A flock of feeding or roosting birds that is attracting newcomers provides an ideal situation for detailed observation. The settled birds serve as a decoy flock, and the observer can devote full attention to new arrivals. These arrivals first appear in the ragged V's or long strings that characterize the cross-country flight formation. As they approach the settled flock, their in-line formation will usually break up into families and other functional groups, and these often circle the decoys before landing. Groups should be identified and recorded in the interval between break up of formation and actual touch-down. With experience, the observer will learn the best time to identify these groups and their members. Groups may coalesce temporarily when flocks are excited or disturbed but, being the basic units of social organisation among the geese, they make themselves clearly evident when circumstances are favourable.

While incoming flight birds are the first choice for observation, groups that take wing and depart from the settled flock in a normal unexcited manner also are suitable. Complete appraisal counts can be made from birds passing overhead, provided they are moving such a short distance that functional groups do not tend to merge. Once the latter have coalesced into the larger flight formations, age-ratio counts may still be feasible but groups cannot be recorded. Birds that are settled on the ground or water are tallied only when they are not crowded, and when visibility is exceptionally favourable.

The experienced observer knows that sun angle, wind direction, and background (cloud masses and landscape) can influence his observations, and he learns to position himself so as to take advantage of these factors. As a general rule he will want the sun at his back. Birds land into the wind, so he may prefer to be located down wind from landing Snow Geese whose young have diagnostic markings on the back, upwind from species such as Blues (early winter) and Whitefronts, and across the wind from late-winter Blues and some other species.

Good field glasses are essential in this work. Most observers prefer glasses of 6- to 8-power. Greater magnification is advantageous for special studies, but reduces the field of vision, making the location and identification of fast-moving flying groups most difficult. 'Heat-shimmer' and other atmospheric distortion may be aggravated by great enlargement. When a team of two is available for the work, one man can serve as observer, calling out data to be recorded by the other. If one must work alone, he will find a battery-operated recording device most valuable.

We have adopted a standard field record sheet (Figure 1), and a routine method of calling out data. When only a simple age-ratio is desired from wintering birds, all obvious first winter young and all older birds all tallied (as in Item 1, Figure 1), without reference to groupings. If the average brood is to be determined, but no other data are wanted, counts would be confined to recognisable family groups.

In the complete appraisal of productivity, all groups are taken as they come, and there is no selectivity. As each group is identified, its members are entered in appropriate columns on this field sheet in the following manner (items are numbered as in Figure 1): (2) *A group having two adults and one or more young*, would be a normal family group (brood and parents) and is so entered in Figure 1; the number of

Figure 1. Productivity Appraisal: a Sample Field Record

Locality_____ Date_____ Size of Concentr._____ Obs._____

	(sp)	(Blue, snow, or other)		
	IN FAMILIES		NON-FAMILY	
	Adults	Young	Adults	Young
(Sample entries) Item (1)			5,3,4,2,etc.	2,2,3,etc.
(2)	2 —	— 3		
(3)	1 —	— 2		
(4)			2	
(5)				2
(6)	2 —	— 2 (and) —	1 (3 —	— 2)
(7)	(See #8-11)		(6 —	— 8)
(8)	2 —	— 1		
(9)	1 —	— 3		
(10)	0 —	— 2		
(11)	(See #1)		(Tot. Ads.	Tot. Young)
(12)	Ad. Blue	Ad. Snow	Young Blue	Young Snow
(13)	1 —	— 1	2 —	— 2
(14)	2 —	— 0	2 —	— 2
(15)	0 —	— 2	1 —	— 2
(16)	0 —	— 0	1 —	— 1
(17)	1 —	— 1	0 —	— 0

Figure 1. A sample Field Record of goose productivity.

young per fall or winter goose family usually ranges from one to five, occasionally to seven in the Blue and Snow and rarely to nine in the Whitefront. (3) *A family group with only one surviving adult* will appear now and then as hunting and other winter mortality make themselves felt on a concentration, and the prevalence of single-adult families enables us to monitor such mortality through the season. (4) *A group of two birds (or one to many)*, all in adult plumage and not accompanied by young, may represent full adults that have lost all young or failed to produce any, or they might be sub-adult yearlings (16 months of age in October and therefore not yet fully mature). Among Snows and Blues it is practically impossible to distinguish sub-adults from mature adults in the field. In the case of Whitefronts some yearling birds can be told from the more heavily marked adults and the unmarked young; while we do not attempt to make such differentiation in regular Whitefront surveys, separate yearling field records could be maintained in the course of special Whitefront appraisals. (5) *A group of two (or one to several) young birds*, not accompanied by older birds, probably represents 'orphans' that have lost both parents.

(6) *This group of three adult-plumaged and two young birds*, might show every evidence of being a family, but has an extra adult-plumaged bird. The frequency of such aberrations determines the method we employ in handling them. Where they are few (such as on the wintering grounds where our records show that the 'three-adult families' comprise less than 3% of all recorded families), we arbitrarily separate the group as has been done in Figure 1, to a family of two adults (with two young in this case), and non-family adults (one in this case). This odd grouping invites speculation that the 'ménage a trois' described in the Mute Swan (Dewar, 1936) may occur also in Blue and Snow Geese; in our captive flock there have been instances of a Blue gander 'pairing' with two females, although these arrangements did not progress to the nest-building stage. The important thing from the standpoint of surveys is that normal goose families should have only two parents; if odd groups are seen to be unusually common in study flocks, they are handled as described in Item 7.

(7) *Grouped adults and young, that fit none of the above categories* may be seen in some places, especially at migration stop-over points. When we encounter such in a wintering flock, we simply decide that the flock is too excited or disturbed for its groups to segregate properly that day, and re-schedule it for later appraisal at some time when it is more co-operative. Observers in the more northerly areas may not have this freedom of choice, for they are working with migrating flocks that could leave the area at any time. An alternative method of appraisal suitable for use under these circumstances involves a two-fold operation. One job is to determine the number of young and the number of parents in the 'average family'. Therefore, all families that can be identified as such (this includes all identifiable family remnants) are recorded as follows: (8) *An obvious family, two parents with young* (one in this case), (9) *An obvious single-adult family*, and (10) *A group of young, probably a brood remnant*, that has lost both parents. Along with family counts, *another separate record is maintained of all young birds and all older birds (as in Item 1)*, regardless of their groupings. This second operation provides us with an age-ratio for the concentration. Knowing the total number of birds in the latter (from aerial estimate or other total enumeration), we can estimate the total number of young in the concentration. Then, applying to the latter the ratio of family adults to young (average from Items 8, 9 and 10) we can estimate the total number of productive adults.

(12) *Mixed groups of blues and snows* are encountered whenever Blue Geese and Snow Geese are found in the same locality. To record these mixtures, we alter one of our field sheets as indicated in Figure 1, item 12, and tally the following: (13) *A family with one blue and one snow for parents*, having blues or snows or both among the young. Young snows can be distinguished from young blues without difficulty; we have seen cases where a very pale 'pearl-grey' young blue and a muddy or rust-discolored young snow might be confused, but these are extremely rare. As for adults and yearlings, all Blue Geese, whether the dark-bellied or white-bellied phase, are obviously 'blues'. We have never seen an adult Snow Goose that had traces of Blue Goose plumage such as could be detected at the distances these field observations are made. Other mixtures to be recorded are: (14) *A family having blue parents but some of its young are snows*, (15) *A family with snow parentage*, but some of its young are blue (this mixture is encountered too frequently on the Gulf Coast to be entirely accidental), (16) *An orphan group that includes both young blues and young snows*, and (17) *A pair of birds in adult plumage*, one of which is a blue and the other a snow; they may be recorded as indicated on Figure 1, or a separate record may be maintained for them at the bottom of the sheet.

There can be no substitute for experience and knowledge of the habits of these birds, although new observers seem able to master the techniques of appraisals in a remarkably short time. When the novice is able to work with an experienced observer, he will do well to start with the task of recording, meanwhile scanning the birds with field glasses as time permits. Then an hour or so of actual identification, under guidance, is usually ample to acquaint him with the rudiments of method. We have seen new observers attain a high degree of competence in this work after a few hours of practice. Many have become proficient without benefit of tutelage, although some made minor errors or omissions until they gained a better understanding of the social organisation among geese, and the purpose of the observations.

The data turned in by our corps of observers over the years assure us that accuracy can be developed and maintained in these appraisals. The work in Texas is launched each fall at Eagle Lake, where all observers, old and new, appraise productivity in selected flocks of Blue-, Snow- and White-fronted geese and compare results. At the start of the fall 1960 work in Texas, 8 observers turned in almost 5,000 snow goose records that averaged 49·0% young. The percent young among the individual sets of data from this locality ranged from 47·0% to 51·5%. An equally convincing picture may be seen in the fall 1959 productivity appraisal for continental Blue Geese (Lynch *et al.* 1959) wherein 14 observers turned in 17 sets of area records that totaled 30,861 birds, of which 51·4% were young; individual area records ranged from 48·0% to 56·9% young. Average brood, and ratio of productive adults to birds in adult plumage, can also be determined with consistency. In the course of a post-hunting season appraisal of a Louisiana flock of 45,000 Blue Geese in January 1961, 4 observers turned in 6 sets of records of over 6,600 birds, wherein the average brood figure ranged from 1·6 to 1·7, while the proportion of adult-plumaged birds that was productive ranged from 28·0% to 33·1%.

Productivity appraisals are usually made in late fall or early winter, when most birds have arrived on their wintering grounds but before hunting and other mortality have broken up families or otherwise distorted the picture of nest success. When possible they should be conducted during the same period that total counts are being made. Special appraisals to examine the effects of hunting or protection, as shown by the frequency of group remnants, may be started earlier in the fall, and repeated at intervals throughout the winter season. Special appraisals are also of value in critical banding studies, for they provide information as to the nature and composition of local populations at times of actual banding, and at times when banded birds are being recovered from those populations.

The Sampling Problem

Wintering Blue Geese are confined largely to Louisiana and Texas, and so it is possible for one or two observers to conduct a complete annual appraisal of productivity for this species. The Whitefront, the Lesser Snow and other candidates for these surveys are much more widely distributed in winter. Appraising their productivity calls for teamwork among several strategically located observers, and direction by a competent agency. Not all the birds of a wintering population will be tallied in the course of these surveys, so the problem of methodical sampling must be considered at all levels of the job. Fortunately the samples in these appraisals can be apportioned with direct reference to birds, and need not deal with populations through an intermediary such as the hunter or trapper. The matter of determining minimum adequate sample is seldom of concern in this work; once the observer is in proper position, his opportunity to get records is almost unlimited. Our fall 1960 regular and special appraisals amassed a grand total of 115,430 blue and snow goose records, and our 1959 records contained over 75,000 entries for the Blue Goose alone. But the matter of getting samples that are representative must be considered.

The responsibility for distribution of sample within any one flock and among the various flocks in one wintering region rests with individual observers. There is sometimes a tendency among new workers to focus too much attention on large families or certain other conspicuous groups in a flock. One way to avoid selectivity is to train the field glasses on a fixed spot in the path of incoming or passing small groups, recording every group that crosses the field of vision. Slow, methodical sweeping of the glasses across a wave of incoming birds, recording all groups, also helps assure proper sampling.

The various major flocks in a wintering region should all receive equivalent attention. These geese tend to be colonial both in their nesting habits and on the wintering grounds. Nesting failure one season may affect some colonies but not others, so the wintering flocks may show important disparity in their numbers of families and young. Great numbers of young produced

in one season may show up the following year (when 16 to 20 months old) in largely independent flocks of adult-appearing yearlings instead of mingling with productive adults and young. For these reasons we strive to sample every major flock in a region, and after a sample of about 5% of birds in any one flock is achieved, we move on to another.

Sometimes several major winter flocks will move into an area while one unit of observation is in progress. In some regions, almost all of the major wintering flocks may move into a single refuge area. If productivity should vary greatly among these flocks, the sampling must be adjusted accordingly. We use a simple expedient to detect variability. As soon as any one column on a field sheet (Figure 1) is filled, we immediately start an entire new sheet, instead of trying to fill all columns on one sheet. Thus each record sheet becomes a miniature sample, valid for the time it was taken. Quick perusal of completed sheets will show whether new flights differ from earlier records to any important degree. Reconciliation of area or regional samples that are disproportionate is discussed under 'Computations'.

Aerial observers can discern first-winter young while flying over Blue and Snow Geese, swans and some other birds. Scouting by plane is therefore helpful in detecting variability, and in deciding whether flocks wintering in remote areas are so atypical as to warrant the special effort that would be required to reach them by boat or car for more detailed appraisal. Simple age-ratio may be ascertained from aircraft, either by visual counts or colour photography, but the meaningful groupings of geese are seldom apparent to the aerial observer.

Computations

When the appraisal seeks to determine only a simple age-ratio, all first-winter young and all older birds in the records (item 1, Figure 1) are totalled; this ratio is often expressed in terms of young to all older birds, although in winter work with geese it would be more realistic if expressed as a 3-way ratio (as in Table III), involving first-winter young (6 months old in December), yearlings (18 months), and mature adults. When complete appraisal has been made (items 2-6, Figure 1), all columns would be totalled, and grand totals of first-winter young, older birds, and all birds set forth. It then becomes possible to determine the percentage of adult-plumaged birds accompanied by broods, the average number of young per recognisable brood, and the average number of parents and young for all families or identifiable remnants thereof. These are indications of the magnitude of productivity, although some items are subject to further interpretation (see Population Plot).

Summaries can be made by simply adding the data from the field sheets if about the same percentage of birds is counted from each flock, area and region. Sometimes, however, it is difficult to sample each flock or area proportionately. The sample may be 15% or more of total birds in one area, and only 2 or 3% in another. If the flocks in these areas differ in proportion of young, a direct total will be biased. So it usually is better to weight the data before combining it. The weighting procedure is basically simple, and is done as shown in Table I. The percentage of birds counted in each category is multiplied by the total number of birds in the flock that was sampled. Instead of doing this flock by flock, we combine data from these flocks that have about the same proportion of young in them. Table II shows the weighted estimates for the group of data used as an example in Table I. The figures are rounded for final use, for they are not accurate to the digits shown in the tables.

