Movements and flock behaviour of Barnacle Geese on the Solway Firth

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Summary

Caerlaverock National Nature Reserve is described in relation to its importance to wintering Barnacle Geese. Barnacle Geese arrive in the Solway Firth, from the north or north-east, in late September or early October, though 40 days may elapse before the flock is at full strength. Immigration reaches its peak during the first 20 days of October. Northward migration may be more abrupt and occurs most often in late April. In winter quarters Barnacle Geese occupy three main types of habitat – saltmarsh, farmland and tidal sand. Factors which appear to limit feeding areas are discussed. Changing conditions in the Solway and the incidence of bright moonlight apparently affect Barnacle movement to some extent. Amongst recognisable causes of disturbance, the geese react most often to passing aircraft, moderately often to man, and least often to other birds and farm stock. Barnacle Geese spend most of their daylight hours in feeding, except when occupying tidal foreshore. Their observed activities, including flock segregation and characteristics of flight, are described and discussed.

Introduction

As the first full-time Warden of Caerlaverock National Nature Reserve, Dumfriesshire, the writer has been in a position to observe and record, almost daily, the numbers, local movements and general behaviour of wintering Barnacle Geese *Branta leucopsis* in the inner Solway Firth over the eight seasons from 1957–58 to 1964–65. Over this eight-year period an average daily time of four hours in each of a total of 818 days was spent in observing the geese. On a further 334 days the birds were absent from Caerlaverock though known to be elsewhere in the Solway.

In order to understand much of what follows it is necessary to briefly describe Caerlaverock National Nature Reserve and explain its management from the point of view of wildfowl conservation. On 4th April, 1957, the Caerlaverock merses and offshore tidal sandflats were declared a National Nature Reserve by agreement with His Grace the Duke of Norfolk, for the merses, and the Crown Estate Commissioners, for the foreshore. On 21st August, 1957, a full-time Resident Warden was appointed, and on 12th September, 1957, 22 bye-laws came into force.

One reason for the declaration of the Reserve was the fact that for very many years the Caerlaverock merses have been the most important wintering grounds of Barnacle Geese on the mainland of Great Britain. The Solway flock had become much reduced during the first half of the present century. It was desirable that disturbance to at least a small part of the wintering grounds should be reduced by the creation of a National Wildfowl Refuge as an integral part of the Nature Reserve, in addition to the total legal protection given to the species in Great Britain from 1st December, 1954, by the Protection of Birds Act (1954).

Caerlaverock was also a traditional wildfowling area, and so that an important and increasing section of the community should not be prevented from continued enjoyment of their sport, provisions were made under the byelaws whereby permits to shoot wildfowl on a portion of the Reserve between one hour before sunrise and one hour after sunset, and subject to the Protection of Birds Act (1954), could be issued to a limited number of applicants.

The Nature Reserve comprises about 12,000 acres of tidal sandflats known as the Blackshaw Bank, a very important roost for grey geese as well as Barnacle Geese, and about 1,500 acres of grazed merse (or salt marsh above high water mark ordinary spring tides), the whole Reserve being bounded to east and west by the deep water channels of the Lochar Water and the River Nith.

Under the Nature Reserve Agreement with the Duke of Norfolk the merses were apportioned as follows:

(i) About 580 acres at the east end to form a sanctuary or refuge (East Park) into which public entry is restricted under the byelaws.

(ii) The shooting area, a central section of about 470 acres.

(iii) The western area of merse (Lantonside), where shooting rights are retained (though seldom exercised) by the owner.

No shooting is permitted on the tidal foreshore, though the public have unrestricted access to it, as well as to all merses excepting East Park. In practice, however, the tidal sandflats are unfrequented by the public during the winter months and are potentially dangerous at all times.

The agricultural land adjoining the Reserve's northern boundaries belongs to the Duke of Norfolk, who only very infrequently exercises his shooting rights thereon. On the tidal sandflats east of the Lochar Water there is no restriction on shooting, though the shootings over the adjoining merses (Priestside and Powhillon) are leased to the Solway Wildfowlers' Association, who actively discourage 'sand-crawling' by wildfowlers.

Thus the East Park sanctuary, which is the area most resorted to by Barnacle Geese, is flanked to east and west by areas where shooting pressure is usually quite intense; is bounded to the south by an undisturbed roosting area; and, excepting Powhillon, abuts to the north upon agricultural land where shooting is virtually non-existent.

