Numbers, distribution and behaviour of Pink-footed Geese in Lancashire

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Introduction

For as long as records exist, the Pink-footed Goose *Anser brachyrhynchus* has been a winter visitor to the Ribble Estuary and surrounding farmlands of Lancashire. During the latter half of the 19th century it was said to be more plentiful than other geese species, with about 200 in an average season (Mitchell 1892). Wagstaffe (1935) described it as the commonest goose within the Southport district, many hundreds frequenting the estuary and inland fields. Hardy (1941) confirmed this, stating that 200-2000 visited the area in winter. Oakes (1953), writing of the pre-war years, referred to the Pinkfoot as regular, often abundant, on the Ribble Estuary, but knew of no count greater than 2200 birds. Some of these authors suggested that the greatest numbers of geese occurred during autumn and spring migrations. During the 1950s counts produced peaks varying between 1500 and 4500, and Atkinson-Willes (1963) cited the Ribble as one of the main arrival points for the species in England, with numbers rivalling those on the Humber.

From the 1960s, numbers visiting the county increased dramatically, reaching 9000 birds in 1965, 11,500 by 1970 and 15,000 by 1973. Each winter since 1975 the peak count has reached at least 16,000 birds, and has exceeded 20,000 on several occasions. The periods 1961-1965 and 1971-1975 brought particularly sharp increases and the area has now attained outstanding national and international importance with not less than 20% of the British wintering population present during part of every season since 1975-76, representing also not less than 16% of the world population.

Despite these increases no attempt was made to study the Lancashire Pinkfeet intensively before the early 1970s, and counts remained unco-ordinated and incomplete. Apart from the Wildfowl Trust's annual grey goose census, which produced a November total for Lancashire every year from 1960, other counts may be found in Boyd & Ogilvie (1969), Shorrock (1971) and Greenhalgh (1975). From 1973-74 to 1976-77 I carried out systematic monthly counts of Pinkfeet in southwest Lancashire (Forshaw 1979), but these also were incomplete.

Because of the growing international importance of the Lancashire Pinkfeet, a series of nine co-ordinated counts from October to March every season throughout the feeding area was organised from 1977. The analysis of the first five seasons' results forms the main subject of this paper. Data on distribution, food preferences, roosting habits and disturbance factors were also gathered.

Counting methods

Feeding flocks of Pinkfeet may be found over a considerable area south of the Ribble Estuary along the belt of rich, flat farmland stretching inland of Southport and Formby down to the northern outskirts of Merseyside. Most of this land has been reclaimed from low-lying peat mosses and marsh, and includes Martin Mere, once the largest lake in Lancashire but now also reclaimed. A part of the Fylde Peninsula north of the Ribble holds smaller numbers. See Figure 1.

This feeding area consists of three distinct zones: 85 sq. km. in Fylde north of the River Wyre; 100 sq. km. inland of Southport and the Ribble Estuary (including the Martin Mere area); and 75 sq. km. inland of Ainsdale, Formby and Crosby. Thus an area of 260 sq. km. needed to be covered by the counts. The area was divided into five sectors, the Fylde, and the other four in southwest Lancashire, Marsh, Northern, Central and Southern sectors. A team of counters was assigned to each and from a common starting time toured its sector by car and counted all goose flocks. Notes were made of geese arriving at or leaving each

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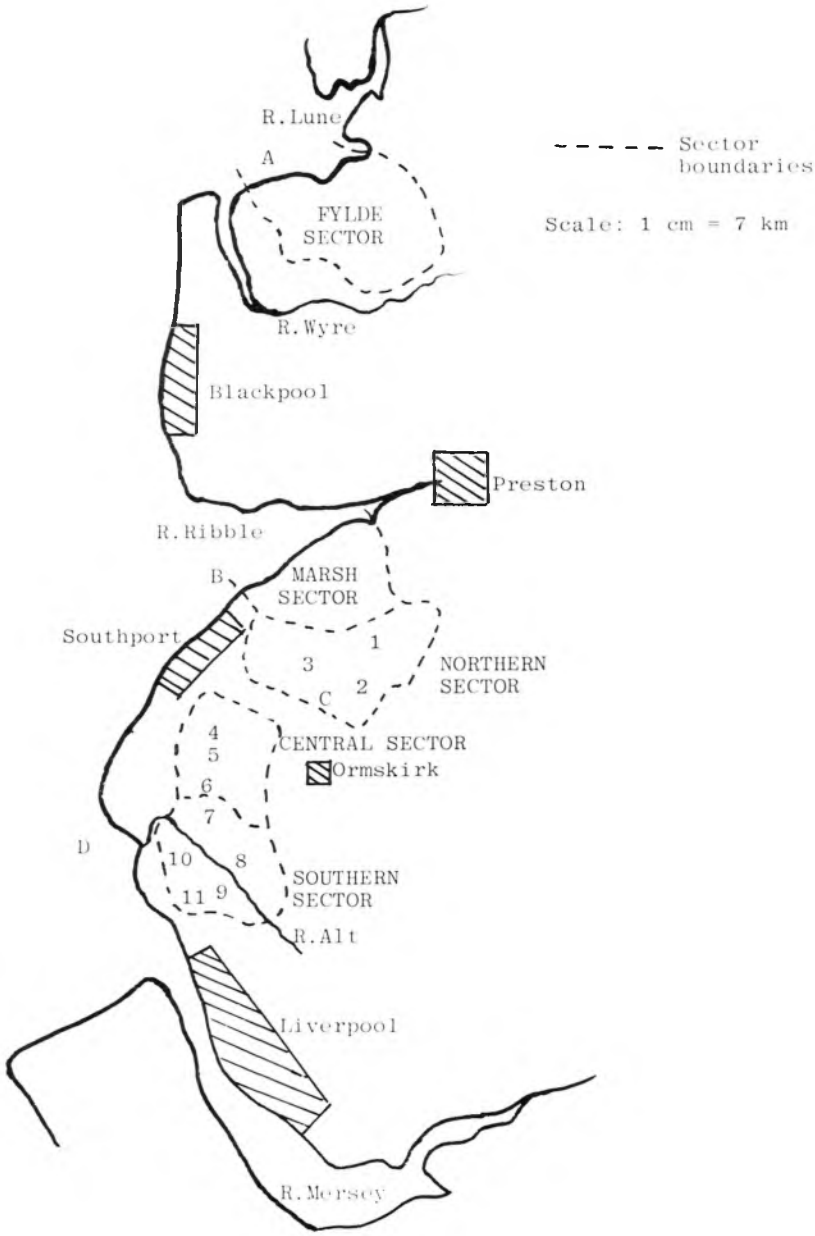