Even carefully collected data may be interpreted incorrectly if gathered from only a part of the winter range of a species. For example, productivity appraisals of Snow Geese made in the Pacific Flyway in 1958 suggested that the birds wintering in California had a less successful nesting that year than the birds that came down the Central and Mississippi Flyways to the Gulf Coast. Yet the total California population was about 27% greater than it was the previous year. The reverse was true in the Gulf Coast, where productivity estim-

Table I. Method for weighting estimates in combining flock samples

	field data	*% of geese observed*	*weighted estimate*[1] *(tot. pop. 230,000)*
ADULTS			
In families	1,105	16·40	37,729
Not in families	4,567	67·80	155,940
Total adults	5,672	84·20	193,669
YOUNG			
In families	1,003	14·89	34,247
Not in families	61	0·91	2,084
Total young	1,064	15·80	36,331
TOTAL GEESE	6,736	100·00	230,000

[1] The figures are rounded for final use, for they are not accurate to the digits shown.

Table II. Weighted estimates for Blue Goose Stratum 2, South-west Louisiana 1958

locality	*Sabine*	*Crowley*	*Iota*	*Marsh Island*	*sub-total field data*	*weighted estimates*
TOTAL FAMILIES	147	28	222	203	600	20,486
FAMILY						
Adults	280	55	401	369	1,105	37,729
Young	248	50	327	378	1,003	34,247
NON-FAMILY						
Adults	1,275	170	1,754	1,368	4,567	155,940
Young	1	0	25	35	61	2,084
Total Ads.	1,555	225	2,155	1,737	5,672	193,669
Total Young	249	50	352	413	1,064	36,331
Total Birds	1,804	275	2,507	2,150	6,736	230,000
% Young	13·8	18·2	14·0	19·2	15·8	**
% Prod.*	18·0	24·4	18·6	21·2	19·5	**
Average Brood	1·7	1·7	1·5	1·8	1·6	**

* of birds in adult plumage
** to be recomputed when all strata combined

Table III. Comparison of annual productivity of the Blue Goose, 1949-59 (from winter appraisals)

year (fall of:)	*per cent imm.*	*ad:subad:imm ratio (in thous.)*	*aver. brood (fall)*	*field* % prod.*	*true** % prod.*
1949	47·6	90:108:180	2·1	46·4	100·0
1950	35·5	111:101:117	2·1	37·3	71·2
1951	11·2	177: 97: 35	1·6	13·2	16·0
1952	48·5	179: 23:190	2·4	66·7	75·0
1953	38·9	157:148:195	2·2	51·0	99·0
1954	1·8	200:134: 6	1·6	1·6	2·7
1955	54·9	200: 4:247	2·7	75·7	77·0
1956	31·8	117:143:121	2·1	30·7	68·0
1957	46·1	156: 73:196	2·3	62·5	91·6
1958	16·3	154:129: 55	1·6	19·7	36·0
1959	51·4	202: 39:255	2·5	75·0	89·6

* % of geese in adult plumage (including sub-adults) that brought young to the wintering-grounds.
** Probable % of mature adults (24 months of age or older) accompanied by broods in fall.

ates were higher but the population was lower. This anomaly, which was resolved when regional data were weighted and combined (Lynch and Singleton, 1958), could have been produced by some of the yearlings and non-productive adults shifting to the Pacific Flyway in 1958. Such a shift would tend to inflate productivity estimates for the Gulf Coast and depress estimates for California.

The 'field percentage of productive adults' (Table III) refers only to the ratio of productive adults to birds in adult plumage in fall, and determination of 'true' percentage of productive adults is discussed in the next section. The 'average brood' figure is derived from intact families that have at least one surviving parent, since orphan young probably have a much greater vulnerability (average of only 1·4 survivors per 'stray' young group in the fall of 1957) than would young with 1 or 2 parents (2·28 young per group at that time).

The data from 'mixed groups' of Blue and Snow Geese (items 12-17 in Figure 1) are for special study of the blue-snow complex (Cooch and Beardmore, 1959); while the method of gathering these data is described here, their analysis is beyond the scope of the present paper.

The geese discussed here are not known to nest in their first year of life. In analysing data from productivity appraisals, it is assumed that most if not all Blue, Snow and White-fronted Geese will attain sexual maturity at approximately 22 months of age, and may nest at age 24 months unless prevented from doing so by unfavourable breeding conditions. This determination is largely inferential, but is based on a wealth of data such as is presented in Table III. The high productivity among Blue Geese in the 1949, 1953, 1957, and 1959 nestings (Table III) could scarcely have been accomplished without considerable assistance from birds that nested successfully when only 24 months of age. Hanson and Smith (1950) present evidence that Canada Geese reach sexual maturity at a similar age. The present authors carefully refrain from citing breeding age of geese in 'years', for a female goose that reached sexual maturity and mated at age 22 months may lay eggs at age 24 months, while still '2 years old', but these eggs would not hatch until the parent was 25 months of age and therefore 'in her third year'. To avoid confusion, ages in geese are given in months from hatching.

It is recognised that some productive pairs may have lost all their young on the nesting grounds or en route south, and therefore will appear in our fall appraisal records as 'non-productive'. Various other components of goose populations will undergo some changes in the interval between the nesting season and the time we conduct our appraisals. These changes seem not to be of consequence in our analysis of data, for such analysis is largely on a calendar-year basis (see Population Plot), and is concerned primarily with net gains and losses. There are some obvious advantages in appraising the success of a waterfowl nesting season after, rather than during, the tumultuous period of hatching and rearing.

The Population Plot

The population plot is a graphic layout of data obtained from productivity appraisals and total inventories. It gives a picture of the history of the population that is helpful in following the progress of mortality and recruitment from year to year. It is especially useful when constructed for a period of several years. For simplicity, the method of making the plot will be explained on the basis of data collected during two successive annual surveys.

Figure 2 shows the population plot we constructed for calendar year 1957 Blue Geese from the data of 1956-57 and 1957-58. The total populations for each year are taken from the data of the midwinter aerial surveys. The numbers of young birds, adult-plumaged birds, and adult birds accompanied by young are from the productivity appraisals. Our working data for the period are:

winter of:	*1956-57*	*1957-58*
Total population (midwinter)	380,000	425,000
Per cent young (winter)	31·8	46·1
Per cent productive, of birds in adult plumage (winter)		62·5
Average brood (winter)		2·3
Average August brood (estimated)		3·3

First, the total figures (from January surveys) are plotted for calendar year 1957 and 1958 at points 'B' and 'C' respectively. We know from the 1956 productivity appraisal that 31·8% of the January 1957 population were young birds, so point 'a' can be located (reading from 'B' to 'A'). Point 'b' also can be plotted since our fall 1957 appraisal showed that 46·1% of Blue Geese at the end of 1957 were young. Then the line from the base point 'A' to 'a' represents the 259,200 adults and advanced sub-adults, and line 'a-B' represents the 120,800 young (from 1956 hatch) that are becoming yearlings at the start of 1957. Line 'D-b' represents the number of adults and advanced sub-adults, and line 'b-C' the number of new young surviving at the end of calendar year 1957.

Mortality can be expected to be somewhat disproportionate between adults and sub-adults, but banding returns (personal communications, F. G. Cooch, Canadian Wildlife Service) offer assurance that it is not greatly so. Therefore, we assume that the ratio of adults to sub-adults at the start of 1957 was still the same at the end of the year. This enables us to locate point 'c' (31·8% of line 'b-D'), and line 'D-c' then represents the approximate number of breeding-age adults at the end of the year. Line 'c-b' represents the 72,800 birds from the 1956 hatch that now are advanced yearlings. Productivity appraisals showed that 62·5% of birds in adult plumage at the end of 1957 were accompanied by young. When computed, 62·5% of the 229,100 birds in adult plumage (line 'D-b') amounts to 143,200 productive adults, shown as point 'd'. Since the total number of mature adults (line 'D-c') was 156,300 at the end of 1957, the 143,200 productive adults (line 'D-d') would represent a nesting success of 91·6% among eligible breeders. This is the 'true' percentage of productive adults (Table III) rather than the 'field' percentage of adult-plumaged birds (full adults and sub-adults).

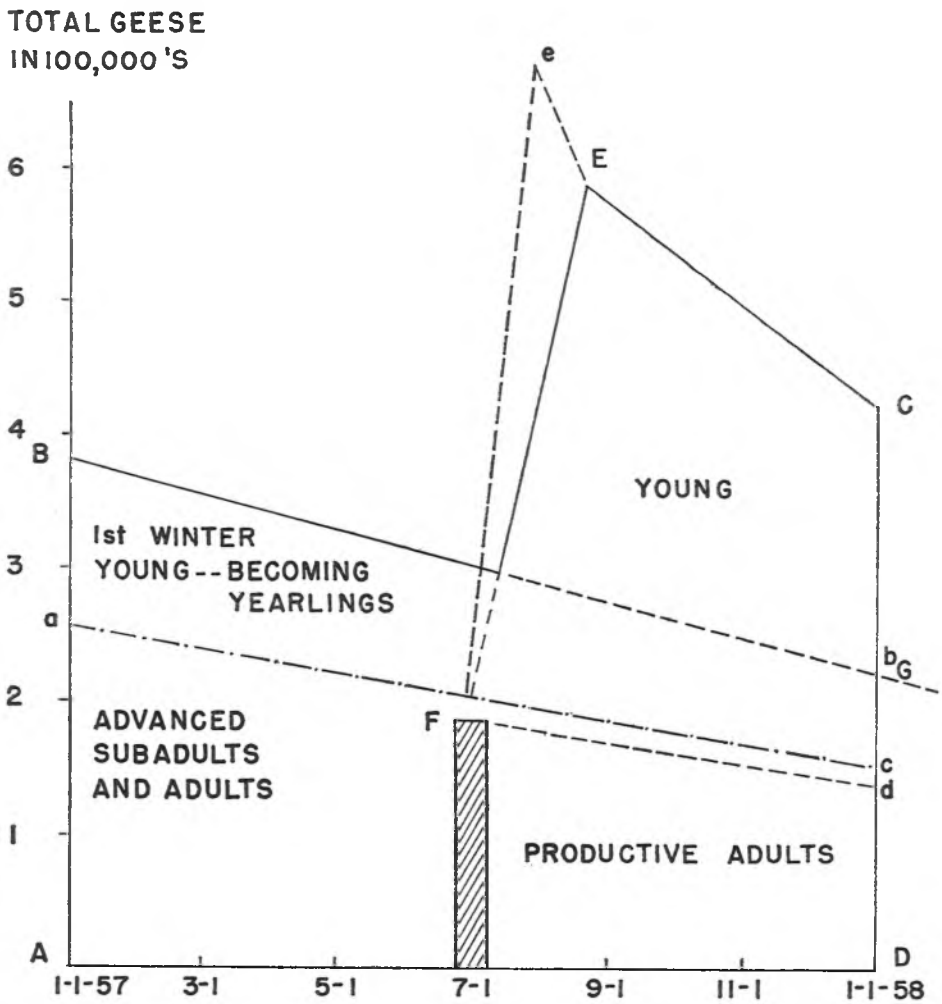

Figure 2. A sample population plot, from the 1957 Blue Goose surveys.

An average annual mortality rate can be estimated here since we know the total number of birds the first year and the number of these surviving to the second year (points 'B' and 'b' on Figure 2). Assuming constant rates, we may then approximate the number living either at an intermediate time like July or at some later time such as the following spring. The graphical method depicted by the population plot seems adequate for present purposes even though using a straight line plotted on an arithmetic scale, as in Figure 2, implies literally that the proportional rate of mortality is continuously increasing.

A rough approximation of mortality of young of the year can be made by using brood figures from nesting-ground studies in combination with our data as follows. The July point on line 'B-b' suggests that there were about 300,000 adult-plumaged birds present then. We found in the fall that about 62·5% of the adult-plumaged birds were accompanied by young. If we assume that this same percentage were successful breeders in July, then we can estimate their number at 187,500 (62·5% of the 300,000 adult-plumaged birds presumably present in July). This number is shown at point 'F'. If broods averaged 3·3 goslings at Class III stage (fledged but not flying), this would mean that the 93,750 pairs (assuming an even sex ratio) contributed 309,400 advanced goslings to the population. This number is plotted at point 'E'. If we knew from breeding-grounds observations the average number of goslings per Class I (downy) brood, we could locate point 'e' as an approximation of the total number of goslings produced for the

season. Mortality is shown by the line 'E-C' or 'e-E-C'.

When accurate population plots are available for several consecutive years, the histories of each year's population can be traced. Turnover rates and rates of population replacement may be examined. Life expectancies and other vital statistics also can be calculated by methods described by Petrides (1949) and Farner (1955). Survival curves we calculated for Blue Geese were very similar to those calculated from band returns (personal communication, F. G. Cooch). Longevity figures produced by both methods also were similar.

Estimates of Total Numbers

Since a knowledge of total numbers of birds in populations is of great value in organising productivity appraisals and in exploiting the data they produce, we report here certain refinements that improve the accuracy of visual estimates of waterfowl numbers. Continental goose populations are enumerated during the midwinter waterfowl surveys described by Bell (1937). Other counts of area and regional flocks may be made during each fall and winter for the guidance of productivity appraisals and for special purposes. These 'counts' are actually visual estimates, usually made from aircraft, of total numbers of birds in each concentration. Goose counts present fewer problems and can attain greater accuracy than census of some other waterfowl. Most geese frequent open terrain during the winter period, and usually all birds take wing simultaneously when a goose flock is approached by an aircraft. Unlike some ducks of the wooded swamps or large open waters, all wintering geese can be found with adequate search, and since they can be seen, they can be enumerated. Furthermore the application of productivity data to total population figures over a period of years provides a means of monitoring the credibility (if not the absolute accuracy) of the historical record of numerical estimates for a species.

Census work among the geese is not without problems. The task of locating all the important flocks in some far-flung wintering regions is somewhat formidable, and calls for experienced survey teams that have intimate knowledge of the birds and their ranges. Many of these winter ranges were almost inaccessible at one time, but now are flown at frequent intervals by private and business aircraft as well as by pilots of conservation agencies. Most major goose concentrations are therefore under almost constant surveillance throughout the winter period. Exchange of information among these many observers simplifies the task of locating concentrations.