Migratory movements

Migration in autumn

Gladstone (1910) claimed that the first appearance in autumn of Barnacle Geese in Dumfries occurred on 28th–30th September and that the geese 'always arrive on our shores during the afternoon or evening'. He subsequently reported (Gladstone, 1923) the exceptional arrival of 12 Barnacles on Lantonside on 6th September, 1912. Blezard (1943) records another early gaggle on 15th September, 1913, and Laidlaw (1904) three crossing Maxwelltown from the north-north-east at sunrise on 18th September, 1903. Since 1957 arrival dates at Caerlaverock have ranged between 22nd September and 7th October. Build-up to full strength may thereafter occupy as little as eight days or as much as 40 days (Table I). It must be borne in mind, however, that the full complement of birds may have arrived in the Solway Firth prior to the date on which they are first seen at Caerlaverock, having spent the intervening days at Rockcliffe or elsewhere. The same, of course, could possibly be true of the first arrivals, though there is no known case in recent years of Barnacles being seen in Cumberland before their appearance at Caerlaverock.

It should, perhaps, be mentioned that in 1965 numbers had attained 3,000 by 11th October and remained at this level until 5th November, when the peak figure of 3,700 was reached for one day. There was a second, similar peak in mid-December, but the first appears sufficiently early in the season to be included in the initial build-up period.

In three years there has been good evidence of newcomers arriving in Solway from the north. At midday on 3rd October, 1957, the first 40 Barnacle Geese were seen flying in at a great height from a northerly direction. On 1st October, 1958, the first 24 were similarly seen very high and approaching from the north, to be followed by a further 24 which R. T. Smith reported flying due south over his house, 12 miles north-east of Caerlaverock, at 07.30 G.M.T. on 4th, on which date an influx of 450 occurred at Caerlaverock. At dusk on 12th October, 1962, only 200 Barnacle Geese were present at Caerlaverock, but at 23.30 G.M.T. on the same date R. T. Smith heard a large pack of Barnacles passing over his house and at daybreak on 13th, 2,000 birds were present at Caerlaverock.

Most Barnacle Geese have left Spitsbergen by the end of August, and birds have never been recorded there later than 22nd September (Løvenskiold, 1964). During the last week of August, 1964, M. Norderhaug (unpublished report) found only 60–70 Barnacles in the Kapp Berg – Kapp Borthen area, where there had been 600 six weeks earlier, and only a very few birds elsewhere. The breeding localities were deserted, and sightings of Barnacles at Isbjornhamna and a flock of

Table I. Arrivals of Barnacle Geese at Caerlaverock N.N.R., 1957–65.

	First arrival		*Completion of flock*		*Number of days*
Year	*date*	*number of birds*	*date*	*number of birds*	*from first to last arrivals*
1957	3rd Oct.	40	29th Oct.	1,000	27
1958	1st Oct.	24	8th Oct.	1,250	8
1959	24th Sept.	60	13th Oct.	1,650	20
1960	28th Sept.	50	9th Oct.	2,500	12
1961	7th Oct.	400	1st Nov.	2,800	26
1962	27th Sept.	17	15th Oct.	2,700	19
1963	1st Oct.	17	30th Oct.	3,300	30
1964	22nd Sept.	28	12th Oct.	2,500	21
1965	27th Sept.	2	5th Nov.	3,700	40

60 passing south near Hyttevika on 25th August indicated that southward movement had begun. The first arrivals in Solway in 1964 were 28 at Caerlaverock on 22nd September.

About four weeks elapse between the desertion of the breeding grounds and the first arrival in Solway. It seems probable that the birds proceed in a leisurely fashion down the Norwegian coast, thence crossing the North Sea to strike the British coast usually somewhere between the Shetlands and north-eastern England. Various observers have reported small numbers of Barnacle Geese in autumn at points between Fair Isle and Yorkshire. G. Bolam (1912) suggested that small flocks seen at Holy Island might be on passage to or from the Solway, and R. A. H. Coombes confirms that he has seen Barnacles arriving in the Solway from the north-east (Bannerman, 1957). Several other observers have reported movements from the north-east in autumn and a reverse movement in spring (Blezard, 1943; Bannerman, 1957). The statement by Gladstone (1910) that 'they come down in a direct line from the Clyde, probably from the Hebrides' does not now appear correct and may refer to some of the East Greenland population. Gladstone subsequently quotes one observer as having seen Barnacle Geese resting on moorland near Moffat (about 25 miles due north of Caerlaverock).

Recent recoveries of Barnacle Geese ringed at Caerlaverock and in Spitsbergen amplify these observations (Table II). The number of islands off the Norwegian coast capable of sustaining Barnacle Geese for a few weeks in autumn is large, and the number of people visiting them and liable to report rings from geese shot is small, so that the distribution in Norway is not likely to be fully understood for some years.