Figure 1. Principal feeding areas and roosting sites of Pink-footed Geese in Lancashire, together with recording sectors used during the co-ordinated counts.

sector, together with time of movement and direction of flight. The grid reference of each flock was taken, with details of the type of land used and any causes of disturbance.

Nine counts were made each season: two in October, November and December, the period of increasing and peak numbers of geese, and one in January, February and March. So far as possible, equivalent dates were used every year. Of 45 scheduled counts only one was cancelled (fog), one was incomplete (two sectors not counted because of snow-

bound roads), and three were affected by mist so that some birds are believed to have been overlooked.

Results

Numbers

Table 1 shows the number of Pinkfeet found during each count in the five seasons 1977-78 to 1981-82. The first geese usually arrive during the third week of September; numbers build up gradually and seldom exceed 1000 until early October. The population continues to rise and reaches a peak late in November or in December. Numbers generally persist until January, declining in February and March so that most have left by the end of that month. Numbers greater than 2000 have not been recorded in April and the last birds are gone by early May.

A clean harvest on the Scottish feeding grounds, with little spilt grain, seems to cause large numbers of birds to move south to Lancashire early in autumn, as in 1979-80 and 1981-82 (Table 1). Lancashire then held the highest Pinkfoot numbers of any British wintering area during the Wildfowl Trust's annual grey goose census, about 20% of the British wintering population in both cases (Ogilvie 1980, 1982a). In 1981-82 this early influx was especially marked, with record numbers present on the early and late October counts.

Seasonal peaks have not coincided with the early November national count but occurred later in November or in December. An exception to this was 1981-82 when severe snow and frost made other British wintering grounds unavailable to the geese. Huge numbers gathered in Lancashire during January and February 1982, leading to an unprecedented total on 22 January of 36,580 birds. This count was not part of the series but was carried out by members of the counting team. The next scheduled count on 31 January produced 33,880 geese.

In 1979 a similar but smaller peak occurred when bad weather on other wintering grounds resulted in an upsurge of numbers in January, with a count of 15,440 on 13 January. There is some evidence that as many as 20,000 geese were present just prior to that date.

In 1979 and 1980 fluctuations during November interrupted the normal steady increase in numbers. In 1979 numbers continued to increase following the high count of 16,260 on 11 November and

Table 1. Numbers of Pink-footed Geese found in Lancashire, 1977-78 to 1981-82.

Season	E. Oct	L. Oct	E. Nov	L. Nov	E. Dec	L. Dec	Jan	Feb	Mar
1977-78	1310 (2)	[1]3720 (15)	8680 (6)	18,950 (26)	17,970 (10)	14,730 (24)	14,290 (15)	13,300 (5)	[1]4,700 (5)
1978-79	1110 (8)	3250 (21)	5280 (5)	16,060 (26)	15,490 (10)	10,680 (24)	15,440 (13)	11,760 (4)	3590 (4)
1979-80	700 (7)	3680 (21)	16,260 (11)	8270 (25)	12,760 (9)	20,640 (23)	6730 (12)	8540 (3)	8250 (2)
1980-81	1150 (5)	4050 (19)	8820 (9)	8730 (23)	20,040 (7)	19,910 (20)	19,400 (11)	[2] – (1)	6100 (1)
1981-82	1960 (4)	7230 (18)	17,890 (8)	16,910 (22)	20,000 (6)	[3]16,590 (20)	21,240 (10)	33,880 (31/1)	6000 (28/2)
mean	1250	4390	11,390	13,780	17,250	[4]16,490	15,420	[4]16,870	5730

Notes. 1 Some birds probably overlooked due to misty conditions.
2 Count cancelled due to fog.
3 Count incomplete due to snowbound roads.
4 Mean of counts only.
Figures in parenthesis denote date of count.
E = Early.
L = Late.

were thought to have reached at least 18,700 by 19 November, but on 25th only 8720 birds were found, the lowest late November total for many years. On 20 November severe fog occurred in southwest Lancashire and this is believed to have caused disorientation of the geese and widespread dispersal from the county. This is supported by many reports of wandering flocks seen on that date in parts of Lancashire away from the regular feeding grounds. Not until late December had numbers recovered.