The reliability of visual estimates of numbers in large flocks of birds is an aspect of census work that evokes more critical than constructive comment. Perhaps some are prone to think that an ability to estimate numbers is a faculty with which a few gifted individuals are endowed at birth. In reality, such ability is nothing more than a skill that can be developed by anyone given normal eyesight and appropriate training. But development of such skill is of little avail if proficiency in the skill is not maintained and brought up to its highest possible level at the instant counts are to be made.

To improve accuracy of the estimates we employ a series of transparent plastic sheets, marked with crayon or 'glass-marking' pencil to represent flocks of various numbers in various formations. Cellulose-acetate or -nitrate sheets were first used in open-cockpit aircraft, but the development of the vinyl, polyethylene and other plastics of 6- and 8-mil thickness gave us pliable sheets that proved much more convenient for use in modern aircraft. All observers, regardless of their prior experience, seem to profit from a concentrated scanning of these training devices before making any aerial counts. These sheets with their known numbers of 'birds' can be held up to the aircraft windshield during census flights, for comparison with actual flocks of geese against any background. Materials for these sheets may be found at upholstery and stationery counters in any dry-goods store, and their preparation requires no special equipment. In emergencies, we have used for this purpose standard plastic 'freezer bags' that were marked with ballpoint pen, and have even resorted to marking model 'flocks' on the windshield of the aircraft. Other training devices are described by Spinner (1953). Any type of training device will serve the purpose, so long as it is used conscientiously to develop and maintain skills, and affords a standard for ready reference.

A portion of a sheet deliberately folded back upon itself several times serves to illustrate some facets of the problem of estimating numbers. Ground observers who approach a large flock of geese may see only a veritable maelstrom of objects, moving in many directions and on many planes, and have no way of determining the dimensions of this confused mass. To the aerial observer, the same flock is seen moving in one direction on a single plane. The advantages of aerial estimates in this instance are quite obvious. When very large concentrations of geese (as

great as 50,000 birds or more) are encountered by aerial observers, the pilot may split them up into more convenient units by judicious herding. Aerial photography is also of value in estimating numbers, provided that weather and background are favourable and the subjects are reasonably 'photogenic'.

Appraising Productivity in Other Species

The methods we describe for Blue, Snow and White-fronted Geese can be used with only minor changes for other birds whose first winter young are identifiable in the field and who stay in family groups. This 'Category 1' of candidates for winter appraisal of productivity would include all American geese except the Canada and its races, and would encompass the Whistling Swan (*Cygnus c. columbianus* (Ord)) and Trumpeter Swan, Atlantic Brent, Black Brant (*Branta bernicla orientalis* Tougarinov), Whooping Crane and Sandhill Crane (*Grus canadensis* L.), and perhaps some Old World waterfowl and wading birds.

Modifications of method for birds of other categories are now in various stages of development. Category 2 birds would include waders such as the Little Blue Heron (*Florida caerulea* (L.)) and sea birds like the Herring Gull (*Larus argentatus*) whose young have distinctive first winter plumage but whose broods soon lose their identity. Category 3 comprises certain Arctic-nesting ducks such as Eiders (*Somateria* spp.) and Goldeneyes (*Bucephala* spp.) whose first winter young resemble in plumage the adult female but not the adult male. Much remains to be learned about sequence of plumages in some of these candidates, although study of captive specimens is helping to shed light on this subject.

In Category 4 are birds such as the Canada Goose (*Branta canadensis* and subspp.) whose first-winter young cannot readily be distinguished from adults and sub-adults in the field, but whose families, sub-adults and mated pairs have distinctive flocking patterns. Elder and Elder (1949) and Hanson and Smith (1950) suggested that fall average group counts of Canada Geese might reflect prevalence of families and could therefore be used to determine annual productivity. This thesis was challenged by Lebret (1956), who pointed out that some groups of family size in the Whitefront might be bands of yearlings.

Since our appraisals of Blue and Snow Geese and other Category 1 species recorded all groupings as well as ages of birds, their data could be analysed as though representative of species of Category 4. Such study showed (Lynch *et al.*, 1959) that the size of the average group in fall populations of these species varied directly with their percentage of young, under our conditions of observation (which, as previously stipulated, would tend to favour recognition of basic groups). This analysis also disclosed that the bands of yearlings designated as 'pseudo-families' by Lebret (*op. cit.*) and generally thought to number several to many birds per group, actually averaged two birds per group in our observations (Lynch *et al.*, 1960). Even in winters such as 1949-50, 1953-54, and 1957-58, when most fully adult Blue Geese had young and therefore appeared in our records (Table III) as larger 'family groups', the small bands of adult-appearing Blues not accompanied by young (undoubtedly yearlings) still averaged two birds per group. It would perhaps be mere rationalisation to suggest that an old brood bond that had persisted more than a year, or a newly-forming mating bond, either of which would tend to be of two birds or thereabouts, would be stronger than the bond that held together any larger, more casual aggregation of unrelated birds. Yet it is pure speculation to suggest that the latter would invariably override the former.

In any event, we now use fall average-group counts to determine whether distant flocks of Blues, Snows, and Whitefronts are worthy of closer inspection, having learned from special appraisals that this procedure gives acceptable results and saves much field travel. There is every reason to hope that similar group counts can be made to reflect fall *per cent* young in the Canada Geese, provided observations are carried on at times when basic groups would be most conspicuous.

Acknowledgement

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Charles D. Evans and C. E. Addy have pioneered the use of these appraisals on geese of the Pacific and Atlantic coasts and have contributed refinements in method. M. C. Hammond achieved important advances in developing appraisals for whitefronts and swans. As the appraisals expanded further to become continental in scope, many co-operators joined in to help; we here acknowledge the competence and enthusiasm of all these workers, and their individual contributions are set forth in our various annual reports. We have been particularly fortunate in having the wholehearted co-operation of F. Graham Cooch, Alexander Dzubin, and other biologists of the Canadian Wildlife Service who have been working in recent years on the nesting grounds of the species we have been studying. To C. R. Lynch go thanks for avicultural services and plumage observations of captive birds at Lafayette.

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A preliminary study of the breeding biology of Ross's Goose

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Summary

Studies of a breeding colony of Ross's Goose in the Perry River region, N.W.T. from June to August, 1963 are reported. The first geese arrived on 5th June, probably about 10 days later than usual. The first eggs were laid on 9th June. No courtship was seen and copulation probably occurred somewhere further south. Nests are made on islands in lakes, preferably in cover provided by scrub or rocks. Nests on open moss are larger than those in sheltered places. Nesting territories, which were fiercely defended, may be as small as 150 sq. ft. Eggs are usually laid daily. The average size of 769 clutches was 3·67, range 1-6 eggs. Egg size did not vary with sequence in the clutch. The female alone incubates for 23-24 days from the laying of the last egg. 90 of 93 nests (96·7%) were successful, and 93·5% of eggs laid hatched. Though the goslings are polymorphic, 75% of broods were monomorphic. 1963 was mild but in some years bad weather may be a serious mortality factor. Some goslings died after being trapped in bushes or in crevices. Predation, by gulls and jaegers, is slight. There was an unexpected excess of males in yearlings caught for banding.

Ross's Goose (*Anser rossii* Cassin) breeds primarily in the Queen Maud Gulf region of the central Canadian Arctic. It has also been recorded in the Lesser Snow Goose (*A. c. caerulescens* (L.)) colonies on both Southampton and Banks Islands. All known nesting grounds of Ross's Goose are within Migratory Bird Sanctuaries administered by the Canadian Wildlife Service. Ross's Goose was first described by Samuel Hearne in 1772 from observations made during his search for the Coppermine River. However, the nesting grounds were not discovered until June, 1940 when Angus Gavin, manager of the Hudson's Bay Company trading post at Perry River, was successful in a direct attempt to find them. The nesting grounds of the Ross's Goose were the last to be discovered among those of the native North American geese. Subsequent investigations in the Perry River region have been few. Hanson, Queneau and Scott (1956) obtained considerable data on nesting Ross's Geese, but unfortunately were not present at a colony for the entire season. MacInnes and Weske (1962) spent part of July and August in the region surveying banding potential there.

In the spring of 1963, the author, supported by the Canadian Wildlife Service, initiated an intensive study of the breeding biology of Ross's Geese. The present report is based on the results of the first seasons' work. Included in the report are winter inventories from 1961 and 1962, by courtesy of the United States Fish and Wildlife Service. The population estimates and location of major nesting colonies are from aerial surveys by the Canadian Wildlife Service.

Population status

Over the past two decades there has been an apparent increase in the total population of Ross's Geese. Estimations made in the 1940's were done primarily on the wintering grounds of the species and put the population at five to six thousand. Hanson *et al.* (1956), were the first to count Ross's Geese along the Queen Maud Gulf and estimated two thousand in the region between the Perry River and the Simpson River. In July and August, 1960 Canadian Wildlife biologists surveyed the Central Canadian Arctic in an effort to map out and count geese numbers on the major nesting colonies. From this survey much valuable information was obtained as to the whereabouts of the greatest concentrations of Ross's Geese. The survey extended from the Anderson River on the west to Sherman Inlet on the east. Nesting areas between these two points included Victoria Island, Banks Island and the mainland of the Queen Maud Gulf. Nine thousand Ross's Geese were counted along the Gulf and two hundred (+) on Banks Island. At the time of the survey over the Queen Maud Gulf (16th-22nd August, 1960), many of the geese had completed their post-nuptial moult and were able to fly. Consequently, many of the birds were situated a considerable distance from their nesting sites. However, a large number was concentrated around a large unnamed lake (67°20′N, 98°25′W) and river which flows into McLauglin Bay of the Queen Maud Gulf, one-hundred miles east of the Perry River (T. W. Barry, personal communication). The size and location of other colonies are listed in Table I.

Figures obtained from aerial surveys of the wintering grounds in California show that the number now stands in the vicinity of twenty-five thousand and Mr. A. Dzubin estimates the population to be from 35,000-40,000 from counts made on the

Table I. Sites and size of known breeding colonies of Ross's Geese

location	*numbers*	
Banks Island (72°N, 123°W)	200+	(est.)
Queen Maud Gulf Mainland	9,000	(est.)
Atkinson Pt. (67°55′N, 103°W)	48	
Perry River (67°42′N, 102°15′W)	282	
Ogden Bay River (67°40′N, 101°30′W)	12	
Pitok River (67°42′N, 101°18′W)	22	
Simpson River (67°45′N, 100°40′W)	101	
McLauglin Lake and River (67°45′N, 98°25′W)	2,365	

comparatively narrow migration route in south-western Saskatchewan (see MacInnes, 1964).

Ross's Geese also occur in the Hudson and James Bay areas of the eastern Canadian Arctic. The first record was that of Hearne in 1772, when he reported flocks of them near Churchill, Manitoba (Hearne, 1795). Subsequent investigations by Cooch (1954), Barry and Eisenhart (1958) and MacInnes and Cooch (1963), indicate that the species has inhabited the eastern Arctic for a long time and that the distribution in this area does not necessarily represent an extension of the range eastward from the Perry River region, but simply is the result of increased activity of Arctic ornithologists. Perhaps with the gradual accumulation of data concerning the breeding biology and distribution of Ross's Geese it will no longer be considered a relict and vanishing species.

Topography of the Region

The Queen Maud Gulf region is described admirably by Hanson *et al.* (1956) as follows: 'The Ellice River-MacAlpine Lake-Simpson River-Queen Maud Gulf quadrangle is underlaid by folded, foliated, pre-Cambrian rocks of varying hardness. Relief is generally low. Glaciation and differential erosion have frequently produced a "banded" topography of parallel ridges separated by elongated, roughly parallel lakes or river courses. This relief is more pronounced where the strike of the formation approximates the northerly direction of past glacial movement. Many parts of the area are underlaid by massive rocks of more uniform character which has resulted in a low, rounded "mamillated" topography. The terrain occasionally has a rather rugged appearance due to "crag-and-tail" and "roches moutonnees" hills, which in the more extensive tundra areas "crop up like seal-heads in the sea". Actually the term "whalebacks" would be more appropriate in some cases than Knud Rasmussen's simile. The altitude of the hills at the coast does not exceed 200 feet; inland the ground rises gradually to a maximum of 800 feet just north of MacAlpine Lake.'

The Ross's Goose colony studied is located at Arlone Lake, N.W.T. (67°22′N, 102°10′W), approximately twenty-five miles inland. There are eight islands on the lake, six of which are utilized by Ross's and Lesser Snow Geese. The two islands at the south end of the lake are too high and steep sided for suitable nesting sites (Hanson *et al.*, 1956). In Figure 1 the islands are designated by letters, as assigned by Hanson. Their approximate dimensions are shown in Table II.

Table II. Dimensions of breeding islands, Arlone Lake, N.W.T.

island	*area in square metres*
A	8,536
B_1	24,021
B_2	4,745
C	8,036
D	13,482
E	17,100
Total area	75,920

The immediate vicinity of the Arlone Lake is surrounded by low drumlins. The flat terrain between the hills is composed of tundra corrugations, each corrugation being approximately one foot high.

The lake is shallow (approximately 10 feet) and turbid due to the constant wind. At no time during the season was the bottom visible.

Gavin (1945) recorded –59°F as the coldest winter temperature. During the summer of 1963 we recorded 82°F on 30th June and 6th July. For weekly means see Table III. The winds are almost continuous, the maximum being estimated at 40 m.p.h. from 6th-9th June, 1963. The mean summer wind velocity approaches 15-20 m.p.h., primarily from the N.E. and N.W.

The ice on the lake started to break up during the first week in June, and by 7th June four to six inches of water were present on the surface of the lake. Bottom ice continually rose to the surface throughout the major part of the nesting season.

Snow cover upon our arrival at Arlone Lake on 2nd June was 85%. No snow cover existed by 12th June, except on the sides of the drumlins, where deep drifts persisted well into July. The islands were free of snow by the middle of the second week in June.