A search in local journals for autumn records of Barnacle Geese seen in southern and eastern Scotland and northern England has yielded few, though they occur annually in Northumberland and in most years in the Lothians. Table III shows that most records refer to the first three weeks of October. In the seven years 1957–63 arrivals were detected at Caerlaverock on 34 days out of a possible 245 in the period between 22nd September and 26th October. Sixteen reported instances of arrivals or passage elsewhere occurred on those 34 days, and only 22 on the remaining 211 days. More intensive observations would be needed to demonstrate whether the extent of 'fall-out' of migrants is related to the time of immigration or to particular weather conditions.

Migration in spring

Barnacle Geese leave the Solway Firth for the north usually during the second half of April: from 18th–20th according to Gladstone (1910). Blezard (1943) stated that they 'leave, usually in a body, generally within the week following 21st April'. In 1962, 300 were present at Caerlaverock up to 8th May, and in 1965, 450 remained until 5th May. The main departures often take place from Rockcliffe, to which the majority of the Solway flock resort late in the season. Exceptions were 1959 and 1960 when all or most of the Solway population were present at Caerlaverock on 29th and 14th April respectively. In both cases all the birds had departed within 48 hours.

Barnacle Geese do not arrive in Spitsbergen until late May or early June, so that, as in autumn, their migration must be interrupted. Though there are as yet no recoveries from Norway in the spring, a Spitsbergen-ringed goose (Stavanger 307024) was found dead at Rolfsuy, Finnmark (71.00N, 24.00E) about 10th

Table II. Recoveries in September, October and November of Barnacle Geese ringed in Spitsbergen and near Caerlaverock N.N.R.

Ring	*Where found*	*When found*
Ringed Spitsbergen July 1962 (*Stavanger Museum and Statens, Viltunpersøkelsre rings*)		
20164	Burgh Marsh, Cumberland	2.11.64
20190	Coquet Island, Northumberland	17.10.62
20289	Solway Firth	10.11.63
309575	Sandvaer, Helgeland, Norway (65.54N, 11.58E)	26.10.64
309586	Vigra, Ålesund, Norway (62.33N, 6.06E)	23.10.62
310445	Fair Isle, Shetland	12.11.62
Ringed Store Dunøy, Spitsbergen, 27.7.64 (*stat. vilt. rings*)		
21626	Sandvaer, Helgeland, Norway	2.10.64
21655	Sandvaer, Helgeland, Norway	12. 9.64
Ringed near Caerlaverock, February 1963 (*B.T.O. rings*)		
101.1351	Florö, Norway (61.36N, 5.04E)	8.10.64
101.1446	Druridge Bay, Northumberland	12.10.64
101.1565	Walton, Brampton, Cumberland	12.10.64
101.1585	Irvine, Ayrshire	20.10.64
101.1633	Blaydon-on-Tyne, Durham	17.10.63

Table III. Frequency of records of Barnacle Goose migration over eastern and southern Scotland and northern England in autumn, 1950–64. (Records from Caerlaverock excluded.)

Period	*Number of records*
before Sept. 15	1
Sept. 15–20	4
21–25	7
26–30	2
Oct. 1–5	12
6–10	12
11–15	12
16–20	14
21–25	5
26–30	4
Oct. 31–Nov. 4	1
Nov. 5–9	1
10–14	1
after Nov. 14	2

July, 1961, and a British-ringed one (101.1419) was found shot at Sandnessjoen, Helgeland (66.01N, 12.40E) on 7th July, 1963. A hint that the spring migration may be more complicated is given by the recovery of Stavanger 20265, found dead near Harboore, Jylland, Denmark (56.37N, 8.15E) on 14th June, 1963.

Local movements

Once the Solway Barnacle Geese are established in their winter quarters, their movements are very local and of a simple pattern. The diet of the Solway Barnacles has yet to be investigated, but Campbell (1936) found that the food of Barnacle Geese wintering in North Uist was very largely green grasses (93.2 per cent), including *Festuca rubra*, which is the dominant vegetation of the Caerlaverock merses (Marshall, 1962). By day, and occasionally in bright moonlight by night, the Barnacle Geese spend much of their time on the merse, flighting to and from the sandflats at dusk and daybreak. At some periods all or part of the flock will resort to farmland – almost invariably pasture-land, though stubbles are very occasionally visited. In the eight-year period during which Barnacle Geese were under observation, it was computed that during daylight hours they spent 65 per cent of their time on the merse, 28.5 per cent on farmland and 6.5 per cent on tidal sandflats (Table IV).

These figures must, however, be treated with reserve as they do not necessarily represent a true pattern of 'natural' movements. Some farmers have complained of damage when Barnacle Geese have resorted to farmland, and the birds have often been moved from fields to merse or sandflats by using bird-scaring devices. Other farmers did not object to Barnacle Geese resorting to their land, and sometimes the flock has used such ground for protracted periods.