In 1980, numbers increased from 8820 on 9 November to not less than 13,950 on the 16th, but only 8730 were found on the 23rd. By the 26th, 13,000 were again believed to be present. The cause of this fluctuation is unknown.

Table 2 shows the importance of Lancashire for Pinkfeet relative to the British wintering and world populations in the last 30 years. The data are grouped into five-season periods and average peaks quoted. During the 1950s and 1960s, numbers of Pinkfeet visiting Lancashire increased at approximately the same rate as the British wintering population, but from the 1970s numbers rose dramatically at a much greater rate and this trend has continued. Over the 30-year period shown in the Table, Pinkfeet visiting the county have increased more than six-fold whilst the British wintering population has increased approximately two-and-a-half times. Lancashire has held over one quarter of the British and over one sixth of the world populations in four of the last six seasons. Undoubtedly the number of individual geese visiting the county in a single season is even greater than these figures suggest.

Distribution

Table 3 gives an impression of usage during the five seasons. The majority of geese were found south of the Ribble (87.6%). Within southwest Lancashire the inland feeding grounds held, on average, 79.5%, the Marsh sector only 8.1%. The Northern and Southern sectors, which consist of old Martin Mere basin and Altcar/Ince Blundell areas respectively, each held just under a quarter. The Northern sector was of greater than average importance in 1977-78 and below average in 1979-80. The Southern sector held fewer birds than normal in 1977-78. The Central sector, of which Halsall, Plex and Downholland mosses are the most important parts, held the greatest numbers (32.3%), except in 1977-78. Additional count data gathered over nine seasons from 1973-74 show that the Central sector is of even greater importance than the count day totals suggest, and that the Northern and Southern sectors, rather than being equal in status, are second and third respectively.

Each sector is of varying significance to the geese during a single season (Table 4). The Fylde does not hold geese before November and then increases steadily in importance to the end of the season, so that by March up to half the geese may be there. The Marsh sector does not

Table 2. The importance of Lancashire for Pink-footed Geese relative to the British wintering and world populations 1951-1981; a comparison of average peak counts in Lancashire with the average numbers in Britain and Europe.

Periods	Lancs.	Britain	Britain and N.W. Europe	Lancs & Britain	Lancs % total
1951-52–1955-56	3000	36,000	42,000	8.3	7.1
1956-57–1960-61	3700	50,300	60,000	7.4	6.2
1961-62–1965-66	6800	61,300	76,000	11.1	8.9
1966-67–1970-71	7910	73,700	88,000	10.7	9.0
1971-72–1975-76	14,720	76,500	91,000	19.2	16.2
1976-77–1980-81	18,780	78,600	101,000	23.9	18.6

Notes. Column 1 figures not known to include birds in Fylde before 1977-78.
Column 3 figures from Ogilvie(1982b).
Other figures are from Boyd & Ogilvie (1969), Forshaw (1979 & unpub.), Greenhalgh (1975), Ogilvie (1978), Shorrock (1971) and Wildfowl Trust files.

Table 3. Total numbers of Pink-footed Geese in each recording sector on count days during 1977-78 to 1981-82.

Sector	1977-78	1978-79	1979-80	1980-81	1981-82	Means
Fylde	10,990	13,755	13,750	10,370	12,605	12,290
	(11.2)	(16.7)	(15.8)	(11.8)	(8.9)	(12.4)
Marsh	8750	160	10,400	3,535	16,955	7960
	(9.0)	(0.2)	(12.1)	(4.0)	(12.0)	(8.1)
Northern	34,740	18,845	16,905	19,710	30,805	24,200
	(35.6)	(22.8)	(19.7)	(22.3)	(21.7)	(24.5)
Central	29,460	27,390	24,665	30,585	47,235	31,870
	(30.2)	(33.1)	(28.8)	(34.7)	(33.3)	(32.3)
Southern	13,710	22,490	20,285	23,990	31,730	22,440
	(14.0)	(27.2)	(23.6)	(27.2)	(22.4)	(22.7)

Note. Figures in parentheses denote percentages of total number of geese recorded on count days throughout each season.

Table 4. Total number of Pink-footed Geese in each recording sector on the nine count days during five seasons, 1977-78 to 1981-82.

Sector	E. Oct	L. Oct	E. Nov	L. Nov	E. Dec	L. Dec	Jan	Feb	Mar
Fylde	–	–	1245	3345	6790	9250	15,075	11,185	14,400
			(2.2)	(4.9)	(7.9)	(11.2)	(19.9)	(16.9)	(50.3)
Marsh	–	–	–	1635	600	1850	4335	19,380	12,000
				(2.4)	(0.7)	(2.2)	(5.7)	(29.2)	(41.9)
Northern	2260	6260	21,835	16,980	24,420	17,005	15,570	15,505	1140
	(36.3)	(28.6)	(38.4)	(24.6)	(28.3)	(20.6)	(20.5)	(23.4)	(4.0)
Central	1025	5225	18,655	25,230	36,025	40,115	21,600	10,360	1095
	(16.5)	(23.8)	(32.8)	(36.6)	(41.8)	(48.6)	(28.5)	(15.6)	(3.8)
Southern	2930	10,435	15,155	21,730	18,430	14,320	19,255	9945	–
	(47.2)	(47.6)	(26.6)	(31.5)	(21.4)	(17.4)	(25.4)	(15.0)	

Note. Figures in parentheses denote percentages of total geese found on the relevent count throughout the series (1977-78–1981-82).
E= Early.
L= Late.

generally hold geese before December; numbers increase rapidly in the New Year and by March it shares with the Fylde nearly all remaining birds. The Northern sector is of fluctuating but considerable significance from October to February. The Central sector increases steadily in importance until December, declining thereafter. The Southern sector is of greatest importance in October; it then remains of considerable importance until January, after which it declines rapidly.