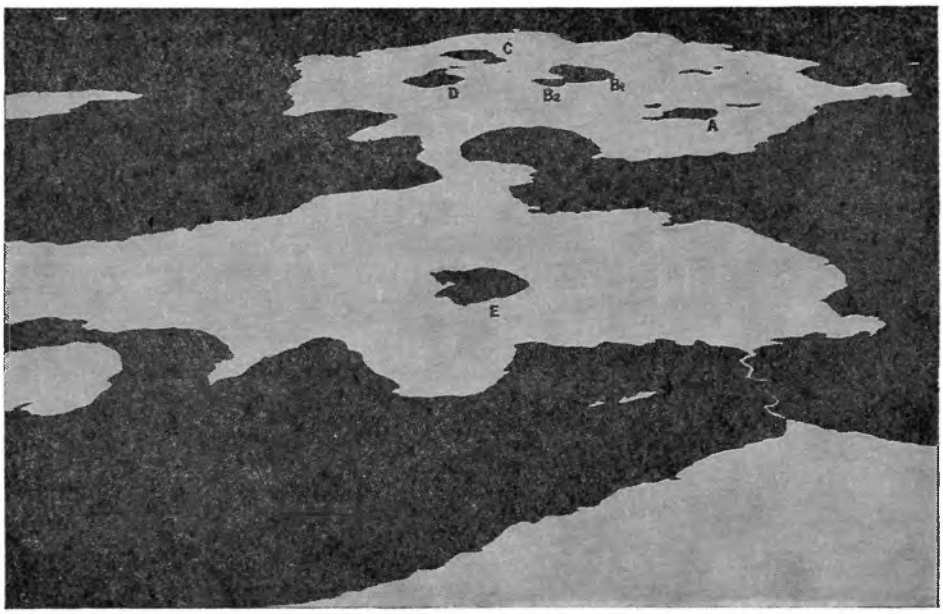

Figure 1. Arlone Lake, N.W.T. (67°22′N, 102°10′W), after Hanson, Queneau and Scott, 1956.

Table III. Weekly temperatures (°F.), Perry River Region, 1963

week	*maximum*	*minimum*	*mean*
June 3–9	56	20	34
10–16	72	33	48
17–23	74	32	46
24–30	82	33	54
July 1–7	82	35	54
8–14	74	38	54
15–21	65	35	48
22–28	80	39	56
Aug. 1–4	69	33	50
5–10	76	37	54

Arlone Lake supported 1,538 breeding Ross's Geese and approximately 600 Lesser Snow Geese. In addition, nests of two King Eiders (*Somateria spectabilis* (L.)), two Red-throated Loons (*Gavia stellatus* (Pontoppidan)), one Old Squaw (*Clangula hyemalis* (L.)), and one Glaucous Gull (*Larus hyperboreus* Gunnerus) were found on the islands. A complete faunal survey report is being published by M. Aleksiuk (1964).

Arrival

Arrival dates of Ross's Geese are entirely lacking in the literature. Hanson *et al.* (1956) reported sighting them near the mouth of the Perry River, at the junction of the Gavin River, on 7th June, 1949.

In 1963 the first Ross's Geese (12) were observed flying over Arlone Lake on 5th June. Snow cover at this time was 75%. On 6th, a total of 21 were observed over Arlone Lake. These were in small flocks and not in association with Lesser Snows, which were comparatively abundant at this time. On 7th, 50 white geese were seen on islands B_1 and B_2 (Figure 1); the majority of these were Ross's Geese. Seventy Ross's Geese were seen on these same islands on 8th June. Ross's Geese continued to arrive in small flocks until by the end of June a total of approximately 1,500 were present on all six islands.

The arrival in the area was probably late. Other geese were noted before the Ross's Geese, although in small numbers. The Eskimos on the coast reported that Ross's Geese are usually present in the area by the last week in May. If this is true, then the arrival was about one and a half weeks late. Spring temperatures and other meteorological factors might affect the arrival of geese on the nesting grounds. Reports in the 'Canadian Weather Review' for June 1963 state that temperatures were below normal in the eastern Arctic. The June minimum temperature (4°F) at Cambridge Bay was the lowest ever reported. These facts suggest a possible correlation between arrival of the geese and weather conditions. Perhaps they follow the 35° isotherm as do Canada Geese (Lincoln, 1939).

Territorial behaviour

Based on observations at Arlone Lake, it appears that the geese are mated when they arrive on the nesting grounds. Presumably copulation has occurred somewhere further south. No courtship behaviour was observed in the vicinity of the lake. Mr Lawson Sugden, Wildlife Biologist for the Canadian Wildlife Service, Edmonton, Alberta, observed two pairs of Ross's Geese copulating at Beaverhill Lake, Alberta (53°27′N, 112°32′W) during the 1963 spring migration. Courtship is a lengthy and strenuous process, which would most certainly be selected against in such a region (Barry, 1962). It seems almost inevitable that most copulation should occur during spring migration, so that successful completion of egg laying, hatching and brood raising can be achieved during the extremely short Arctic season.

As soon as the geese arrive on the breeding grounds, territories are established and nest building begins. Nesting began on 9th June, four days after the first Ross's Geese were seen. The peak of arrival was 7th June, so the geese probably started to build their nests as soon as possible after they arrived.

The wind had been blowing constantly from the south for five days at about 40 m.p.h. The effect of this on the geese was marked. They concentrated on the north side of the islands, even though more favourable nesting sites existed in the form of dense birch stands, and rock out-croppings, on the south side of the islands. As a result, the concentration of nests on the northern (lee) side of the islands was probably higher than if the wind force had not been so strong initially.

The first observation of 'aggressive' behaviour was as follows: 'An adult Ross, in an effort to ward off a neighbouring goose, charged the latter within or on the border of the territory. The neck was held horizontally outstretched, and the mouth agape. Actual physical contact was not achieved. Following the charge, the goose made a quick withdrawal back to the mate.'

Subsequent observations of territorialism and aggression indicated that during the egg laying period both partners take part in defence of the territory. Typically, the defence procedure takes the form of a charge with the neck held horizontal and mouth open. Accompanying the charges are two vocalizations: a high-pitched squawk, by both partners, and a low moaning grunt prior to and after the charge. The former is heard only during the more intensive fights, usually when physical contact is made, the latter during the more subdued interactions but also to a lesser extent during serious conflicts.

The member of the pair which pursues the intruder, presumably the male, then runs back to the mate, and with neck stretched upwards at about 60°, utters the low moaning sound. The retreat behaviour was considered to be a form of post-nuptial display (which is defined as any display or ceremony that takes place between the sexes after copulation has ceased and incubation has begun (Van Tyne and Berger, 1961)), since it happened more commonly during the incubation period than before it. Armstrong (1947) suggested that birds which exhibit this post-nuptial display recapitulate briefly the features of the pairing-up ceremony.

The length of the territorial 'fight' is short, usually lasting only a few seconds. Very little resistance is shown by intruders, which usually run away or take to the wing immediately. Even the larger Lesser Snow Geese do not show resistance to the small Ross's Geese.

On one occasion only, 27th June, I saw a Ross's Goose fly up at another which was flying low over the former's territory.

Nests and nest-sites

Two study areas, each of 13,500 sq. ft., were marked out on the south and north side of island E. The proportions of the different habitats in the plots were estimated, and the situation of each nest recorded. Nest composition, size, and density seem to be governed in part by the particular sub-habitat in which the nest is located. The rather high proportion of geese on the north side of the island probably resulted from strong south winds which prevailed during the initiation of the nesting period, when the leeward side offered considerably more protection. Subsequently, the birds distributed themselves over the entire area. The sub-habitats are described below:

A. *Open Moss*

Regions of open moss, with no apparent protection, are common on all the islands. The nests in such regions tend to be larger than others, and are composed of a thick circle of plucked moss, many old scats, and to a lesser extent dried leaves and grass. Open moss made up 40% of the study plots. Nine nests were found in the open, with a density of only 0·8 nests per 1,000 sq. ft.

B. *Rock-outcrop*

The nests occurring in this habitat inevitably are well protected by a single rock or group of rocks. Rocks formed 15% of the study plots, with 16 nests, 4·0 per 1,000 sq. ft.

C. *Birch and Willow Stand*

A large number of nests occur in this sub-habitat. The birch is more extensive in distribution than is the willow (35% and 5% of the study plots, respectively), but wherever each occur, utilization was seen. The nests consist primarily of a mound of dead leaves, twigs, and to a lesser extent old scats. Moss is absent. During the incubation period these nests were elaborately filled with down, so much that the entire nest seemed to be constructed of it. In the study plots there were 21 nests among birch and 4 among willow, at densities of 2·2 and 3·0 nests per 1,000 sq. ft.

The highest density of nests (6·7 per 1,000 sq. ft.) was found in a small tract (5% of the whole) where birch, willows and rocks were mixed.

Hanson *et al.* (1956) found that nests on the open moss are larger than those in the two other 'types'. Measurements of 15 nests in each habitat-type confirm this (Table IV).

The protection given by bare moss is nil. Presumably the larger nests there compensate for this.

There were 38 nests in the southern plot compared with 21 in the northern one. The difference was probably due to the predominance of shrubbery in the former, only 20% of which was open moss, against 60% of the northern plot.

The minimal distance between active nests was measured to find out the density within the three major sub-habitats. On the east side of island B_1 the habitat consists primarily of willow, large open moss patches, and scattered rock. The mean distance of fifteen active nests was 16·2 feet (range 7·5-27 feet). On the extreme north side of the island thick birch predominates. Here the distance between fifteen active nests was 13·7 feet (range 6-21 feet). The summit habitat contained many small scattered rocks, a long bare clay strip, and sparse vegetation. The mean separation of fifteen nests in this region was 23·4 feet (range 15-39 feet).

The data do not represent the territory size in the three areas, but suggest that the nest densities do vary. This in itself may indicate that the territory size is flexible in the species, depending on the type of terrain in which the nest is located. However, communal areas exist where any goose or group of geese can be situated, without aggressive interactions – a sort of 'no man's land'. Barry (1960) noted that Atlantic Brant (*Branta bernicla hrota* (O. F. Müller)) had similar areas and stated that during the incubation period, the males often stayed in these areas close to their own territories.

The difference in spacing of nests is presumed to indicate a difference in size of communal areas, the largest being on the open moss, and the smallest in the dense birch regions. One may speculate that the separation values in the birch are nearly equal to the individual territory, because birch is the preferred sub-habitat and crowding prevents the existence of communal areas. If this is the case, the territory is about 14 feet in diameter with an area of approximately 150 square feet. Communal grounds are secondary in importance to the nesting territories, and they occur only where the nesting habitat is not optimum. There are more extensive communal areas on the open moss simply because there are relatively few suitable nesting sites. Thus density calculations for the three sub-habitats are not a valid method of estimating territory size.

Egg-laying

The first Lesser Snow Geese eggs were seen on 7th June. The first Ross's Goose eggs were seen on 9th June, four days after the first geese were seen flying in the vicinity. Thus the geese were ready to lay as soon as they arrived on the breeding grounds, which may be indicative of a late season. The peak of the laying season fell between 11th and 13th June (Figure 2).

It has been found commonly among other species of geese that one egg is laid per day. From the rather scant data ob-

Table IV. Dimensions of nests in relation to sub-habitat (measurements in inches)

site	*outer diameter*	*inner diameter*	*depth*	*diameter of down*
Open Moss	18·1 (15–21·5)	6·8 (6–7·5)	2·9 (2–4·5)	10·6 (9–12)
Rock	17·7 (14–22)	6·5 (6–7)	2·9 (2·5–3·5)	10·6 (9–12)
Birch and Willow	15·7 (11·5–19)	6·4 (5·5–7)	2·8 (2·5–3·5)	10·6 (9–13)

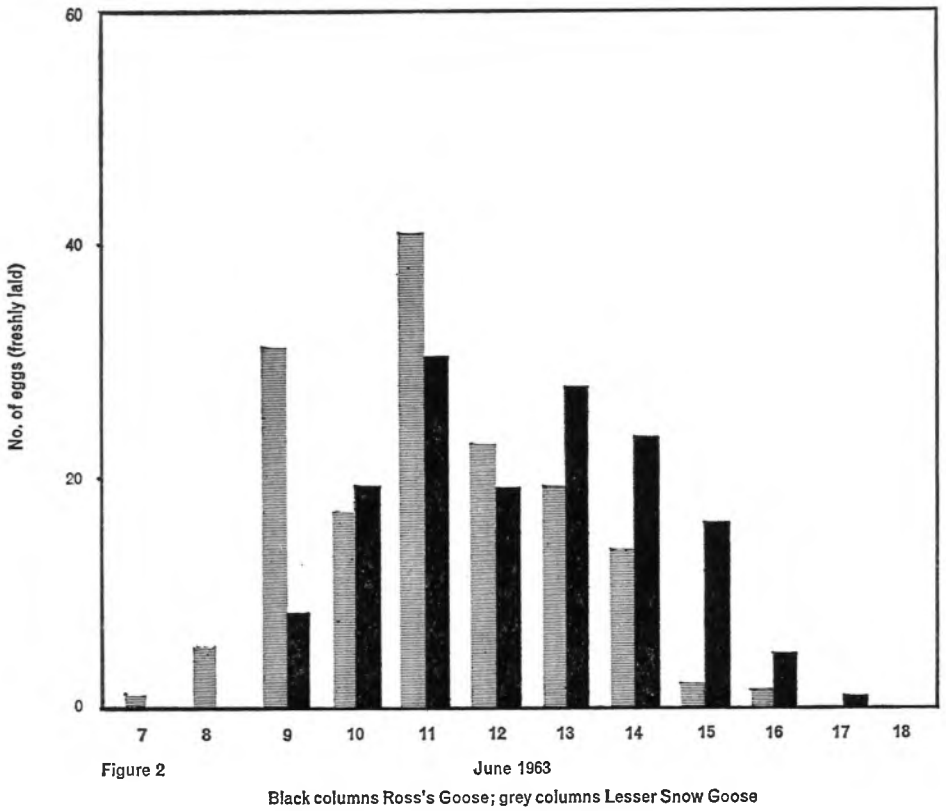

Figure 2. Frequency of egg laying in 67 marked goose nests at Arlone Lake, N.W.T. in June, 1963. Black columns – Ross's Goose; grey columns – Lesser Snow Goose.

tained during the 1963 season, the Ross's Geese seem to be no exception (see Table V).