It is difficult to assess whether or not there exists a correlation between flock size and a tendency to resort to farmland. The farmland most favoured – that immediately to the north of the Wildfowl

Table IV. Proportionate use of different habitats by Barnacle Geese at Caerlaverock N.N.R. during daylight, 1957–65.

Season	*Numbers of geese* *Max.*	*Average*	*Farmland*	*Merse*	*Sandflats*	*Bird-scaring intensity*
1957–58	1150	500	20%	68%	12%	Nil
1958–59	1300	900	47%	39%	14%	Very low
1959–60	1650	1000	23%	70%	7%	High
1960–61	2500	1400	19%	74%	7%	High
1961–62	2800	1600	18%	79%	3%	Very high
1962–63	2700	1000	10%	89%	1%	Very high
1963–64	3300	1400	47%	51%	2%	Low
1964–65	2500	1200	44%	50%	6%	Low
Average:			28.5%	65%	6.5%	

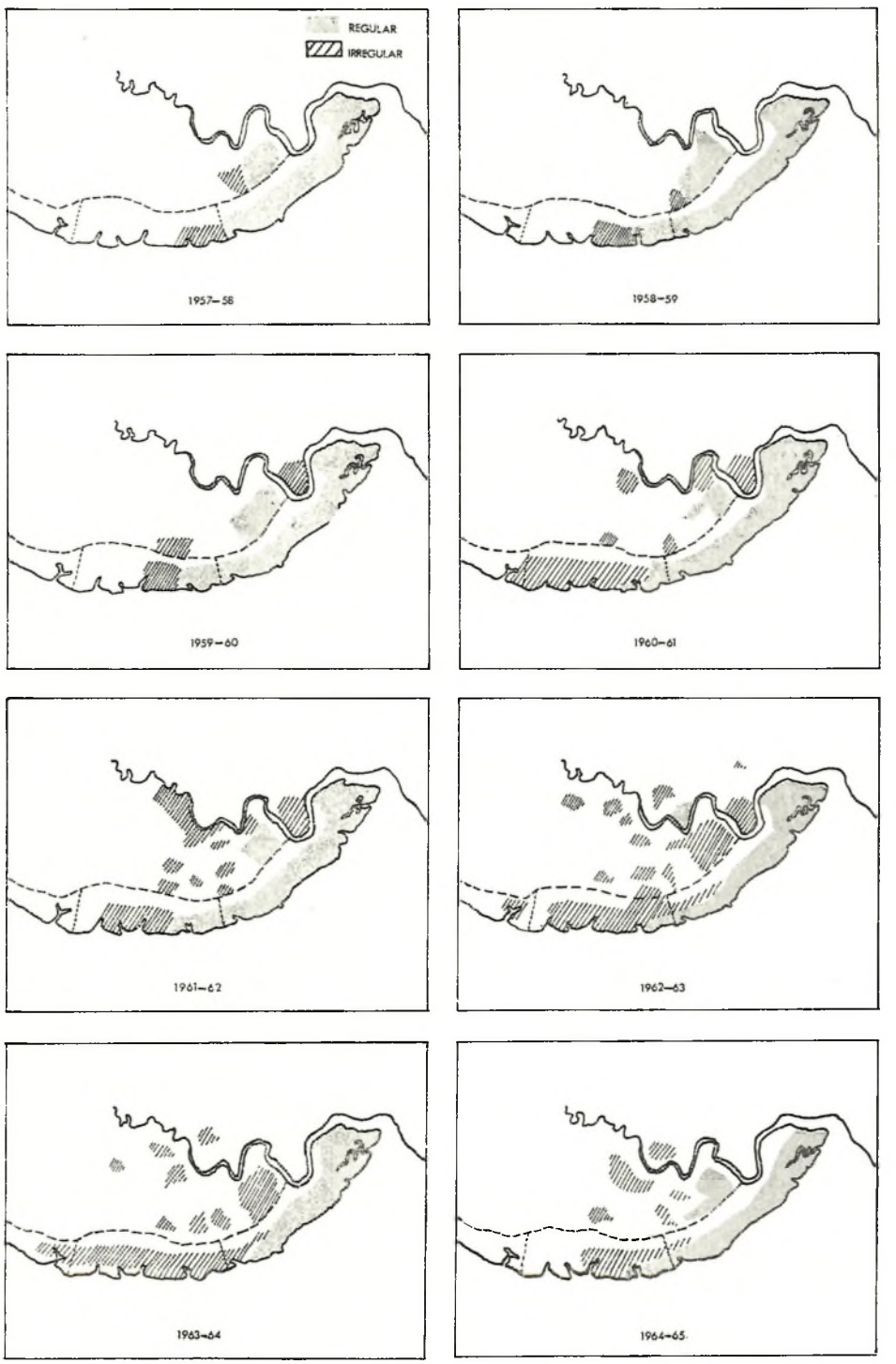
Refuge – was also that which was the subject of most complaints of damage. There have been periods, however, when bird-scaring measures were not employed there with any regularity, and observations indicated that at such times the Barnacles tended to resort to the farmland more persistently (Table IV).