There were large sections of the feeding area which the geese rarely visited although conditions appeared suitable. Instead theyconcentrated on a number of favoured feeding areas (Figure 1). The total number of geese observed using these areas has been recorded over a nine-year period, and yielded 1.96 million goose-days. Analysis of this figure shows the following to be most important: Martin Mere (23.4%); Altcar Withins (17.9%); Downholland Moss (12.9%); Plex Moss (12.6%). Nearly 67% of all goose-days have been recorded on the 3950 ha. comprising these four areas which represent only 22.5% of the goose feeding area south of the Ribble. Martin Mere and Downholland Moss have increased in value (from 17.9% to 23.4% and 5.6% to 12.9% of total goose-days respectively) over the past seven winters, whilst Altcar Withins has declined from

36.3% to 17.9%. Plex Moss has shown no trend. There is a concentration of first arrivals at Martin Mere and Altcar Withins; not until early November is there much use of other feeding areas.

Within these and other feeding areas it has been possible to identify sites where the annual concentration of geese is especially high. These have been recognised by plotting every goose flock on large-scale maps and identifying those areas where plots are most dense. The four most important of these yielded 57.8% of goose-days although accounting for only 9.7% of the total feeding area.

Feeding

Since 1977-78 the type of field used by feeding geese has generally been recorded. Pinkfeet in Britain have fed mainly on farmland for many years and in Lancashire this applies to 85% of all feeding birds observed. A further 8.8% were seen on estuarine saltmarsh, and 6.2% on the managed grassland of the Wildfowl Trust's reserve at Martin Mere. The principal foods of the Pinkfoot in Lancashire, as elsewhere in Britain (Cramp & Simmons 1977), are grasses, cereal grains, potatoes and growing cereals, also carrots in some areas.

A total of 1.39 million goose-days were recorded and 18 field-types were used by the geese. The field-types can be divided into four main food sources and shown their respective importance as a percentage of the total goose-days (Table 5). Established grassland includes saltmarsh. Cereal stubble includes that which had been recently disc-harrowed but had not re-sprouted. Potato and carrot fields include areas of unharvested crops. The remaining 9.6% of goose-days were spent on unidentified ploughed land (4.9%), cereal stubble re-sprouting after harrowing (1.5%), grass leys (1.5%), winter cereals (1.3%) and swede/turnip fields (0.4%).

Feeding on cereal stubble increased during the study period and feeding on potatoes decreased slightly. Cereal stubbles were much more favoured than grass in 1979-80 and 1980-81 and much less in 1977-78 and 1981-82. This probably relates to the amount of spilt grain available following harvest. Potato and carrot fields were never so favoured as cereal stubbles and grass, accounting for at most 24.1% and 10.2% of goose-days respectively in a single season. Carrots remained the most constantly used from year to year, varying only between 4.6% and 10.2% of total goose-days.

Further examination of these sources shows more detailed preferences: 82% of goose-days on cereal stubbles related to land not ploughed or harrowed; 55% of goose-days on established grassland related to permanent pasture and 26% to saltmarsh; 65% of goose-days on carrots were on unharvested fields. Winter cereals and grass leys were of minor value, accounting for only 1.3% and 1.5% respectively of recorded goose-days. Their acreage within the goose feeding area is rather limited, but not to the extent suggested by these figures.

Grass is of considerable importance throughout the season (Table 5), with fluctuating use early on, followed by a steady increase from December through to April. Cereal stubbles are used most during the first half of the winter, declining rapidly after January when spilt grain has been eaten or ploughed in. Potato consumption is greatest in November and December, and is almost unrecorded after February. Carrots are a midwinter food. It is probable that frost (most prevalent in Lancashire during January) makes the carrots softer, more palatable, and easier for the geese to break with their relatively small bills. In January, root crops attain an im-

Table 5. Number of goose-days per calendar month spent on four principal field types, expressed as a percentage of total goose-days during the month.

Field type	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Established grassland	42.7	15.3	38.6	25.7	29.8	60.0	76.8	100.0	100.0	33.4
Cereal stubbles	57.3	71.4	38.2	41.1	31.2	9.6	16.4	–	–	36.9
Potatoes	–	10.3	16.9	15.2	8.9	11.9	0.4	–	–	12.8
Carrots	–	–	1.4	4.5	21.6	8.6	4.2	–	–	7.3

portance equal to that of grass and cereal stubbles.

The results confirm the general view that Pinkfeet move from cereal stubbles to root crops and then to grass during a winter season, but there is clearly much overlap in Lancashire, with grass in particular being used throughout. The increase in use of cereal stubbles during March may be due to the attraction of regeneration from spilt grains.