Eggs

At first, difficulty was experienced in differentiating between the eggs of Ross's and Lesser Snow Geese. Both are a creamy white, but become darkened with age. However, their dimensions proved to be quite different, and with experience they became easy to identify. The average dimensions of 175 Ross's and 104 Lesser Snow Goose eggs were found to be 7·37 cms. × 4·88 cms., and 7·98 cms. × 5·27 cms. respectively. Barry (1960) found that both egg length and width varied according to laying sequence in the Atlantic Brant. He reported that the egg length decreased with each successive egg in the clutch and that egg width was smallest in the first, largest in the second, and then decreased with each successive lay. No such trends are apparent in the measurements of Ross's Goose eggs in 1963 (Table VI).

Clutch size

From observations in 1963, the Ross's Geese seem to be determinate layers of three to four eggs (see Figure 3). A total

Table V. Interval between laying of successive eggs by Ross's Geese

eggs	*number of nests*	*0 days skipped*	*1 day skipped*	*2 days skipped*
1st and 2nd	21	13 (61·9%)	7 (33·3%)	1 (4·8%)
2nd and 3rd	21	15 (71·4%)	5 (23·8%)	1 (4·8%)
3rd and 4th	17	10 (58·8%)	7 (41·2%)	
4th and 5th	4	2 (50%)	2 (50%)	

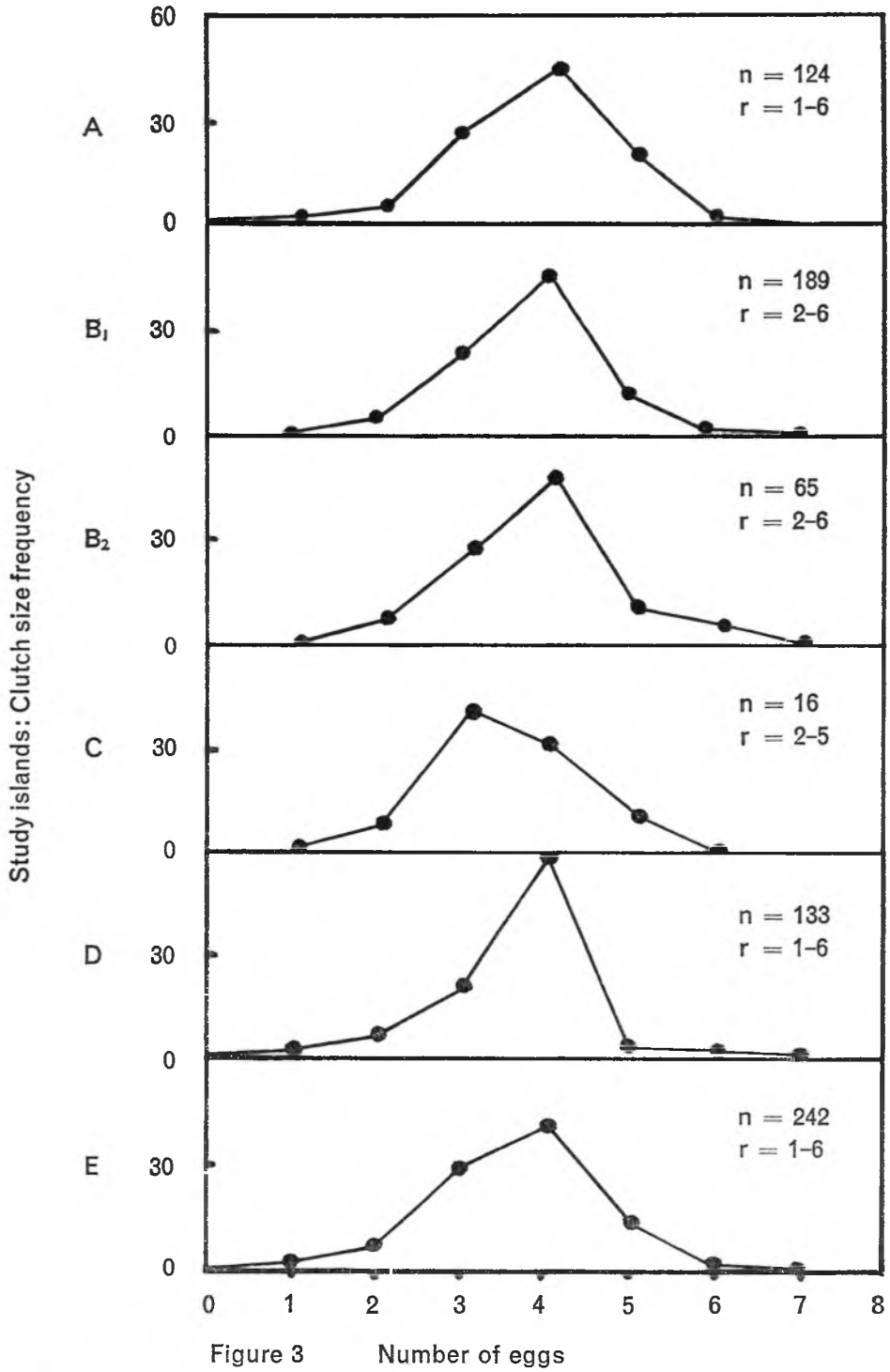

Figure 3

Figure 3. Clutch-sizes of Ross's Geese nesting at Arlone Lake, N.W.T., in summer 1963.

Table VI. Variation of egg-size with sequence of laying in Ross's Goose

egg number	*mean length (cms)*	*mean width (cms)*	*number of eggs*
1st	7·43	4·88	36
2nd	7·37	4·92	21
3rd	7·68	4·80	21
4th	7·31	4·87	21
5th	7·45	4·72	6
6th	7·30	4·85	3

colony count completed on 20th June, 1963 showed that 769 nests contained 2,849 eggs, giving an average clutch size of 3·70. The range was from one to six eggs. The individual averages for each island were not markedly different (Table VII). The frequency of egg numbers on each island is shown on Figure 3.

Table VII. Numbers of active goose nests and corresponding clutch sizes of Ross's Geese on nesting islands at Arlone Lake, N.W.T., 1963

island	*no. of active nests*	*mean clutch size before predation*	*mean clutch size after predation*
A	124	3·73	3·69
B_1	189	3·80	3·59
B_2	65	3·78	3·48
C	16	3·44	2·93
D	133	3·62	3·54
E	242	3·65	3·59
Total	769		
Mean		3·67	3·47

In 1949, the average size of 10 clutches was only 3·0, the range 2-4 (Hanson *et al.*, 1956).

Behaviour during the egg-laying period 7th-18th June, 1963

During this period, the geese remained for a major part of their time on the territories although frequent pair flights occurred. When on the territory or communal area one member of the pair usually sat down or crouched, while the other kept watch over the territory. The mated pair stayed together always; the author has never seen separation of mates.

The geese were timid and tended to retreat from the territory for almost no reason at all. When disturbed, large groups took flight, soon splitting into smaller 'subflocks', settling on the lake 10-40 yards from the islands. Within 10-15 minutes, the small groups and pairs returned to the islands and settled down on the territories. This was when territorial displays and conflicts were most commonly seen. The birds inevitably seemed to land in another's territory. The uproar continued until the birds arranged themselves on their appropriate grounds. Then the islands became comparatively quiet again.

A considerable amount of time was spent feeding on the islands. Despite the poverty of the flora, the geese apparently found enough to subsist. On island E there were two pools which furnished aquatic and semi-aquatic vegetation. At all periods of the day, pairs inhabited these areas.

Behaviour during the incubation period

No sign of incubation was observed during egg laying, indicating that, as in other geese, eggs are not incubated until a complete clutch has been laid. The start of the incubation period was taken to be 18th June, one day after no newly-laid eggs were found in the 67 marked nests on island B_1. The initiation of this period was marked by a noticeable silence over the area. When the birds were disturbed, they tended to hover in huge circles directly above the islands instead of dividing into small flocks as previously described. Within 5-10 minutes they were back on the territory.

Down deposition seemed to be characteristic of this period. This material fills the inside of the nest and, as stated before, is more abundant in nests in the birch subhabitat. Its cohesion is generally poor. At the beginning of this stage the willows and birch are covered with wind-strewn down. Later, when leaves, twigs and scats have been mixed with it, it remains in the nest. When leaving the nest, the incubating goose covers up the eggs with the down by pulling it over the clutch with its bill.

Three females were nest-trapped on island E, with the falconer's bow trap. They were neck-tagged with navy blue neck bands and painted so that I could tell them easily from a good distance. After hours of observations on these three geese and other unmarked birds, I came to the conclusion that only the female incubates. They are not constant incubators or 'close-sitters' as has been described for the Lesser Snow Geese. The longest observed period of incubation was 46 minutes. Generally the incubating goose sat on the nest for a short time, then got off and accompanied the male on the territory. During the time the female is on the nest, the male stands close by in the territory actively defending it.

The incubating posture of the Ross's Goose is similar to the Lesser Snow. The head and neck are held vertical, not horizontal as occurs for instance in Brant and the King Eider duck. The female often pushes down in towards her body with the bill. She often moves in circles while on the nest, presumably rotating the eggs, in this way distributing heat over the complete clutch.

Nest abandonment

Ross's Geese abandon their nests at any time during the breeding season. Many reasons have been postulated for this phenomenon, such as overcrowding, inter- and intraspecific competition, predation and weather. Sufficient information is not yet available to state an exact cause or causes.

Nesting success

The first evidence of pipping was seen on 5th July. On this date only a few goslings were hatched and dry, indicating that the process began early on 5th. The peak of the hatch occurred on 7th and 8th July.

Delacour (1954) records the incubation period as 24 days. This presumably refers to eggs laid in captivity. Though this period was not investigated in great detail in 1963, most clutches seem to have been incubated for 23 or 24 days, though some for no more than 22 days.

Information on hatching success was obtained by marking nests in which clutch size was known. Ninety-three were marked on 24th June on island E. Records were kept on egg losses as the result of predation and other causes. These 93 nests originally contained 351 eggs. Three of the nests, representing a total of 12 unproductive eggs, did not hatch. If a successful nest is defined as one where at least one egg hatches, then in 1963 the nesting success was 96·7%. The total number of unproductive eggs, including those from the 3 nests where none hatched, was 23 from 11 nests. This represents a 93·5% egg hatching success. 4 eggs (from 1 nest) were sterile; 8 (4 from 1 nest) were destroyed; 7 (4 in 1 nest) contained dead embryos; and 3 were addled.

Hanson *et al.* (1956) report that nesting losses were 'negligible' in 1949: of 260 nests located, 6 were destroyed by gulls and 3 or 4 were apparently deserted, so that nesting success that year was also about 96%.

Goslings

Young Ross's Geese are precocious. They are helpless until dry, but by the time they leave the nest a few hours later they have acquired protective instincts of concealment. When approached on land they crouch with head and neck flat on the ground. This makes them very hard to see, as they blend in well with the surroundings. On water they have been seen to dive in an effort to escape intruders.

As is mentioned by Hanson *et al.* (1956), the goslings are polymorphic. The colours basically are in two phases, yellow and grey, although intergrades occur between these two extremes. From 34 brood counts made one day after the first eggs were seen hatching 72·8% were monomorphic and 27·2% were dimorphic: in 1949, Hanson *et al.* (1956) found 42 of 56 (75%) broods to be monomorphic.

Behaviour of family groups

After the hatch the geese form small flock units or family groups. The common unit or flock is made up of two to fifteen family groups. By 9th July, four days after the initial pipping was observed, over 80% of the geese had left the breeding islands and were heading north for the post-breeding moult.

Movement from the breeding grounds to the lower reaches of the Perry River is slow but continuous. The birds do not congregate initially in large groups along the route north but maintain the small flocks of from 6-30 family groups. After the migration and moulting is in progress it was common to see large flocks of 100-200 geese on the river and inland lakes.

Unfortunately, because of bad ice conditions and limited time, the observations made during the moulting period were entirely restricted to the Perry River *per se*. Overland travel is arduous, and most time was spent banding the geese seen along the river itself. It was obvious from the total number of Ross's and Lesser Snow Geese seen while banding operations were in progress, that many, if not the majority, of the geese do not move to the mouth of the Perry, but stay inland and moult on the numerous lakes in the region. This fact in itself makes post-breeding studies on large numbers of Ross's Geese rather difficult.

Mortality factors

Mortality of adults on the nesting grounds is almost non-existent. A few old rifle shells were found in the area but these were probably used by the Eskimos during the spring caribou hunting rather than for shooting geese. The Eskimos I did interview showed little interest in geese as a food resource and said they do not bother the waterfowl unless the caribou or seal hunting is poor.

Only one Arctic fox was seen all summer. Presumably, even if the fox population was at a peak, the islands, being situated a considerable distance from the shoreline, offer ample protection from such potential predators.

The major mortality factor may well be the weather. A serious or late spring snowfall could decrease the annual productivity, as has been shown in other Arctic waterfowl. Fortunately, 1963 was a mild summer and productivity was on the whole good, despite a supposed two week delay at the beginning of the season.

A number of factors on the islands cause losses of young. The large willow and birch stands act as traps from which the newly-hatched goslings find it impossible to escape once entangled. Many young were rescued by the author and his assistant this summer. These trapped goslings are abandoned by their parents. Old Eskimo caches and rock piles acted as traps in the same way. Nests built in these regions often lost young before they had moved far. It seems almost ironical that the most suitable nesting habitats should be somewhat detrimental to the young.

Avian predation on the newly hatched birds is comparatively high. The most common predator was the Glaucous Gull. The Herring Gull (*Larus argentatus* Pontoppidan) occurred but to a lesser extent. All three species of jaegers were present: the Long-tailed Jaeger (*Stercorarius longicaudus* Vieillot) being the most common; the Pomerine Jaeger (*S. pomarinus* (Temminck)) and the Parasitic Jaeger (*S. parasiticus* (L.)). At the beginning of the hatching period a marked increase in the numbers of these predators occurred. They nest in large numbers between the lake and the coast, and presumably as soon as the geese start to hatch, they move to the lake. On one occasion eight Glaucous Gulls were seen flying over island B_1 at the same time. This is a high concentration over one island, as prior to this one or two per hour was normal. On two occasions, the author was fortunate enough to observe the taking of young Ross's Geese by both Glaucous and Herring Gulls. Only once was this situation encountered with a Parasitic Jaeger.

Egg predation was low. The low rate of egg loss probably can be attributed to the fact that the geese stay close to their nests for most of the season and it is not hard for them to ward off predators. However, when a gosling wanders off by itself it becomes vulnerable to attack.