Some likely reasons for the Barnacle flock confining itself to a large extent to the Wildfowl Refuge have already been mentioned. However, a given acreage of grazing habitat will support only a given number of geese for a given period, though conditions obtaining in this habitat are not static and may vary from year to year. There is the strong possibility of competition for food with farm stock, as the Refuge area is heavily grazed by cattle and sheep throughout the year. Both quantity and quality of the vegetation may vary depending upon weather conditions. For instance, a very wet summer and autumn in conjunction with heavy demands upon grazing by stock may well result in 'puddled' conditions which Barnacle Geese do not appear to like. Again, hard weather following flooding by either rain or tides can result in the merseland becoming virtually a sheet of ice with food almost unobtainable. Gales accompanying the highest tides will also result in the merses being inundated for longer periods and to a greater depth than at other times.

The feeding distribution maps (Figure 1) indicate a marked tendency on the part of the Barnacle flock, as it has increased since 1957, to spread westwards along the merse and northwards into farmland. The spread into farmland has been to some extent deterred, as has been mentioned, by the use of bird-scarers. Undoubtedly, were it not for the existence of the controlled shooting area immediately to the west of the Refuge, the Barnacle flock would spread out westwards along the merse. It would almost certainly also resort much more than it does at present to other Solway salt-marshes were it not for shooting pressure in those areas. Evidence in support of this contention has manifested itself in three ways: (*a*) On Sundays, when wildfowling is prohibited under Scottish law, the Barnacle Geese have not infrequently resorted to the Shooting Area to graze. They have behaved similarly when for various other reasons shooting pressure has been negligible. The Barnacles also attempt to enter the Shooting Area at other times, but are quickly deterred by the sound of shots or the sight of wildfowlers, and return to the Refuge. (*b*) Due to outbreaks in the district of foot-and-mouth disease during the winter of 1960–61, shooting was suspended at Caerlaverock Nature Reserve between 26th November and 11th December (16 days), and between 25th December and 20th January (27 days). Human disturbance during these periods was at an absolute minimum. Throughout the first period the movements of the Barnacle Geese appeared to be unaffected, but after eleven days of the second period had elapsed the birds suddenly moved *en masse* over the whole of the Shooting Area and beyond, remaining there daily until the end of restrictions. Thereafter, such was the birds' attachment to this ground that, despite the resumption of shooting, considerable and persistent 'herding' was necessary in order to move them back to the safety of the Refuge. (*c*) All legal wildfowl shooting ceases after 20th February. On six occasions all the Barnacle Geese have left Caerlaverock within seven days of this date for marshes in Cumberland – chiefly Rockcliffe – where they could resort unmolested to untapped food supplies. On one of the remaining two occasions the geese did not leave Caerlaverock until 8th March, 16 days after the cessation of shooting. The other occasion was in 1963 when the Barnacle flock remained at Caerlaverock until 10th March, a date which marked the end of a slow thaw following a very prolonged spell of severe arctic conditions. The actual timing of some of these movements may also be influenced by the phase of the moon, a factor to be discussed later.

If merse grazing on the Refuge is inadequate and the birds are deterred from overflowing on to farmland and adjacent merses, the flock must extend its range in some other way. This has been achieved by all or part of the Caerlaverock flock spending varying periods of the winter elsewhere. As has already been described, the entire Caerlaverock population absents itself annually after shooting has ceased, for periods of from 20 to 37 days. Fluctuations in numbers ranging from shorter periods of total absence to the presence of the entire flock have occurred every season, but it was not until 1961, when the numbers of Barnacles had risen to 2,800, that the flock displayed a marked tendency to divide into two main units of approximately equal size, though this did not take place until about 10th February. From that date onwards, however, numbers at Caerlaverock never rose above 1,800 and were sometimes as low as 1,200. In the following season, 1962–63, the flock, numbering 2,700, divided into approximate halves before the end of October, and thereafter the birds were present at Caerlaverock in full strength for only 36% of the total time

Figure 1. Distribution of Barnacle Geese over feeding areas on and near Caerlaverock N.N.R.



they were under observation. The absent half-flock, often in two or three subdivisions, were reported on several occasions in the Southerness area by W. Austin and others, at Rockcliffe and Moricambe by R. Stokoe, and on sandflats near Rockcliffe by R. T. Smith. In 1963, half of the flock of 3,300 birds left Caerlaverock on 1st November, within two days of the completion of the initial build-up of the flock. Five days later R. T. Smith reported 'a large number' at Rockcliffe. Throughout the remainder of that winter rarely more than half of the original flock of 3,300 was present at Caerlaverock.