Ministry of Agriculture figures on acreage of crops grown from 1966 were available for the entire feeding area south of the Ribble. They show that during the 16 seasons to 1981 cereal acreage declined slightly; potatoes and established grassland declined to a moderate extent and carrots increased considerably. The crop data are registered on a parish basis. Although the entire goose feeding area south of the Ribble forms a large part of the parishes concerned, the latter include land outside it. Changes in crop acreage may not be constant over the entire area and it is possible that any decline or increase might relate wholly or partially to land outside the preferred goose feeding sites. It is important, therefore, that the data should be interpreted with caution.

Cereal acreage in the feeding area remains large; there has been a decline averaging 4% since the mid-1960s. Goose-days on cereal stubble have fluctuated greatly from season to season but there has been a significant overall increase during the last 7 seasons; from an average 26.5% in the period 1975-76 to 1978-79 to an average 40.8% in 1979-80 to 1981-82.

Potato acreage has declined by an average of 17% since the late 1960s, but increased by 2% since the mid-1970s. During this recent increase, goose-days on potatoes have declined on average by 6%.

The carrot acreage in southwest Lancashire has increased by an average of 190% since the late 1960s. Increases were particularly marked from 1968 to 1972; there has been a decline of about 10% since 1978, not apparent from Figure 2. The number of goose-days on carrots has remained rather low over the past seven seasons, without any great seasonal fluctuations and without showing any trend.

The moderate decline in established grassland since the late 1970s has not been matched by a corresponding drop in goose-days on grass. This may suggest that geese are actively selecting grassland in the face of a declining acreage.

There has been a recent increase of 30% in winter cereals but numbers of goose-days on these have always been low and there is no sign of any corresponding increase. Ogilvie & Boyd (1976) and Ogilvie (1978) suggested that, within the winter range of the Pinkfoot, disc-harrowing of cereal stubbles during autumn, as an alternative to immediate deep ploughing, was peculiar to Lancashire, and that subsequent re-sprouting of the lightly sown spilt grains and weed seeds created additional grazing for the geese there. The Lancashire Pinkfeet do not seem to make great use of this additional grazing, only 1.5% of all goose-days being on stubbles regenerating after harrowing.

Greenhalgh (1975) stated that Lancashire Pinkfeet fed almost entirely on potatoes from November to January. We have already seen that only 12.8% of goose-days during the study related to this food source, and Table 5 shows that although most potatoes were taken in November and December they were only the third most important source of food during November to January. He also stated that geese fed on brassica crops and beet from January onwards, but this was not recorded during the study. Pinkfeet did occasionally feed in turnip fields during severe frost, but only 0.4% of goose-days relate to this crop.

Newton & Campbell (1973) at Loch Leven found 20.2% of goose-days spent on potato fields and considered potatoes the most important food from late autumn to early spring. They recorded 21.5% goose-days on established grassland and 39.7% on cereal stubble, compared with the Lancashire figures of 33.4% and 36.9%, but found no Pinkfeet on carrot fields which were few, small and disturbed in the Loch Leven area. As in Lancashire, winter cereals were unimportant with less than 2% of goose-days (c.f. 1.3% in Lancashire).

Roosting

Robinson (1977) discussed changes in the

Ribble Estuary roost. During the 1950s, when peak counts of geese averaged about 3000 birds, most if not all roosted on the Horse Bank opposite Southport. A Sanctuary Order was made in 1956 to protect this site, but this could not prevent the extraction of sand from the site, using heavy lorries by day and night. More recently the roost has moved upriver to the intertidal areas of Great Brow, George's Brow and Banks Sands, and during 1971-76 only 12% of geese roosting on the Ribble used the Horse Bank, while Great Brow was the most popular (36%). During 1974-75 and 1975-76 the importance of Banks Sands increased markedly. This trend has continued and numbers using the Ribble roost have recently been as high as 12,000 birds on occasion (F. Mawby, in. litt.), while flights of 7-8000 are regular, and the site is in use throughout the season. Fortunately George's Brown and Banks Sands are now protected by the Ribble Marshes National Nature Reserve, established in 1979 following an alarming attempt to acquire the area for land reclamation. The geese quite often use the roost by day, especially (but not invariably) at spring tides when the combination of high water and full moon encourages them to fly at night to feed either on the adjacent saltmarsh or on inland fields. Sometimes they will roost on the saltmarsh if undisturbed (F. Mawby, in. litt.).

This practice of daytime roosting and night-time feeding becomes especially prevalent on the Ribble from February onwards and may be connected with the end of the shooting season when it becomes safer to move off from the roost after dark. The considerable disturbance of geese on the estuary by jet aircraft may add extra incentive to spend the day on the roost, where the birds presumably feel safer, and to feed at night when aircraft activity has ceased. Owen (1980) stated that geese feed more often at night following disruption of their daily routine by disturbance.

Taylors Bank at the mouth of the River Alt has not been so well documented as a roost compared to the Ribble. It is a lower bank covered by all but the smallest tides and it is possible that birds roosting initially at Taylors Bank may be pushed off by the higher tides along the coast to the Ribble, returning overland to their feeding fields the following morning. There is no sanctuary order protecting it, but it is part of the Altcar Dunes & Foreshore Site of Special Scientific Interest and is used by up to 3000 geese. It serves the feeding areas of Altcar Withins, Ince Blundell, Hightown Moss, Little Crosby, Altcar Moss and Downholland Moss. (Figure 1). Observations suggest it is used only during early season, mainly in October. There are no reports of its use after the first week of November, by which time very large numbers of geese are present at the south end of the feeding grounds and field roosts are preferred.