Growth rate of young

The hatching weight and one-day-old weight of Ross's Geese is approximately 65 grams. Four-week-old goslings weighed on the average 900 grams. No information is yet available on the weight increment of migrating yearlings. Growth is rapid and by the time goslings are four weeks old the legs are the same size as those of mature geese. Although no specific data on food and nutrition are yet available, it is believed that the young goslings feed on insects while accompanying their parents on the northward moult migration, and hence have a high protein intake, which may in part account for the rapid growth.

Sex ratios

From ringing operations it was found that in a total of 420 geese (237 yearlings and 183 matures), the sex ratio was 137 males to 100 females among the yearlings and 84:99 for adults. A ratio close to 1:1 would be expected for a monogamous species. The adult ratio is not significantly different from unity, but the observed discrepancy in yearlings is unlikely to have arisen by chance.

Ringing operations

Banding started on 20th July at the mouth of the Perry River. A temporary camp was set up and the procedure was to canoe up the River for 15 miles every day intercepting as many flocks as possible. In 10 days 493 geese were ringed, 409 Ross's and 84 Lesser Snows. Sexes were separated in both age classes by ringing the left foot of males and the right foot of females. Four neckband colours were used to differentiate age-sex classes.

Acknowledgements

Many people contributed their efforts to the initiation of this study. Foremost, I would like to thank Mr. T. W. Barry, Wildlife Biologist, Inuvik, N.W.T., for introducing me to the problem; Mr. Michael Aleksiuk, for accompanying me on my first trip north; Drs. D. A. Boag, J. Holmes, and V. Lewin, of the University of Alberta for reading the manuscript; and Mr. Duncan M. Pryde, Manager of the Hudson's Bay Company, Perry Island, N.W.T. for his invaluable aid during the ringing operations.

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The status of Ross's Goose in 1962-63

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Summary

In 1962-63 there were at least 25,000 Ross's Geese in California. Earlier estimates, of as few as 2,000 in 1949, were probably too low because too little was known about the distribution of Ross's Geese in California and of their mixing with Snow Geese. Attempts to estimate the population size by the mark and recapture technique, utilising 161 geese colour-marked in the Perry River breeding area in the summer of 1962 and a further 292 marked in Saskatchewan later that year, proved unsatisfactory. Some neck-bands had been lost and no red-dyed geese could be detected, but the main cause of failure was the low ratio of marked to unmarked geese.

During the summer of 1962, John S. Weske and I spent six weeks in the Perry River region of northern Canada (see Hanson, Queneau & Scott, 1956) trying to band moulting geese. I was primarily interested in the Canada Geese (*Branta canadensis*), as this was to be the last of four summers' work on this species. However, our chief sponsors, the Canadian Wildlife Service, requested that, in addition, we band as many species of geese as possible, including the Ross's Goose (*Anser rossii* Cassin).

As a part of my Canada Goose study I had attempted to adapt the well-known mark and recapture technique of population inventory for use on goose flocks. Because geese are so difficult to catch in large numbers during the winter, it appeared logical to substitute sight records for actual recaptures. Conspicuous plastic neck-bands with trailing streamers (Craighead and Stockstad, 1956) proved very satisfactory for this purpose. The principal difficulty encountered in the Canada Goose study was the large overall size of the population. Even though nearly 2,000 marked birds were present in the fall of 1961, the frequency of marks was less than six per thousand geese sampled. (Detailed results of the Canada Goose study will be presented elsewhere.) Ross's Goose seemed to offer a perfect opportunity to overcome this difficulty. Since the most liberal estimates available indicated that the population did not contain more than 20,000 birds, a total of only 150 colour-marked

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birds would give a more favourable marked: unmarked ratio.

In order to test my technique, therefore, Weske and I put green neckbands on all the Ross's Geese large enough to retain them. We were able to mark a total of 161 birds. Later in the fall, Mr. Alexander Dzubin of the Canadian Wildlife Service marked an additional 292 Ross's Geese, 138 with purple neckbands, 67 with red dye and 87 with yellow dye. Thus the stage seemed set for a most successful counting experiment and accordingly I set out for California in mid-February 1963. For a week I scanned flocks of Ross's Geese, first near the Merced National Wildlife Refuge in the San Joaquin Valley, and then in the rice farming lands of Butte County in the Sacramento Valley. At the end of the week I was forced to admit that my experiment was a dismal failure. The reason for failure, while unexpected, was a happy one; there were too many Ross's Geese!

In the Merced area, under the expert guidance of Mr. R. G. LeDonne of the California Department of Fish and Game, I examined critically over 1,000 Ross's Geese under very good viewing conditions, and yet found only six marked birds. In the Sacramento Valley, Mr. William Anderson and I were able to examine Ross's Geese flying less than 100 feet overhead, mixed with huge flights of Snow Geese (*Anser c. coerulescens* (L.)). In two days we counted 707 Ross's Geese, but only four were neck banded. (The dyed birds were coloured chiefly on the back, and so were not readily distinguishable when flying overhead.) It is quite evident that these samples are too small to allow calculation of a reliable population estimate.

It seems likely that part of the lack of marked birds may be explained on the basis either of loss of the marking device, or of selective mortality of neck-banded birds. I now have evidence that neck-banded Canada Geese suffer higher mortality than do birds which are marked only with standard leg bands. Although I saw at least four of Mr. Dzubin's yellow-dyed birds, no red Ross's Geese were reported at any time during the winter. Mr. Dzubin has confirmed that the red dye washes off.

However, the unexpected increase in the Ross's Goose population cannot be ascribed entirely to missing marks. Two other independent counts of the Ross's Goose population were available for the winter 1962-63. Mr. Dzubin made age ratio counts of the birds near Kindersley, Saskatchewan and estimated a population of 30,000-35,000, based upon the previous winter inventory figure of 20,000. The United States Fish and Wildlife Service official inventory for the winter of 1962-63 was 25,250. This count was made by two airborne observers the very week that I was counting the birds on the ground.

While 25,000 geese do not constitute a large population by any means, this figure represents a dramatic increase over the 'declining' population of 2,000 geese counted in 1949 (Hanson *et al.*, 1956). With knowledge of the breeding success of the species still fragmentary, it is difficult to find a precise reason for the growth of the population. Perhaps, however, the answer does not lie entirely on the breeding ground. In answer to my question 'What caused the increase?', Mr. Frank M. Kozlik of the California Department of Fish and Game ventured the following opinion: 'I believe that the "increases" in populations have resulted from more effort being expended studying these birds. At one time it was believed that these geese wintered only on the Sacramento Refuge. Later, this was expanded to include the Sacramento Valley. Now we know that the San Joaquin Valley is equally important.' The consequences of this new knowledge may be appreciated if we examine the basis of the 1949 estimate. ' "Decidedly smaller numbers of the Ross' goose were seen on the Sacramento National Wildlife Refuge, California, during December 1940, as compared with those of the preceding year . . ." On 5 November 1949 U.S. Fish and Wildlife Service observers checked the Ross' Goose population at Tule Lake, California, and accounted for about 2,000 birds along with almost 100,000 Lesser Snow Geese.' (Reports cited in Hanson, Queneau and Scott, 1956.) Bill Anderson told me that few people, even in California, believed it possible to identify scattered Ross's Geese among the hundreds of thousands of Snow Geese which winter in the Sacramento and San Joaquin Valleys. Thus attention was focused on those Ross's which held aloof from the Snow Geese. Yet, when we two examined a group of 60,000 Snows in Butte County (Sacramento Valley), we found at least one or two Ross's for each hundred Snows, mixed and scattered throughout the flock. Small wonder, then, that many Ross's Geese have been over-looked in the past.

I do not concur with the opinion expressed by Hanson, Queneau and Scott that census of the Ross's Goose population may be accomplished more easily on the breeding grounds. Aerial surveys by the Canadian Wildlife Service in 1960, and by a U.S. Fish and Wildlife Service aircraft with the author aboard in 1962 failed to reveal any substantial increase in the number of Ross's Geese inhabiting the Perry River region compared with the 1949 survey of Hanson,

Queneau and Scott. Furthermore, the discovery that Ross's Geese nest at the edges of Snow Goose colonies in the eastern Arctic (MacInnes and Cooch, 1963) leads me to believe that the breeding grounds of the California populations may not be restricted entirely to the coast of the Queen Maud Gulf.

The future for Ross's Goose appears bright. Concentrated study of the breeding ecology of the species has been undertaken by the Canadian Wildlife Service. New refuges are being established in California under both state and federal programmes. Hunting of Ross's Geese was made legal in 1963, but this should make little difference to the annual kill. In the past, a few hundred Ross's Geese were shot each year by hunters who mistook them for the more abundant and much sought after Snow Geese. The new regulation makes it legal for the hunter to take his kill home instead of throwing it in the rushes, or surrendering it to a game warden.

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The Ontario Waterfowl Research Foundation

A. T. CRINGAN *Executive Director, Ontario Waterfowl Research Foundation, Guelph, Canada*

The Province of Ontario occupies an area of 1,070,000 sq. km. in Eastern Canada, and includes 107,000 sq. km. of inland fresh water and 97,000 sq. km. of the Great Lakes. Life zones range from Upper Austral in the south to Arctic along the Hudson Bay Coast. More than forty species of waterfowl occur naturally in Ontario. Forest-inhabiting species, such as Black Duck (*Anas rubripes* Brewster), Canada Goose (*Branta canadensis interior* Todd) and Wood Duck (*Aix sponsa* (L.)) are among the most important. In view of the tremendous potential for waterfowl management in this Province, a group of interested sportsmen and wildlife biologists formed the Ontario Waterfowl Research Foundation in 1961. The Foundation's aim is improved waterfowl management in Ontario. It seeks to achieve this by supporting basic research in waterfowl biology, training students as biologists and managers, and distributing results of research for application.

Administration

The affairs of the Ontario Waterfowl Research Foundation are governed by a Board of Trustees and Honorary Trustees. It is advised on scientific matters by a Scientific Advisory Board, made up of representatives of the Canadian Wildlife Service, two Branches of the Ontario Department of Lands and Forests, and Ontario's universities. There is an Executive Director.

Through board members and advisers, the Ontario Waterfowl Research Foundation maintains contact with the North American Wildlife Foundation, Delta Waterfowl Research Station, Ducks Unlimited (Canada), Canadian Wildlife Federation, government agencies and other international, national and provincial groups sharing mutual interests in waterfowl.

Niska Waterfowl Research Station

In recognition of the fact that much waterfowl research requires the use of captive

birds and a well-equipped research station, in 1962 the Foundation purchased a property which had previously been developed as a private game farm. It is the Niska Waterfowl Research Station, situated in a Federal Wildfowl Sanctuary on the River Speed, five kilometres from the campus of the Ontario Agricultural College at Guelph. Dr. Antoon de Vos is the Station Director and the noted wildlife photographer William H. Carrick is Resident Manager.

Niska has facilities for holding and rearing small numbers of wild waterfowl. Existing buildings are suitable for modification as a library, laboratory and office. Living quarters for visiting scientists and resident students will be built. There is ample land on the property to build small dugouts and impoundments, to demonstrate management methods available to private land owners. In addition to a research area which will be closed to the public, a demonstration area capable of attracting tens of thousands of visitors annually is planned.

Research programme

The Ontario Waterfowl Research Foundation supports a study of waterfowl movements in relation to Luther Marsh, an artificial wetland of 5,000 acres situated 60 kilometres from the research station. It is co-operating with individuals and other agencies in studies of stocking, productivity of selected habitats, screening of herbicides, and appraisal of artificial nesting devices. Foundation personnel ringed 2,606 ducks of eight species, and 238 other birds, between 1961 and 1963.

Additional research by the Director of the Research Station and Executive Director, being supported directly by grants to their employing agency rather than through the Foundation, includes studies of the breeding behaviour of Trumpeter Swans (*Cygnus cygnus buccinator* Richardson), breeding biology of the Redhead (*Aythya americana* (Eyton)), and productivity of selected wetland habitats at Long Point and other places.

This Foundation is interested in waterfowl research as it relates to Ontario. Its research station facilities may be used by scientists and students who are supported by other granting agencies. In addition, the Ontario Waterfowl Research Foundation may support basic research in waterfowl biology which does not require the facilities of the research station.

Further details of the Foundation's operations may be obtained from the Executive Director, P.O. Box 163, Guelph, Canada.

Extinction and the Anatidae of New Zealand

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Summary

The historical and present status of each species of Anatidae found in New Zealand is described and causes of change are discussed. Of 19 native or self-introduced species believed to have bred, five natives and two Australian stragglers became extinct before European settlement. *Mergus australis* is the only native species to have become extinct since 1800. Seven native species survive: all but two have been reduced in numbers or range, or both. The Grey Teal and the Shoveler continue to thrive. The two in greatest danger are the Brown Teal and the Blue Duck. Destruction of habitat is the most serious threat. Four species have been successfully established and four others have been stragglers from Australia in European times.

Introduction

The depletion of New Zealand's avifauna since European settlement, from about 1800, has often been cited as an example of the ever-increasing effect of modern man upon natural ecosystems. Unfortunate though these effects may have been, the degree to which they have hastened the extinction of various species is frequently over-emphasised. I have recently reviewed the extent and timing of the known cases of extinction of land- and fresh-water inhabiting birds (Williams, 1962). The present paper discusses the past and present status of all forms of the Anatidae known to have occurred in New Zealand, including stragglers and species introduced by man, with the object of putting into better perspective the recent changes in the status of the endemic species. 'New Zealand' is used here to include only the North Island (44,000 sq. m.), South Island (58,000 sq. m.), Stewart Island (670 sq. m.), the Chatham group (370 sq. m.), Auckland Islands (250 sq. m.) and Campbell Island (42 sq. m.). The small offshore islands of each of these subdivisions are considered part of the nearest mainland. Cook Strait, with a

minimum width of 15 miles, separates North and South Islands. Foveaux Strait, 20 miles wide, separates Stewart Island from South Island. The Chathams lie 400 miles east-south-east of the South Island, the Auckland Islands 200 miles to the south-south-west and Campbell Island 350 miles south.

The Anatidae of New Zealand may be conveniently divided into five categories: (1) species becoming extinct in pre-European times (i.e. before 1800 approximately), (2) those becoming extinct since, (3) stragglers and temporarily established invaders, (4) surviving native species and (5) surviving introduced species. These are listed separately in Table I.

