BTO Research Report no. 551

Reducing the risk of exposure of free range poultry to Highly Pathogenic Avian Influenza (H5N1) in Britain

Authors

Simon Pickett, Rachel Coombes, Alex Sansom, Andy Musgrove and Gavin Siriwardena

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Executive Summary

1. H5N1 Avian influenza has the potential to cause significant impacts on human health and the economics of the poultry industry. The disease has been identified in both wild bird populations and domestic flocks, so the infection of poultry kept for meat and eggs from wild bird sources is a real possibility. For housed birds, this possibility can be removed by effective biosecurity, but this is not possible for free-range birds, which need to be kept outside for set periods.

2. For this project, the British Trust for Ornithology was contracted by the British Poultry Council and British Egg Industry Council to investigate the nature of the interactions that occur between wild birds and free-range turkeys and chickens that are kept for meat and eggs. The overall objective was to identify the major influences on the use of free-range poultry sites by wild birds with a view to recommending management policies to minimize contact with species presenting higher risks of AI transmission. This included field assessments of wild bird use of poultry farms with respect to the local landscape and the bird habitat features of the poultry site, analyses of existing BTO data sets to reveal the migration patterns and "background" populations of higher risk wild birds local to study farms and farm-specific AI risk assessments drawn from collation of these different data sources.

3. Field visits (MODULE I) were made to 22 poultry farms across England, in November to December 2009, including ten chicken farms from the egg industry, eight chicken farms from the broiler industry and four from the turkey meat industry. Birds were recorded using standardized protocols: (i) flight line observations to test whether birds were actively choosing to move towards poultry farms; (ii) two different surveys of bird-habitat associations to investigate which features of poultry farms attracted wild birds.

4. The field survey results showed that few species representing higher risks of AI transmission used poultry farms, with the exception of gulls, which were the group most commonly seen flying over farms, but were rarely observed on the ground and there was no evidence that they were attracted to poultry fields in practice. The absolute level of risk of AI transmission from wild birds, even if the virus were present in the local populations of the higher risk species, therefore appears to be low.

5. The within-farm features that appeared to attract wild birds most were perches (trees and man-made structures), spilt poultry food and, in one analysis, fallow/rough land. Perched birds could present an AI risk via defecation onto the ground, while fallow/rough land can provide both seed and invertebrate food resources for wild birds that could attract them to feed alongside poultry. Minimizing the occurrence of these features in poultry areas would reduce poultry contact with wild birds, but the benefits might be small in practice because the species concerned do not represent high AI risks. It is also noted that the planting of trees/shrubs is becoming standard practice to encourage poultry better to utilise the range area. In relatively high AI risk scenarios, e.g. turkey ranges, it would be precautionary to limit plantings to shrubs, which would provide shade without attracting corvids.

6. In general, landscape context effects were more important than features within poultry farms in determining bird observations. For example, gulls were most common at

farms near to rubbish tips. The species of highest risk in terms of carrying AI tend to be waterbirds, which, although they were not observed using poultry farms, are found on or around large waterbodies (lakes, reservoirs, washlands and open estuaries, the latter especially where they have peripheral salt or grazing marshes), so infection is more likely to be transferred from such species to poultry (via "bridge species" or other means), if poultry farms are near waterbodies.

7. It is important to note that all the assessments of risk in this report relate only to the relative risks posed by the abundance and behaviour of potential risk species in different areas, not to any estimate of the absolute risk of infection. In general, the absolute risk of infection actually being present in any of the species considered remains very low (i.e. the proportions of populations that carry AI are close to zero), even in "high risk" species). Differences between farms or habitat contexts should, therefore, be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high. Exactly how low the "low risk" is will be determined, mostly, by the overall risk that infection will be brought into Britain by wild birds. Another important point is the 24 species considered to be major risk species by Snow et al. (2007) were all rare (with the exception of black-headed gull) on the study farms for this project. Thus, while there may be relatively high risks of these species being in the areas surrounding some farms, these risks may well not translate into real increased risks of infection. Finally, in practice, it will be important to consider the susceptibility of focal poultry species to AI: turkeys are the most susceptible, so the need for measures mitigating risks of disease transmission is likely to be greater (although still low in absolute terms, as above) for farms containing this species.

8. An important caveat to the conclusions of this project is that field visits were only conducted at one time of year and over only one or two days. Hence, they cannot represent a complete picture of the bird use of poultry farms and the results could have been influenced by chance sampling effects. Only a more intensive study, using repeat sampling of individual farms, would address this issue.

9. A species-by-species account of the periods of peak migration for key higher risk species (MODULE II) revealed when in the year poultry might be at greatest risk of infection with AI from wild birds, whether directly from these species or, indirectly, via "bridge species". Migration into the UK from the current areas of high AI incidence and of wild bird species likely to interact with poultry occurs entirely in the autumn, so spring migrant species are not considered in this report. The patterns of migration of the species concerned are diverse, so there is no obvious, clearly delimited "risk period", but collation of the patterns across species suggests that risks of transmission may be greatest in September to November, with October probably seeing the largest numbers of higher risk birds arriving overall. However, without more detailed knowledge about the relative likelihood of any of the species concerned actually carrying HPAI, which is likely to be influenced by the behaviour of the birds (e.g. whether they flock or breed colonially outside the UK), it is difficult to be more specific on the precise period of highest risk.