Virtually all birds feeding in Fylde roost on Pilling Sands at the month of the Lune Estuary. It has been protected since 1963 by a Sanctuary Order, and numbers using it generally peak at 5-6000 geese. Atkinson-Willes (1963) stated that there was a considerable decline in the use of this roost between the mid-1950s and early 1960s, and Greenhalgh (1975) confirmed that numbers remained very low into the 1970s. Both claimed that during this period Pinkfeet feeding in Fylde flew there from the Ribble roost. This is not supported by leading ornithologists and wildfowlers who have been operating in the Fylde area continuously from the 1950s to the present time (M. Jones, J. Wilkins, pers. comm.). They state that there has been no decline in the Pilling Sands roost during this period. Geese roosting on the Ribble fly inland to feed on Martin Mere, Halsall Moss and Plex Moss. Less frequently they travel further south to Downholland Moss and the Altcar area, a distance of 16-19 km, usually in the season. Later, when large numbers are feeding there, field roosts are established. A few Ribble birds go north to feed in the Fylde, but such flights are irregular. At all roosts morning flight usually commences before first light and evening flight usually continues after dark. Evening flighting is believed to take place later than was the case 20 years ago. Many feeding flocks do not fly to roost until well after dark in midwinter. Extensive observations of morning flights from the Ribble (F. Mawby, in. litt.) show that the birds rarely leave together but flight at intervals in flocks varying greatly in size. Thus total de-

parture may take up to an hour or more.

During the early 1970s the Wildfowl Trust established a 147 ha reserve at the east end of Martin Mere with shooting controls over a wider area. This soon proved attractive to Pinkfeet as a new roosting site, involving a shorter flight to the feeding grounds and little shooting pressure. Many geese stay on the reserve to feed, especially when surrounding farmland is disturbed, although they probably prefer the latter. The roost is used by varying numbers of geese throughout the season with a recent peak of 10,000. The birds fly out to feed on Martin Mere, Burscough Moss, Sollom Moss and perhaps occasionally Halsall Moss. Observations show they frequently return during the day to drink, bathe and rest.

The widespread use of field roosts is perhaps unique to Lancashire. Newton, Thom & Brotherston (1973) discussed the use of daytime rest stations by Pinkfeet in southeast Scotland but their birds always flew to a water-based roost at night. However, Brotherston (1964) noted incidents of probable field roosting by Pinkfeet in the Lothians and Berwickshire. The term 'field roost' is taken to refer to a roost on a dry inland site. It has not been possible to identify the exact site of every field roost, but two which have been used regularly in recent years by large numbers of geese, are at Downholland Moss and Altcar Withins. The characteristics of these roosts are not fully undertsood, doubtless they must be undisturbed with good all-round visibilty to enable early detection of predators. There seem to be few records of Red Fox *Vulpes vulpes* in the Downholland and Altcar areas, where keepers doubtless control them rigoursly. This would be an added incentive to field roosting. Field roosts are peculiar to the Central and Southern sectors, although rest stations were widely used. They form mainly when very large numbers of geese are feeding in the area and are therefore most often seen from November to January. They may be used by up to 10,000 birds, although 4-6000 is more typical. They are mainly close to the feeding fields, usually less than 2 km, often immediately adjacent, and the same field may be used for feeding and roosting. There is some evidence that a ploughed field is preferred. The same fields or sets of fields appear to be used annually.

Field roosting does not seem to be related to particular weather conditions, nor to phase of moon or tide. Owen (1980) and Dr. J. Kear (pers. com.) have suggested that the artificial lighting from the north end of the Mersey conurbation, particularly when reflected from a low cloud base, creates conditions light enough for birds to detect approaching danger and continue feeding during the night. This is feasible in the Altcar and Ince Blundell areas but less likely in the Downholland area where field roosts are regular but where any effect from artificial light is much less. Additionally, birds feeding close to Southport do not form field roosts despite the presence of much lighting from that large town.

Observations made in the Altcar area at roosting time have shown field roosts to form on clear nights and, equally, flights to nearby Taylors Bank to occur on cloudy nights. Thus, whilst artificial lighting may be of assistance to field roosting geese, it is probably not a prime factor. The widespread freedom from disturbance afforded on the strictly protected estates in the Altcar area may be the most significant stimulus to these roosts, creating conditions where the geese can feed and roost alternately through the night. They save a considerable amount of energy by excluding long roosting flights from their daily routine, with a twice-daily risk from wildfowling. Reduced shooting pressures and a shorter flight to feeding fields are also characteristic of the roost at the Wildfowl Trust reserve at Martin Mere where numbers of geese have also increased dramatically. Thus the traditional Ribble Estuary roost, although carrying more Pinkfeet than previously, is not now so important in terms of the total numbers of geese visiting the county, the inland sites having achieved an equal footing during significant periods each year.

As in eastern Scotland (Newton, Thom & Brotherston 1973), the use of certain fields as daytime rest stations by Pinkfeet is extremely widespread in Lancashire. They were identified in all parts of the feeding area and were distinct from field roosts. They seemed to be used on a casual basis, different sites being in

use in different years. They were always close to the feeding fields and their chief function seemed to be refuge from temporary disturbance. At such times the birds would immediately move to the rest station and remain there, generally without attempting to feed, before gradually filtering back to the feeding field after the disturbance had passed.