It is fortunate that present conditions at Rockcliffe appear to favour the Barnacle Geese. This marsh, which is larger and less liable to tidal inundation than the Caerlaverock Refuge, thus provides a very valuable 'overspill' area, if not an entirely independent 'base', for the Barnacle flocks. In March, 1964, J. G. Harrison and J. Ruxton counted 4,000–4,500 Barnacles at Rockcliffe, including a leucistic bird that had not been seen at Caerlaverock. This suggests that some 700–1,200 Barnacle Geese had never been to Caerlaverock at all. Similarly, J. Ruxton counted 3,300 at Rockcliffe on 28th March, 1965, though the writer, who searched the Solway coasts from Mersehead, Kirkcudbrightshire, to Moricambe, Cumberland, between 26th and 30th March, located no more than 2,500 at Rockcliffe on the latter date.

It is interesting to note (Table IV) that as the maximum numbers of Barnacles at Caerlaverock have steadily risen between 1957 and 1965, the average number present has on the whole shown a tendency to 'level down' to a mean figure of about 1,100. This 'average' is calculated by dividing the sum of all counts made at Caerlaverock throughout the season by the number of days on which the birds were known to be in the Solway. Thus, in 1964–65, 214,700 Barnacles were counted during a wintering period of 158 days:

$\frac{214,700}{158} = 1,358$ (= 1,400, rounded to the nearest hundred).

The possible influence of moonlight on movements

During the season 1958–59 it was first noticed that certain marked movements or fluctuations in numbers of the flock of Barnacle Geese at Caerlaverock occurred simultaneously with periods of bright moonlight, during periods extending from the first to the last quarter of the moon. It was already known that Barnacles, like other geese, will often continue to feed during bright moonlight, and that their normal flighting rhythm thus becomes temporarily disrupted. It was also appreciated that the high spring tides of full-moon periods would inundate sandflat roosts to a greater extent than usual, and that at times the merse feeding grounds would also be affected.

However, over this and succeeding seasons a series of moonlight movements apparently unassociated with tide heights has been observed and recorded. In the 51 periods of bright moonlight involved in the survey there were 41 marked migrational or local movements of the Barnacle Geese compared with 17 similar movements during phases of the moon between last and first quarter, 'marked movements' being defined as known movements of a substantial number of birds between Caerlaverock and other parts of the Solway, and also main arrivals in autumn and departures in spring.

Over a period of seven years, six first appearances or main arrivals in autumn coincided with bright moonlight. Two cases are especially noteworthy. In October, 1960, 2,000 birds arrived within 48 hours following the full moon, and the remaining 500 three days later. In October, 1962, the main arrival of 2,000 birds occurred during the night of the full moon. There is no evidence of comparable migratory movements on dark nights.

It is often difficult, if not impossible, to obtain precise spring departure dates because the Barnacle flock invariably moves from Caerlaverock to other parts of the Solway soon after the close of the wildfowl shooting season. In April, 1959, however, there was a final departure of the whole population of 1,300 birds within the 48 hours following the full moon. Similarly in April, 1960, the total population of 1,650 returned to Caerlaverock from Rockcliffe after a five-weeks absence within the 48 hours following the full moon, and almost immediately departed on northward migration. On the other hand, in May, 1962, 300 birds left Solway on the date of the new moon; 400 did likewise on the day following the new moon of April, 1963; there was a similar final departure of 1,150 birds within the 48 hours preceding the first quarter in April, 1964; and in 1965, 450 birds which had returned to Caerlaverock on the fifth day following the April full moon after an eight-week absence, did not depart north until the new moon of May.

The only reason for these movements, particularly the migratory movements, to suggest itself to the writer is the possibility that Barnacle Geese prefer to travel by night, particularly where moonlight may perhaps aid navigation across the North

Sea. Passage overland and along the Norwegian coast may be less strongly related to moonlight.

Reactions of the flock to disturbance

Close observation of the flocks of Barnacle Geese wintering at Caerlaverock has revealed the immediate reactions of the birds to various forms of disturbance. During a sample study involving one complete winter season there were 203 witnessed disturbances of the flock:

By man on the ground	33 (16.2%)
By aircraft	71 (35%)
By other birds	15 (7.3%)
By farm stock	3 (1.5%)
Cause unknown	81 (40%)

The general effects upon the Barnacle Geese of these various forms of disturbance may now be summarised.