10. Farm-specific assessments of the risk of AI transmission from wild birds to free-range poultry were made for each farm to which field visits were made (MODULE III). These combined the field data on the birds using each farm with published information

on the AI risks associated with each species and data from other BTO surveys on the occurrence and abundance of higher risk species in the 10km and 30km squares in which the farms were found. The results represent a demonstration of how data on wild birds could contribute to planning and management decisions around the establishment and operation of free-range poultry farms.

11. An additional set of surveys were conducted to assess the possible risks to housed poultry from AI transmission from wild birds. Four housed turkey farms in East Anglia were visited to assess their attractiveness to different wild bird species and the apparent biosecurity of the sites. These surveys were not comprehensive, being just single-visit rapid assessments. Nevertheless, the species of most concern found in the surveys were gulls, corvids, stock doves, feral pigeons, pied and grey wagtails, house sparrows and starlings. These all present a relatively high risk of bringing AI into the area as well as of contact with poultry if sheds are not biosecure. Of these species the gulls, and pied wagtails may present the biggest risk of bringing AI from a nearby water source, but are unlikely to enter shed roof spaces. Contamination is therefore likely to be via another bridge species such as feral pigeons that are far more likely to enter the shed. There is potential for the sheds to attract house sparrows and starlings during the breeding season with possible nesting holes present. Further research into the shed design and studies within the breeding season are required better to assess this threat, but absolute risk levels from this route for infection are probably very low.

General Introduction

The risks of wild birds transmitting avian influenza (AI) to free-range poultry could be significant (Yasué et al. 2006; Olsen et al. 2006; Snow et al. 2007; Alexander 2007), but will depend on the degree of interaction between potential disease vector species and poultry flocks in practice. In turn, interactions will depend on which wild species occur in the vicinity of free-range poultry and the extent to which such species, or other, intermediate, carriers, are attracted to and use poultry areas.

In practice, it will always be impossible to reduce contact between wild birds and outdoor poultry to zero, but data on how the risk of such contact with potential AI risk species varies through the year, geographically and with respect to the features of the environment in and around poultry farms would facilitate planning the location and structure of farms, as well as the periods during which poultry might best be housed indoors. We aimed to combine new analyses of existing British Trust for Ornithology (BTO) data on the patterns of migration of birds that visit Britain, and so could act as vectors for disease, with a fieldwork-based study to identify those species that regularly use poultry farms and the specific large- and finer-scale features that may determine the extent of this use. The results should help to indicate where action might be required to reduce the contact between wild birds and free-range poultry and, if it is, to develop appropriate management policies.

We addressed three specific research objectives:

I. To undertake a preliminary investigation of the composition, abundance and distribution of wild bird populations present around selected free range poultry farms and to understand the manner in which wild birds make use of poultry farms.
II. To identify the timing of the peak seasonal risks of incursion of HPAI H5N1 into Britain from overseas, enabling the seasonal poultry industry to take steps to minimise the risks by housing birds for a short period where possible.
III. To undertake a risk mapping analysis to assess significant landscape features in the countryside surrounding a selection of poultry farms, with a view to producing an expert system for risk assessment for all poultry farms. This would inform on the level of potential risk and could also feed into the placement of new farms.

Objectives I and III were addressed by visiting and analysing data relevant to samples of chicken and turkey meat farms, as well as chicken egg farms. In addition, in an additional set of field surveys, we visited four housed turkey farms in East Anglia in order to assess the attractiveness of these sites, and the turkey housing itself, to different wild bird species, and therefore the potential AI risks of wild species making contact with the poultry. This formed a fourth objective of the project.

This report is structured in respect of four project modules, each referring to one of the project objectives.

MODULE I. COMPOSITION, ABUNDANCE AND DISTRIBUTION OF WILD BIRD POPULATIONS AROUND FREE-RANGE POULTRY FARMS AND THE MANNER IN WHICH WILD BIRDS USE THEM

1.1 Introduction

There exists the possibility that free-range poultry in the U.K. could contract the H5N1 virus from wild birds, especially from some species that migrate long distances (Alexander 2000; Olsen et al. 2006). If the virus were brought into the UK by wild birds, the species that are more likely to spread the virus to poultry are those that regularly make use of free-range poultry farms and come into close contact with domestic birds. Infection would be assumed to be transmitted either directly by respiratory contact (Alexander 2007) or indirectly through contact with droppings of infected individuals (Stallknecht 2003; Yasué et al. 2006). Because birds are more likely to defecate when stationary and, particularly, before take off, those species that actively forage or spend a lot of time inside poultry farms are assumed to pose a higher risk of spreading diseases to poultry than those that only pass in flight. The first aim of this pilot study was to assess the numbers and species of wild birds using poultry farms. We further attempt to explore whether any wild bird species appear to exhibit preferences for poultry areas and, if so, to identify the habitat features that are most important in attracting them. In so doing we help to identify those species that pose the highest threats of transmission of H5N1 (based on behaviour only) and make recommendations that are likely to reduce the attractiveness of poultry farms to wild birds.