Disturbance

From 1975-76 onwards, sources of disturbance to goose flocks have been noted on many occasions. Examination of accumulated data for the seven seasons, 1975-76 to 1981-82, reveals relative importance of the following, expressed as a percentage of the total of 208 incidents where the source was positively identified: vehicles (35.6%); aircraft (20.2%); pedestrians (19.7%); birds (12.5%); shooting activities (6.3%); horse-riders (2.4%); others (3.3%). Disturbance by pedestrians and aircraft seems to be increasing. Much disturbance is caused unavoidably by farm vehicles visiting fields close to or occupied by geese, but many examples of unnecessary disturbance have been seen, including vehicular trespass, and illegal motor-cycling in the fields or on farm tracks. Two incidents have been noted of motor-cycles ridden deliberately at high speed through a flock of geese. Many incidents, however, relate to vehicles on public roads. In such cases disturbance was usually due to the vehicles stopping adjacent to a flock (usually bird-watchers), or emitting excessive noise. The large size and slow movement of certain vehicles (e.g mobile plant) also seemed to cause disturbance even if they were not excessively noisy.

Reaction of geese to aircraft was highly variable. In many cases they paid no attention to low-flying propeller-driven aircraft. All observed cases of disturbance, however, were caused by aircraft at low level, less than 500 m in the case of propeller-driven aircraft, rather higher in the case of jets. Low-flying jet aircraft are not common in southwest Lancashire except in the vicinity of the Ribble Estuary where there is a major establishment building and testing military jets. These cause considerable disturbance to Pinkfeet feeding on the Ribble saltmarshes but, curiously, the birds seem to be more tolerant when on the adjacent intertidal roost. Helicopters invariably caused considerable disturbance, the birds reacting when an approaching machine was still several kilometres away.

Roberts (1966) found visible aircraft extremely disturbing to Barnacle Geese *Branta leucopsis* on the Solway, irrespective of altitude. Helicopters and propeller-driven aircraft had the greatest effect; jet aircraft rather less. At Slimbridge, Gloucestershire, White-fronted Geese *Anser albifrons* were extremely disturbed by helicopters, and low-flying light aircraft usually put them to flight; large aircraft were less disturbing (Owen 1973). In Essex, Owens (1977) found all aircraft below 500 m and within 1.5 km, disturbing to Brent Geese *B. bernicla,* especially slow and noisy machines and helicopters. The Lancashire Pinkfeet appear much more tolerant, only on the Ribble Estuary do they react frequently to passing aircraft, not only the jets referred to earlier, but also light aircraft flown near the flock at low altitude (less than 500 m). On the inland feeding grounds light aircraft are almost completely ignored unless flown very low (less than 100 m) and very close to the flock; even low-flying jets are tolerated more than on the estuary. Helicopters, however, almost invariably flushed the geese wherever they were feeding.

Disturbance arose from pedestrians both on roads and in the fields. As is normal in geese, the birds would not permit nearly so close an approach on foot as in a vehicle. Nonetheless, Pinkfeet in Lancashire appear to be more approachable than elsewhere, and this has often been commented on by visitors from other areas.

Geese were also found to be much more approachable at certain feeding sites than others, and this has also been noted of Pinkfeet in Scotland by Newton, Thom & Brotherston (1973) and of Brent Geese in Essex by Owens (1977). Incidents were recorded in Lancashire whereby a flock that would not permit an approach within 500 m by car at one particular site would tolerate less than 100 m at another less than 1 km away and only a short time after moving there from

the first site.

Nearly all disturbance attributable to other bird species was caused by Grey Herons *Ardea cinerea*, which invariably caused at least partial disturbance of Pinkfeet if flying or alighting in the close vicinity and were responsible for 10% of all disturbance incidents. Owen (1973) considered Pinkfeet to be relatively unconcerned by Grey Herons, and Roberts (1966) stated that they rarely flushed the Solway Barnacle Geese. In Lancashire I found this species extremely disturbing to Pinkfeet.

Shooting in southwest Lancashire is controlled by several large estates and is mainly for Pheasant *Phasianus spp.* Parties rarely go out to shoot geese, and disturbance from shooting activities is generally slight. The situation is different on the Ribble Estuary where there is extensive wildfowling and the geese are a prized target. Bag limits are imposed, however, by the clubs. In Fylde, shooting of geese on the fields is much more widespread and disturbance there can be severe on some days (M. Jones, pers. com.).

Pinkfeet disturbed off a feeding field initially milled in the air over the site before settling again when the disturbance was past. If the source of the disturbance did not go away the birds moved to another feeding field, generally in the vicinty. If the disturbance was prolonged and severe the flocks often split and scattered to other sites. The readiness with which disturbed geese moved to a field roost or rest station has already been described. Birds based on an estuarine roost did not return there so often when disturbed, doubtless because of the greater disturbance involved, but were most prone to do so towards the end of the day when normal roosting time was two hours or less away.

Discussion

Lancashire has become one of the most important wintering areas in the world for Pink-footed Geese. Clearly conditions there must be extremely favourable to the geese, and we may enquire what factors have caused numbers to rise at a much faster rate than the British population.