Extinct in pre-European times

Four of the long extinct species belong to endemic genera. Virtually nothing is known about the ecology of these birds. *Pachyanas chathamica* is known only from a small amount of material from the Chatham Islands; the small Finsch's Duck has been found in comparative abundance at several places in the South Island and once in the North Island; *Cnemiornis* was large and flightless; and the Chatham Islands Swan, which was considerably larger than the Black Swan, has been abundantly found in the North and South Islands as well as in the Chatham group and was obviously exploited for food from the time Polynesians began the human occupation of New Zealand, perhaps 1500 years ago.

Because bones of all these species have been found associated with remains of early Polynesian activity, hunting has usually been assumed as the proximate cause of extinction.

Extinct since European times

Just one species of waterfowl has become extinct during European times. *Mergus australis*, the only merganser of the Australasian region, once occurred on at least the east coast of the South Island (Williams, 1962), on the Auckland Islands and, presumably, in some intermediate places as well. When Europeans arrived in the South Island it had already become extinct there and existed in presumably only small populations at the uninhabited Auckland Islands some 200 miles to the south-south-west. The first specimen was taken in 1840, the last in 1909 (Delacour, 1959) and only about twenty are considered to have been taken in all by collectors. Although the disappearance of the species from the South Island could perhaps be ascribed to predation by man (Fleming's (1962) general thesis for pre-European extinctions) this is not a satisfactory suggestion to account for the merganser's ultimate disappearance from the Aucklands. Adams Island, the species' last refuge, has an area of 35 sq. m., and has not only never been inhabited but is still free of mammalian predators and is in virtually a virgin state. Nevertheless, the merganser had gone from there in about 70 years and it is hard to believe that the few specimens taken over this period by very rare visitors was a hunting pressure intense enough to destroy the species.

Man and introduced predators could have played a part on Auckland Island itself or on one or two of the other islands in the group. A general search made for the species by the Cape Expedition during the second world war was unsuccessful (E. G. Turbott, *pers. comm.*).

Little is known of the merganser's ecology. Its habitat was sheltered bays of the coast and the streams running into them.

Stragglers and temporarily established invaders

Of the six species in this category three are recent stragglers to New Zealand and two are known only from a few sub-recent remains. The fourth was a breeding resident for at least thirty years. All occur in eastern Australia and it is obvious that the prevailing westerlies of these latitudes were responsible for carrying them across the Tasman Sea.

Plumed Whistling Duck, *Dendrocygna eytoni*. This has been recorded three times (Oliver, 1955). One was shot on the Thames River, North Island in May 1871; in the same year a flock of fourteen was seen in the neighbourhood of Lakes Tuakitoto and Kaitangata, South Island; and between 1894 and 1896 two males and a female inhabited the lakes in the Ashburton Botanic Gardens, South Island.

Maned Goose, *Chenonetta jubata*. There are four records from the southern half of the South Island (Oliver, 1955). One bird was shot at Lake Wanaka in 1910, one in the Orawia district, Waiau River in 1944 and two others at about the same time – one at Linwood and the other at Wairaki.

Australian Shelduck, *Tadorna tadornoides*. One was shot on Lake Ellesmere, South Island. Oliver gives no date.

Pink-eared Duck, *Malacorhynchus membranaceus*. This is known from a few sub-fossil remains found in Pyramid Valley, South Island and seems referable to the existing Australian species.

White-eyed Duck, *Aythya australis australis*. First recorded by Europeans on Lake Whangape, North Island in 1867 (Oliver), this species may have been present earlier, since the Maoris had a name for it. Buller (1888) remarked that it was common

Table I. Anatidae recorded from New Zealand

		endemic genus	endemic species
EXTINCT BEFORE EUROPEAN SETTLEMENT			
Cygnus sumneransis (Forbes)[1]	Chatham Island Swan		*
Pachyanas chathamica Oliver	Chatham Island Duck	*	*
Cnemiornis septentrionalis Oliver	North Island Goose[2]	*	*
Cnemiornis calcitrans Owen	South Island Goose	*	*
Euryanas finschi Van (Beneden)	Finsch's Duck	*	*
EXTINCT SINCE EUROPEAN SETTLEMENT			
Mergus australis Hombron and Jacquinot	Auckland Island Merganser		*
STRAGGLERS AND TEMPORARY SELF-INTRODUCED INVADERS			
Dendrocygna eytoni (Eyton)	Plumed Whistling Duck		
Tadorna tadornoides (Jardine and Selby)	Australian Shelduck		
Malacorhynchus membranaceus (Latham)	Pink-eared Duck		
Aythya australis australis (Eyton)	Australian White-eye		
Chenonetta jubata (Latham)	Maned Goose		
Biziura delautouri Forbes[3]			*
Biziura lobata (Shaw)[3]	Musk Duck		
SURVIVING NATIVES			
Tadorna variegata (Gmelin)	Paradise Duck		*
Anas gibberifrons gracilis Buller	Grey Teal		
Anas castanea chlorotis G. R. Gray	Brown Teal		
Anas castanea aucklandica (G. R. Gray)	Auckland Island Teal		
Anas castanea nesiotis (Fleming)[3]	Campbell Island Teal		
Anas superciliosa superciliosa Gmelin	Grey Duck		
Anas rhynchotis variegata (Gould)	Shoveler		
Hymenolaimus malacorhynchos (Gmelin)	Blue or Mountain Duck	*	*
Aythya novaeseelandiae (Gmelin)	Scaup, or Black Teal		*
SUCCESSFUL INTRODUCED SPECIES			
Cygnus atratus (Latham)	Black Swan		
Cygnus olor (Gmelin)	Mute Swan		
Branta canadensis (L.)	Canada Goose		
Cereopsis novaehollandiae Latham[3]	Cape Barren Goose		
Anas platyrhynchos platyrhynchos L.	Mallard		

[1] Howard (1964).

[2] The problem of naming the species of *Cnemiornis* smaller than *calcitrans* is unsettled (Howard, 1964). In the meantime I have retained *septentrionalis* for this, and Dawson (1958) states this name is synonymous with Forbes's *gracilis*. The North and South Island forms may eventually prove to have been only subspecifically different.

[3] Species of doubtful status.

on some of the lakes in the Waikato area, North Island, in the 1860s and Oliver added that it was abundant on the lower Waikato River itself, on some of the lakes of the Rotorua district, North Island and that it also occurred on other waters in the eastern and southern North Island and on Lake Ellesmere and in the Otago district of the South Island. Continuous occupation apparently ceased after 1895 and the only record since is of a sighting at Hamurama in the Rotorua district in 1934. One can only guess now at the reasons for the failure of this species to maintain itself.

Musk Duck, *Biziura lobata*. That bones of the existing Australian species have been found in New Zealand seems certain. What does not seem certain is what other species, if any, of this genus are native to this country. Howard (1964) and Dawson (1958) revive Forbes' *B. delautouri* (=*B. lautouri*), 'a *Biziura* somewhat larger than *Biziura lobata*, the musk duck of Australia'.

However, R. J. Scarlett (*pers. comm.*) believes that at least some of the bones attributed to this alleged species could quite well belong to *B. lobata*. The issue is complicated by the fact that he has found bones of a *Biziura* apparently *smaller* than the Australian species. Until the situation is clarified it is probably better to include the Australian Musk Duck as a vagrant and leave other possible species of *Biziura* on the suspense list.

Surviving native species

There are seven in this category of which three are endemic. One of the latter belongs to an endemic genus. Since European settlement all but two of these seven species have been reduced either in numbers or range or both.

New Zealand Shelduck, Paradise Duck, *Tadorna variegata*. Though now absent from areas in which it once occurred previous to heavy settlement, the endemic Paradise Duck is still widespread throughout North, South and Stewart Islands in open country near water from high on the mountains down to the seashore and is still locally abundant in many places. Buller in 1888 remarked that it did not then occur north of 39°S, and in 1905 added that it was becoming rare in Marlborough and had 'disappeared' from the Nelson district as a result of predation by mustelids and the taking of poisoned grain laid for rabbits. (Mustelids – stoats, polecats and weasels – were introduced into New Zealand in the early 1880s in an unsuccessful attempt to control the introduced rabbit, *Oryctolagus cuniculus*.) The Paradise Duck still occurs in Marlborough and Nelson and, in the North Island, has gradually spread beyond 39°S. This occupation of new range in the north has been a partial compensation for shrinkage in range and numbers elsewhere, particularly in the South Island. Destruction or alteration of habitat aside, man has had less detrimental effect upon the Paradise Duck than upon any of the other four species that have become reduced in recent times. Neither introduced mammalian predators nor an annual open season (at present of about four weeks) in most parts of New Zealand seem to be important in the species' ecology.

Grey Teal, *Anas gibberifrons gracilis*. A recent invader from Australia, the Grey Teal has spread throughout New Zealand, aided by the protection from hunting it enjoys, though a few are shot each year in mistake for female Shovelers.

First recorded by Buller in 1866 it may well have occurred earlier for it was known to the Maori as *tete*. Though apparently rare in the 1860s it was taken in other parts of the country in the next 25 years; and, according to Buller (1888), became comparatively plentiful on some of the lakes of the Rotorua district. Now it is found widespread but only locally common on the three main islands, and only south of Auckland in the North Island. Stragglers have reached the Chathams, 400 miles east of the South Island (Oliver, 1955). Of its present status Miers writes (*in litt.*): 'The species seems to have already occupied all suitable habitat, especially since the 1957 invasion. I consider the main reason for the decline since 1958-59 to have been the lack of suitable nesting sites. The nests we find are atypical, 99% of Australian nests are found in trees'.

Brown Duck, Brown Teal, *Anas castanea chlorotis*. I have followed the *Checklist of New Zealand Birds* (Fleming *et al.* 1953) rather than Delacour (1956) in regarding the races of Brown Duck as endemic subspecies of the Australian Chestnut Teal rather than as races of a species, *Anas aucklandica*, endemic to the New Zealand region. After the Merganser, this is the species that has suffered most in European times and there can be no doubt that its present dangerous situation results primarily from destruction of its habitat. Originally Brown Duck were abundant throughout New Zealand and the Chatham Islands. Buller (1888) related that they were to be met with on every inland lake and often in the deep freshwater streams running into them. Habitat also includes intertidal streams, mangrove swamps and quiet inlets of the sea. Nocturnal and crepuscular in activity, during the day Brown Ducks tend to retire to thick cover along the water's edge. Their chief haunt used to be the once-extensive swamp forests of kahikatea, *Podocarpus dacrydioides*, but these have been almost totally destroyed by draining and felling or burning. As a result Brown Ducks are very reduced in both numbers and range throughout New Zealand and are common only in a few places in Northland and Great Barrier Island. Small numbers occur in the eastern part of the Volcanic Plateau in the North Island, in Fiordland in the south-west of the South Island and on Stewart Island and its two largest adjacent islands. They became extinct on the Chathams, presumably as a result of human interference, about 1915 (Williams, 1962).

A subspecies with only weak powers of flight, *A. c. aucklandica*, persists at the Auckland Islands. It, too, has been reduced in range and numbers and is now very rare on Auckland Island proper but locally abundant on other islands in the group. The reasonable assumption is that cats and pigs established on the main island have been responsible for its destruction there; this island has otherwise been but little affected by man.

Another subspecies, *A. c. nesiotus*, has been claimed for Campbell Island. Of this, only about a dozen have ever been seen and about four of these collected and Bailey and Sorensen (1962) have suggested that all these were, in fact, stragglers from the Auckland Islands population some 150 miles away to the south-east. However, a

comparison between some of the measurements they give of a very small sample of birds belonging to the two alleged subspecies is not quite in harmony with this opinion so the question remains undecided. Should the Campbell Island race prove valid it must be extremely rare and was apparently not noticeably commoner when Campbell Island was uninhabited and unmodified by man. The almost inaccessible offshore Dent Island may be its last stronghold.

Grey Duck, *Anas s. superciliosa*. This is the most common and most widespread of all New Zealand waterfowl though it is often second in abundance to the introduced Mallard in settled areas and interbreeds with it. In spite of a steady decline in numbers that goes hand in hand with the advance of agriculture and urbanization, Grey Ducks are still to be found wherever there is water, 'by mountain streams, lakes and lagoons, tidal estuaries and inlets, and sometimes . . . on the sea off the coast' (Oliver, 1955). Their range extends from the Kermadec Islands, 550 miles north-north-east of the North Island, to the Chathams and the subantarctic islands where, however, they are not common, though they have been reported from Macquarie Island, 550 miles south-south-west of New Zealand proper.

Grey Ducks are the main game species among waterfowl. They are decoyed more readily than Mallards and ringing studies have shown that they are subject to a much more intense hunting pressure. Consequently there has been a tendency over many years to shorten season lengths and decrease the daily bag limit as one contribution towards conservation. However, there is little doubt that, until now, habitat destruction has been the most potent factor reducing their numbers.

Grey Ducks disperse widely. Recoveries of ringed birds over hundreds of miles are frequent and birds ringed on the New Zealand mainland have been shot in the Chatham Islands and in inland New South Wales in Australia (Balham and Miers, 1959).

New Zealand Shoveler, *Anas rhynchotis variegata*. Buller (1888) considered that this species was uncommon and absent from the extreme north of the North Island. Oliver (1955) reported it to be present in numerous localities throughout both main islands but not in large numbers. Miers (*in litt.*) sums up the present distribution as follows, 'On the coasts and lowlands where there are satisfactory swamps and lakes this species is often the second most abundant native duck. This is certainly so in Waikato, where there is some evidence of increase, and in the Bay of Plenty and perhaps in Otago too. It is absent from the south-west of the South Island'. The very moderate amount of hunting to which the species is subject is not important and indications are that Shoveler have not appreciably been reduced in either range or numbers over the last 75 years. Settlement and the advance of agriculture may in fact have favoured them. However, they have not been recorded from the Chathams since 1925 though they occasionally straggle to the Auckland Islands.

Blue Duck, *Hymenolaimus malacorhynchos*. Originally common in forested mountain ranges from about 37°S' in the North Island and throughout similar areas in the South Island the endemic and taxonomically puzzling Blue Duck is nowadays to be found only in remote and relatively unmodified localities. Here, under legal protection, moderate remaining populations are in no immediate danger of extinction. Though hunted by early European settlers and Maoris the main reason for the present reduced state of the species is doubtless the destruction of habitat following upon the clearing or damaging of the native forests. This, in turn, accelerated the natural processes of erosion and filled up many clear and swift-flowing mountain streams with rock debris. It is in the pools and rapids of unaggraded streams that Blue Ducks are chiefly found.