By man and stock

Disturbances in this category were caused directly by occasional trespassers, by the Reserve Warden in pursuance of necessary work, by the occupying farmer or his workers tending stock or repairing fences, and indirectly by the noise of tractors, close gunshots and bird-scaring detonators. Stock, notably sheep, occasionally take fright for some unknown reason, and when they run towards the geese they may flush them. When disturbed by people or stock the geese tended to move right away from the source, sometimes quitting the Wildfowl Refuge entirely. If the occurrence took place towards dusk, premature flighting was precipitated, the birds moving in a body to the sandflats and remaining there until dark. At other times the general tendency was for the birds to drift back to more or less their original position in somewhat leisurely fashion, moving in small parties at first until about half or two-thirds of the flock had moved, the remainder then rising in a body and joining those which had already returned.

On 2nd February, 1963, a Wildfowl Trust team rocket-netted 316 birds out of a flock of at least 2,000 on a field adjacent to the Wildfowl Refuge. Uncaptured birds departed in a flock towards the sandflats. After sexing, weighing and ringing, captured birds were of necessity released singly because the holding cages normally used to ensure a mass release could not be used. Many of these birds were released after darkness had fallen and each flew straight out towards the sandflats. On the following day Barnacle Geese were widely scattered, several hundreds being in fields near that where the catch was made[c] but some mixing with flocks of Pink-footed Geese *Anser brachyrhynchus* on fields up to two miles inland. On 4th February, however, the Barnacles had reintegrated themselves. A flock of 2,000 containing many newly ringed birds was then seen feeding normally on the merse.

By aircraft

Nearly all visible aircraft at any height almost invariably flush the Barnacle Geese though, in general, the lower the aircraft, the greater seems to be the panic engendered in the geese. Aircraft at low altitudes, even when concealed by mist or cloud, may also often flush the geese. In practically all cases the geese settle within a few minutes and resume feeding or resting in approximately the same area as that from which they were flushed. Low-flying helicopters, which are rare, cause considerable alarm and can scatter the flock quite widely. Some birds sometimes then leave the vicinity altogether, and it may not be until the following day, or even later, that they reassemble. In February, 1961, the Barnacle flock was very badly disturbed by low-flying helicopters and large search aircraft which patrolled the Caerlaverock area for two consecutive days following the crash on Blackshaw Bank of an American fighter aircraft. However, the birds did not leave the locality and settled down normally on the third day, after this activity had ceased.

Because of their much higher speeds, jet fighter aircraft cause much less apparent disturbance of the flock than do propeller-driven aircraft, which are in view for longer periods.

By other birds (excluding geese)

Exceptionally Barnacle Geese will rise when a Heron *Ardea cinerea*, or Great Black-backed Gull *Larus marinus* passes over or close to them, and usually, though not invariably, upon the appearance of a Peregrine *Falco peregrinus*, Merlin *Falco columbarius* or Hen-Harrier *Circus cyaneus*. The reaction to this type of disturbance closely follows the pattern of aircraft disturbance, both factors probably producing similar stimuli in the geese. The number of records of disturbance by birds may be too low, as some of the disturbances attributed to unknown causes may in fact have been caused by hawks invisible to the observer at a distance.

By other geese

Small parties of grey geese moving about by day had little or no disturbing effect upon Barnacle Geese. However, when a sizeable skein flighted over, calling, the tendency was for the Barnacles to rise and move in the same general direction as the

grey geese, though at a much lower altitude. This was seen to occur only during late afternoon in winter, and when this 'premature flighting' of the Barnacle Geese was precipitated the birds usually flew to the sandflats and remained there, presumably to roost. During morning flight, when grey geese may flight landwards either earlier or later than the Barnacles, this sympathetic behaviour has not been seen. Barnacle Geese normally roost much nearer to the shore than do grey geese and have never been seen to mix with them on the roosting grounds.

By unknown factors

40% of disturbances were of unknown origin. They might have included an unseen predator such as a fox or falcon, the calls of distant geese of either the same or different species which were beyond the observer's range of hearing, or some inexplicable tension or nervousness on the part of individual Barnacles which infected the rest of the flock. It is not thought that distant gunshots enter this category, as the geese appear quite accustomed to the desultory firing that takes place more or less continuously from about October to February. In practically all disturbances of this kind the results were not far-reaching. The flock seldom moved very far and settled down again within a few minutes. Normal flighting movements have not, of course, been included in the figures for this type of disturbance.

Panics

Some forms of disturbance, such as shooting, bird-scaring detonators, helicopters or low-flying aircraft, and the presence of a falcon, occasionally produce a type of panic reaction within the Barnacle flock. When this occurs, the geese rise in a body, often to a considerable height, and begin to wheel and dive at high speed and sometimes in complete silence, in a manner strongly reminiscent of a pack of waders. The geese then may or may not move away from the source of the disturbance, and in some cases will, after a few minutes, abruptly cease their swift, wheeling flight, resume calling and quietly alight at or near the point from which they originally rose.