Elsewhere in England Pinkfoot numbers have severely declined, and the species no longer occurs reularly on the Severn Estuary and Cheshire Dee, nor on the Clwyd Estuary in North Wales. On the Humber and around the Wash numbers have declined to a few hundred birds; the Wash is now regaining its importance but on the Humber numbers remain low. Additionally there has been a marked decline in Pinkfoot numbers on the Solway in autumn from average 4-5000 in the 1960s to less than 750 by the late 1970s, and this is believed due to shooting pressures (Ogilvie 1978). No doubt Lancashire will have gained at the expense of these other haunts.

Major changes in agricultural methods in Britain during the past 20-30 years have benefitted the Pinkfoot. Hedgerow removal and establishment of large fields have allowed geese more secure feeding conditions. Considerable increases in arable land, and especially in the crops which provide the harvest wastes preferred by geese, have resulted in more available food. Widspread use of mechanical harvesters has also created more food due to their relatively wasteful method of operation. Greenhalgh (1975) suggested the increase in Lancashire Pinkfeet was due to a parallel rise in potato acreage. This may have been true earlier in the century but MAFF figures show that potato acreage in southwest Lancashire has declined at least since 1965 (although the yield per acre has increased), yet the spectacular rise in Pinkfoot numbers only began in 1969. These agricultural changes have occurred in other Pinkfoot wintering areas, and cannot be the sole cause of the Lancashire increases.

The wintering climate in southwest Lancashire is characterised by mild, wet and windy weather, limited frosts and very little snow. Many winters pass without measurable snow-lie. This enables food to be available for longer periods. Hard-weather movements into Lancashire have often been noted, and must favour a concentration of geese in the county.

Pinkfeet in Lancashire enjoy considerable protection both directly and indirectly. Most wildfowling is in the hands of local clubs which impose strict bag limits and voluntary severe-weather bans. In addition, Statutory Sanctuaries were established over the Ribble and Lune

roosts in 1956 and 1963 respectively. On the feeding fields the geese are not much shot at except in some parts of Fylde. The large pheasant shooting estates of southwest Lancashire have limited public access and are heavily keepered, hence feeding geese enjoy a large measure of indirect protection and quite low levels of disturbance. It is probably no coincidence that the most important field roost (at Altcar Withins) lies within one of the most strictly preserved areas.

The Wildfowl Trust reserve at Martin Mere has provided further protection for the geese. It is used regularly as a roost and feeding site by large numbers and is immediately adjacent to other important feeding fields. More recently the Ribble Marshes National Nature Reserve has been established over a large area of intertidal mud and saltmarsh along the southern shore of the Ribble Estuary, thus protecting not only an important feeding area but also the major Pinkfoot roost in the county.

It is probably these exceptional protection measures, together with a favourable winter climate and abundance of food, that have led to the present thriving Lancashire Pinkfoot population.

The overwhelming importance to the geese of certain, often very limited, parts of the feeding area has been referred to, and their identification is an important outcome of the study. Newton & Campbell (1973) obtained similar results at Loch Leven in Scotland where they found some fields were visited daily for long periods, others infrequently. They found that 25% of goose-days were spent on 3% of the study area; 50% on 10%, and 75% on 21%. In Lancashire, remarkably similar results were obtained, with 23% of goose-days on 4% of the study area, 47% on 8%, and 63% on 11%.

At Loch Leven field preferences were not correlated to food abundance and the same areas were preferred even though the foods there differed annually. The same holds true for Lancashire. This preference for restricted feeding areas was also referred to by Newton, Thom & Brotherston (1973) working also in eastern Scotland, and Owen (1980) states that the most important attribute of a feeding area for geese is freedom from disturbance. Even a site with abundant food becomes unprofitable if disturbance levels are high. In Lancashire, however, this seems not to be the complete answer since there remain large areas with abundant food which are no more disturbed than the preferred sites, yet the geese rarely go there.

Identification of preferred feeding sites would enable farmers to plan their rotations to avoid so far as possible planting 'high-risk' crops there and otherwise to ensure adequate protection measures are maintained. This is an important area of co-operation between the farming community and conservationists which deserves to be pursued.

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Summary

A series of through the winter co-ordinated counts of the Pink-footed Geese *Anser brachyrhynchus* wintering in Lancashire began in 1977. Earlier counts revealed a gradual rise in numbers during the 1950s and 1960s, followed by a spectacular increase to peak counts exceeding 16,000 birds every year since 1975, representing over 20% and 16% of the British and world populations, respectively.

After late September arrivals there is a rapid build-up to a November or December peak, followed by a gradual decline through to April. Different parts of the feeding area vary in importance during a single season, but nearly 67% of goose-days were confined to 22.5% of the total feeding area, and 58% to less than 10%.

Analysis of 1.39 million goose-days showed 85% of geese feeding on farmland. Cereal stubbles are most valuable during the first half of the season, potatoes and carrots from November to January, while grass is used throughout. Changes in the acreage of main crops in the feeding area are related to trends in usage, geese may be actively selecting cereal stubbles and grass.

The intertidal roosts of the Ribble Estuary, the Wildfowl Trust Martin Mere reserve and certain field roosts are of particular importance Field roosting seems to be unique to Lancashire and is probably encouraged by the security afforded by strictly-keepered estates. It is suggested as a major factor in the recent increase in goose numbers. Field rest stations are also widespread.

Vehicles, aircraft and pedestrians were found to be disturbing to the birds. Shooting was a significant factor in Fylde and on parts of the Ribble Estuary.

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