New Zealand Scaup, *Aythya novaeseelandiae*. 'About a century ago the Scaup was, to quote Buller, "freely distributed over the country, frequenting most of the rivers and lagoons, but seldom being met with in the bush creeks and never on the open sea shores". Now you may expect to see it, in the North Island, in parts of Northland, Waikato, the volcanic plateau and Hawke's Bay but only rarely in this island's south and west. In the South Island the species occurs on the western high country lakes from one end of the mountain chain to the other, occasionally on the eastern side of the Alps and rarely in the south-east. There is a record from D'Urville Island. It is absent from Stewart Island.' (Williams, 1963.) In 1934 Scaup were removed from the game list and any recent tendency to increase (Newcombe, 1959) may be ascribed to absolute protection plus the creation of some new habitat, as in the lakes of the hydro-electric system of the Waikato River. K. H. Miers (*in litt.*) has stated that Scaup proved very vulnerable to shooting until they were protected and has drawn my attention to the rather similar history of the Canvasback, *Aythya vallisneria*, in north America where the problems of maintaining a shootable popu-

lation have now led to the Canvasback's protection.

Surviving introduced species

Of the many species introduced (Thomson, 1922) only four now survive. The Cape Barren Goose, *Cereopsis novaehollandiae*, included in the official checklist (Fleming *et al.* 1953), is now probably extinct. Four were liberated in 1915 at Lake Hawea in western Otago and in 1936 some were reported here and at Lake Thompson, further south in Fiordland. According to Miers (*in litt.*) there has been no report of the species breeding in New Zealand for almost forty years and there are no recent sight records.

Black Swan, *Cygnus atratus*. The main reason for the liberation of this common Australian species in the South Island in the early 1860s was the hope that it would successfully control water weeds in the Avon River at Christchurch (Williams, in press). Secondary considerations were its potential as a game bird and its ornamental qualities. Liberations in other parts of New Zealand, including the Chatham Islands, soon followed and establishment and spread occurred virtually at once. Now the Black Swan is abundant throughout the country wherever there are large, shallow, fresh or brackish bodies of water carrying extensive beds of aquatic plants. The greatest concentrations are found on Lake Ellesmere, where flocks numbering tens of thousands are not uncommon in good years. At Lake Eilesmere eggs are exploited, both commercially and directly for food, and many thousands are taken in a good season without any detriment to the population. In fact, the idea is to exert some control over the swan numbers by large scale exploitation of their eggs. In some years when the population is very high and water levels are above normal, the swans suffer heavy losses arising at least in part from aspergillosis. The disease is no doubt aided in its spread by the birds' poor condition which, in turn, is caused by much of their food becoming inaccessible in the deep water.

Thousands also lived on Te Whanga Lagoon in the Chatham Islands, but K. H. Miers has recently informed me that the Lagoon has now been joined to the sea by a man-made cut. As a result of the increased salinity the weed beds have been destroyed and thousands of swans have died. The survivors are now largely confined to streams and estuaries.

Mute Swan, *Cygnus olor*. Introduced for its aesthetic appeal the white swan is widely distributed throughout the more heavily settled parts of both main islands. It exists in a semi-feral state and is nowhere abundant except on Lake Ellesmere in Canterbury.

Canada Goose, *Branta canadensis*. Since 1876 Canada Geese have been imported on a number of occasions, and these birds or their progeny have been liberated in both North and South Islands until fairly recent times, especially in Otago and Canterbury. Though they have been reported from various parts of the North Island south of Auckland, Canada Geese have so far bred only in the South Island, so these records are merely of stragglers and establishment in the North Island is yet to come, if at all.

In the South they are particularly numerous on lakes and rivers in Canterbury and Otago though they do occur in moderate numbers elsewhere, mainly east of the main chain of the Southern Alps. There is a seasonal movement from the back-country lakes and valleys where they breed to lowland waters. In late summer, for example, Lake Ellesmere, a very large shallow and brackish body of water on the east coast south of Christchurch, carries many thousands of birds and after the post-nuptial moult most will return to their breeding areas with the coming of spring.

Where most common in agricultural areas Canada Geese are considered a pest by many farmers. Flocks form in winter and closely crop pastures which they may foul to such an extent that stock will not graze them. Consequently the geese are regarded as vermin and large scale campaigns are arranged to reduce their numbers. Elsewhere in the South Island they are subject to the usual waterfowl shooting season of about one month with daily bag limits. Because of their wariness Canada Geese are not exploited to anything like the extent their populations would allow.

Mallard, *Anas p. platyrhynchos*. In common with most of the introduced birds of New Zealand, the first attempts to establish the Mallard were made during the 1860s. These early attempts were not very successful but importations were persisted with and locally-bred birds continually liberated until success was achieved. Now Mallards are well established in the North and South Islands and do best in the improved agricultural districts where they tend to replace Grey Ducks or hybridize with them. In the Wellington and Hawke's Bay provinces of the North Island and over most of the eastern side of the South Island, Mallards now predominate over Greys; elsewhere the latter still hold their own. In an attempt to conserve Grey Ducks, Mallards are not now being liberated in localities where they are not already established and sportsmen are encouraged to shoot them rather than Greys whenever possible. Ringing studies

have shown that Mallards not only sustain a much lighter hunting pressure than Greys but seldom disperse beyond 25 miles from the ringing station (Balham 1952, Balham and Miers 1959). A Mallard has, however, been recorded from Campbell Island, 350 miles south by east of the South Island (Bailey and Sorensen, 1962).

Discussion

Because of (1) the physiological peculiarity of the total moult of the primaries, (2) the relative ease with which accessible habitat may be permanently damaged or destroyed and (3) the value of waterfowl as a source of food, the Anatidae are potentially very vulnerable to man and his works.

Though man introduced mammalian predators to New Zealand he alone has generally been the most important predator both of the waterfowl themselves and of their habitats. This is especially true of European times and during this period habitat destruction by forest clearance, swamp drainage and the consequences of accelerated soil erosion and agricultural practices have almost certainly far exceeded the results of hunting and of predation by such species as the Norwegian and Black Rats, mustelids and so on. (It is impossible to assess the ultimate effect, if any, of introduced bacterial and other parasites.) Indications are that competition between native and introduced waterfowl is appreciable only with Mallard and Grey Ducks and then only in the most modified habitats.

No doubt the Polynesians relied very considerably on waterfowl for food during their thousand and more years of sole occupation and we know that they took full advantage of the post-breeding moult to capture the species they fed upon. They brought with them a frugivorous and insectivorous rat, *Rattus exulans*, and a dog, but neither is likely to have been an important predator of waterfowl. Destruction of waterfowl habitat seems to have been only on a very minor scale, especially when compared with that wrought by Europeans. The flightless North Island and South Island Geese must have been especially sensitive to hunting and so the assumption that they were finally exterminated by Polynesian man is reasonable; so too is the assumption that man was at least the proximal cause of extinction of the geographically very restricted Chatham Island Duck. About Finsch's Duck, the widely-distributed Chatham Island Swan and the mainland populations of the Auckland Island Merganser we can be less sure at present that human predation was both the ultimate and proximate cause of extinction. The disappearance of the Merganser from Adams Island is one in which man does not seem to have played the major part.

Establishment of the four extant introduced species is easy to understand: each occupies either a newly-created niche or habitat (Mute Swan, Mallard) or else what was at the time at least a temporarily empty one (Canada Goose, Black Swan).

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Age group counts of Black Brant in Izembek Bay, Alaska

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Summary

The large size of the Black Brant concentration and of the *Zostera* beds in Izembek Bay is noted, together with the timing of the concentration. Low breeding success in part of the nesting grounds prompted inauguration of population studies in Izembek Bay with age group counts, the results of which are presented.

The largest concentration of the Black Brant (*Branta bernicla orientalis* Tougarinov) of eastern Asia and western North America occurs for approximately eight weeks during the fall season in a large lagoon named Izembek Bay, located on the north coast of the Alaska Peninsula near its western extremity. This body of water is shallow, characterized by mud and sand bars exposed at low tide, and extensive beds of the angiosperm *Zostera*, known as eelgrass. The lagoon opens through three gaps between enclosing spits and barrier islands into Bering Sea.

That nearly the whole of the Brant population, along with significant numbers of other waterfowl, concentrate in this lagoon each fall before resuming their south-bound migration is owing to the very large extent of the *Zostera* beds. It is only in Izembek Bay where the very large food requirement of this substantial segment of the Pacific Flyway waterfowl can be met. The average date of arrival from the nesting grounds is 25th August, with departure in an avalanche migration following this by about eight weeks. The precise timing of the southward migration depends upon the development of atmospheric pressure conditions producing favourable winds over the long flight route across the Gulf of Alaska.

Thus each year the bulk of the Black Brant population is available for study in Izembek Bay for approximately two months in fall. This year (1963) a disaster had overtaken the nesting Brant on the Clarence Rhode National Wildlife Range in June in the form of a 'storm tide' (King, 1963). A storm moving across Bering Sea had coincided with spring tides, raising the height of high water to flood the all-important zone occupied by nesting Brant just above mean high water. 'Extensive windrows of debris consisting of huge logs, sticks, thousands of eggs, and downy Brant covered the drift line above the level of the nesting flats' (FWS, 1963). Heavy damage was done to production in this part of the Brant nesting grounds. This prompted a decision to conduct age group counts as a first step in population studies on the Izembek National Wildlife Range.

The count was made in late October, it was in fact begun the very day the southward migration was inaugurated. The effort required just over two weeks as not every day proved rewarding, for storm conditions intervened, and in some cases the birds did not approach the observer closely enough for age determination. Good counts were secured on four days when 5,211 Brant were observed at close range and tallied according to whether they were in first year or adult plumage. First year birds were distinguished by the presence of white edgings to the wing coverts. Other juvenile characteristics, such as the absence of a white neck ring, or the dull black appearance of the plumage as contrasted with the shiny black of the adult, change during the time spent in Izembek Bay and are not considered reliable guides for this purpose.

A good quality 20 power telescope, known to us as a 'spotting scope', was employed mounted on a tripod, leaving the observer's hands free to manipulate a Veeder-Root counter in each hand. The habit of Brant to swim steadily on a fairly definite course when feeding on *Zostera* leaves that are floating free in the water was helpful in conducting the counts. The course of a flock of birds approaching on the water could be anticipated and the telescope swivelled so that a swimming line of birds could be closely observed for plumage characteristics. Birds grazing on an exposed bar, while walking ahead steadily, tended to be more concentrated, hence more difficult to tally. No flying birds were included in the count, but all swimming or walking birds, whether in large or small flocks, that approached the observer closely enough for accurate determination of plumage characteristics were counted.

The counts recorded for the first two days are based on observations made along a half mile strip of beach four miles south-south-east of Grant Point in the part of Izembek Bay known as Applegate Cove. The counts for the last two days were recorded from a point jutting into the Bay two and a half miles east of Grant Point. The effective separation of the two areas over the route taken by flying Brant was

approximately seven miles. These observation points were chosen because of their being free of interference from waterfowl hunters, hence the Brant approached the shore more closely.

The counts are presented as they were recorded, illustrating the size flocks observed. The reader will note the very much larger size of flocks recorded on the final day of the count. This disparity resulted from changes in the tide: on 28th the tide was low while the counts were in progress and the birds were grazing on exposed bars in large, dense flocks.

The sharp difference in percentages of first year birds in the two areas suggests the existence of a regional distribution in the Bay that is, perhaps, a reflection of nesting ground distribution. The movements of Brant in the Bay are so large and continuous as to obfuscate the detection of such a fact prior to completion of this count. Unfortunately, counts were unsuccessful when attempted in other parts of the Bay, for various reasons, nor do we have family size counts. These shortcomings will be remedied, for since nearly the whole of the Black Brant population is available on the Izembek National Wildlife Range a sample taken here on a broad enough base can be expected to furnish the most reliable index possible for this species.

The counts herein presented are surprisingly high in view of the forecast of little or no Black Brant production on the Clarence Rhode Range (FWS, 1963). The implication suggests that production in other nesting areas was high enough to offset this complete loss. If a regional distribution of Brant corresponding to nesting distribution can be demonstrated in Izembek Bay the disparity in production success of the various segments of the population should emerge here also.

date	*number of Brant in flock*	*number of first year Brant*	*percentage of first year Brant*
23 October	94	16	
	125	20	
	136	15	
	124	9	
	205	26	
	38	12	
	79	15	
	140	58	
	151	16	
	1,092	187	17
24 October	213	34	
	346	40	
	52	11	
	313	82	
	31	8	
	251	55	
	1,206	230	19
25 October	304	117	
	48	13	
	150	61	
	513	117	
	58	17	
	111	35	
	47	13	
	84	25	
	1,315	**398**	**30**
28 October	818	239	
	193	36	
	587	153	
	1,598	428	**26**
Total	**5,211**	**1,243**	**23**

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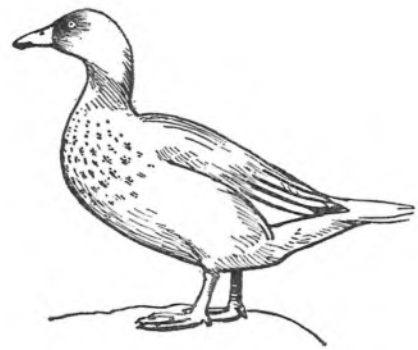

Section 3

Photographs

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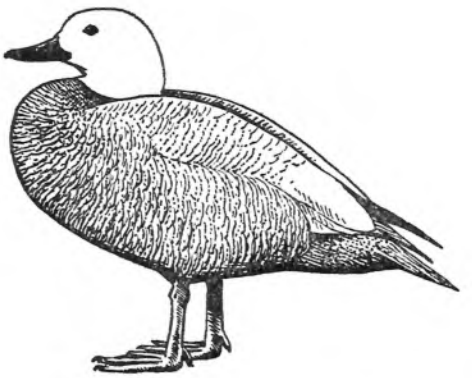

Paradise Duck