General flock behaviour

Studies of the daylight activities of the Barnacle flock covered two complete winter seasons and were accomplished by the selection of 100-bird samples watched closely for periods of up to 45 minutes. These activities fell into four main categories: feeding, resting, preening and bathing, and aggression. The type of activity depended to a major extent upon the type and condition of the ground on which the flock was stationed at the relevant time. Thus, when the flock was on the merse, 87.2% of its time was spent in grazing, with the remainder of the time divided between resting (8.9%), preening and bathing (3.3%), and quarrelling (0.6%). When on farmland 94% of the birds' time was occupied by feeding, 4.8% in resting, 1.1% in care of the plumage and only 0.1% in hostile activities. When on the sandflats during periods between normal morning and evening flighting, 95% of the flock's time was spent in resting, standing idly, squatting or dozing. The remaining 5% of the time was spent mainly in preening or bathing.

The total time spent in aggressive activities was small. Aggression was never long sustained and consisted usually of a few wing-flaps accompanying a desultory peck or a short, darting run at a near neighbour. Nothing remotely resembling actual fighting was ever witnessed. As the flock was invariably absent from Caerlaverock from late February until final departure occurred, evidence of any increased aggressive activity in spring is lacking.

Barnacle Geese usually keep up a continuous low chatter while feeding, and it is thereby often easy to detect their whereabouts even when they cannot be seen. Very occasionally, however, the flock will feed for lengthy periods in almost complete silence. On rising into the air, for whatever reason, the flock usually breaks into a loud clamour of calls, though one notable exception to this rule has been discussed. After evening flight, when the birds have settled to roost on the sandflats they quickly fall silent.

When moving between roost and feeding-ground, or when moving locally about the Solway, Barnacle Geese almost invariably fly in a compact though formless mass and seldom exceed an altitude of about 2–300 feet. Migratory flight, however, appears to occur at much greater altitudes and, as with other goose species, the characteristic skeins are then formed.

Barnacle Goose flocks show a marked disinclination to mix with other geese. In the weeks preceding spring migration it is commonplace for flocks of Greylag *Anser anser* and Pink-footed Geese to resort to merses where Barnacles are feeding. The latter, however, retain their identity as a flock, continually edging away from any encroaching outliers of grey goose parties. Similar separation of the Barnacle Geese from others on the roosts has already been mentioned.

It may be of interest, however, to add that stray individual Barnacles are occasionally found with flocks of other geese, especially Greylags and Pink-footed. The writer has also noted that geese of all species, when unable to undertake northward migration through injury, will join forces during the summer months. In the summer of 1964, for example, two Barnacles, two Greylags and one Pink-footed Goose formed an almost inseparable unit which was temporarily supplemented in September by one Brent Goose *Branta bernicla*.

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Wildfowl Survey in south-west Asia: progress in 1965

CHRISTOPHER SAVAGE

Summary

In this first full year of the survey, information and observations have been collected from Jordan, Iraq, Iran, Pakistan and India, and two working papers have been prepared. The reconnaissance of wildfowl habitats in West Pakistan was continued with special attention to those in Sind and a visit was made to Chitral to study the incidence of trapping during the spring migration. The ringing of ducks in West Pakistan was got under way and special efforts have been made to improve the rate of reporting Russian rings. Of special interest during the year were the protection of the White-headed Duck *Oxyura leucocephala* at its principal habitat in West Pakistan, and news of the Falcated Duck *Anas falcata*, Chinese Spotbills *Anas poecilorhyncha zonorhyncha*, and the White-winged Wood Duck *Cairina scutulata* from Assam.

Introduction

The survey has continued to develop as outlined in the 16th Annual Report (Savage, 1965a), and has benefited from valuable information contributed by several new observers. The Central Ringing Bureau in Moscow and the Institute of Zoology, Academia Sinica in Peking have shown interest in the project with promise of future co-operation and exchange of information. Liaison with the Game Departments of Iran and Pakistan, and with the Bombay Natural History Society has also been developed as corner stones of the project.

Plans for 1966 include intensification of the project with the help of the World Wildlife Fund, to which a gift for wildlife conservation in Pakistan has already been made by Volkart Brothers. A plan has also been submitted to the British Government for providing a training course in wildfowl conservation and management for selected Game Inspectors from Iran and Pakistan. The trainees on return would be expected to train staff to implement conservation programmes and ringing schemes in both countries.

Distribution of species and habitat

In addition to the author's own observations, valuable notes have been received from Jordan, Iraq, Iran, East and West Pakistan, and India. As a result it has been possible to complete a preliminary assessment of the wildfowl situation in West Pakistan (Savage 1965b) and information for a similar study of the situation in East