1.2 Methods

1.2.1 summary

A total of 22 poultry farms across England, including ten chicken farms from the egg industry (henceforth referred to as "layer" farms), eight chicken farms from the broiler industry (referred to as "broiler" farms) and four from the turkey meat industry ("turkey") were visited in October to December 2009. Each farm was visited in the morning (within four hours of dawn) and once again in the evening (within three hours of dusk). During each visit, fieldworkers recorded all wild birds seen on the farms, using three different methods in order to capture variation in a variety of different bird behaviour. Birds were recorded using standardized protocols which meant that data were directly comparable across sites where appropriate.

1.2.2 large-scale flight analysis

This survey was designed primarily to record birds making mid-long range movements in the wider area in and around the poultry farm. Three suitable vantage points were chosen around the edge of the farm perimeter and the flight direction and flock numbers of all birds were mapped for three 20 minute periods in the morning and again in the evening. To avoid bias, the recorder rotated through 90° every five minutes so they covered the full 360° view equally throughout the session.

All the flight lines were plotted using GIS software (*ArcMap*). For each of the three recording points at each farm, the range of detection area was calculated as the minimum circle that fully encompassed all the flights seen from that point. Flight lines were then extended to the edges of their associated detection circles to account for the fact that in most

cases only a short portion of the actual flight will actually have been seen. The farm area was plotted as a polygon in the GIS software and the total lengths of flight lines as well as the proportion of the flight that crossed the farm area were calculated.

Within each of the detection areas the ratio of farm:non-farm area was calculated. If birds were flying randomly with respect to the presence of the poultry farm then the mean ratio of farm flight proportion:non-farm flight proportion would be equal to the farm area: non-farm area calculation. We calculated whether wild birds were more or less likely to fly across poultry farms than would be expected by chance (given no preference or avoidance). This provided evidence as to whether birds were orientating their flights with respect to the local poultry farm, i.e. tending to choose to fly over it or to avoid it. Bird species that tend to avoid a farm area will present less risk of transmitting an AI infection, even if they carry it, while risks from species that select farm areas could be amplified by this behaviour. We used the mean proportion of farm flights:non-farm flights as the dependent variable in a series of subsequent tests, assessing the factors that predict the likelihood that wild birds fly over the poultry fields.

1.2.3 fine-scale habitat usage

This survey was designed to assess quantitatively the relative use of common habitats within poultry farms and, specifically, to explore which habitats appear to be preferred and which are avoided. Firstly, the farm was surveyed and habitats were assigned to one of twelve categories and mapped. Three suitable and representative vantage points were chosen on the edge or within the poultry fields and all wild birds, along with the habitat in which they were seen, were recorded at one-minute intervals for a total of 20 minutes at each vantage point, once in the morning and once again in the evening. The availability of the different habitats was measured as the proportional area of each discrete habitat type. For habitats that occupied very small areas (less than 1%) that were difficult to quantify accurately given the scale of the habitat maps available, a nominal figure of 0.5% was used. Habitat use by wild birds was calculated as the sum of the total number of birds seen during each one-minute period. If wild birds displayed no association or avoidance with specific habitat, percentage habitat use would correspond exactly to the proportion of the area available. We assessed the difference between use and availability for groups of species across all farms to reveal apparent preferences and avoidances for specific habitats. Because this survey could not distinguish between use by single or multiple birds, counts were not used to compare overall wild bird densities between farms.

1.2.4 perimeter survey

This survey was designed as a supporting approach to record the abundance and habitat choice of all birds within the poultry farm, because it was possible that some of the birds present would not be recorded by the minute-interval sampling described above. Fieldworkers walked around the edge of the poultry field for 20-60 minutes, depending on the size of the site visited, and recorded all the birds they encountered and in what habitat they were seen. Data were, again, analysed to reveal the selection of particular habitat types.

1.2.5 analysis

Species were split into six groups for most analyses to provide a sufficiently large sample size for the detection of effects to be reasonably likely. “Gulls” included all gull species, “Corvids” included all crow species, “Pigeons” included all pigeons and doves, Starlings, being by far the most common passerine (small perching bird) were considered separately from “Other passerines” and “Other species” included all other species (waterfowl, waders and raptors). All analyses and data management were carried out using *R* (R Development Core Team). Statistical models were simplified using step-wise deletion based on the unique variance explained by each explanatory variable using *F* tests.

1.3 Results

1.3.1 species summaries

Gulls were the group most commonly seen flying over the study farms (37.6%, Figure I.1), followed by starlings (20.1%), corvids (18.5%), pigeons (11.9%), other passerine species (9.0%) and other bird species including raptors, waterfowl and waders (2.8%).

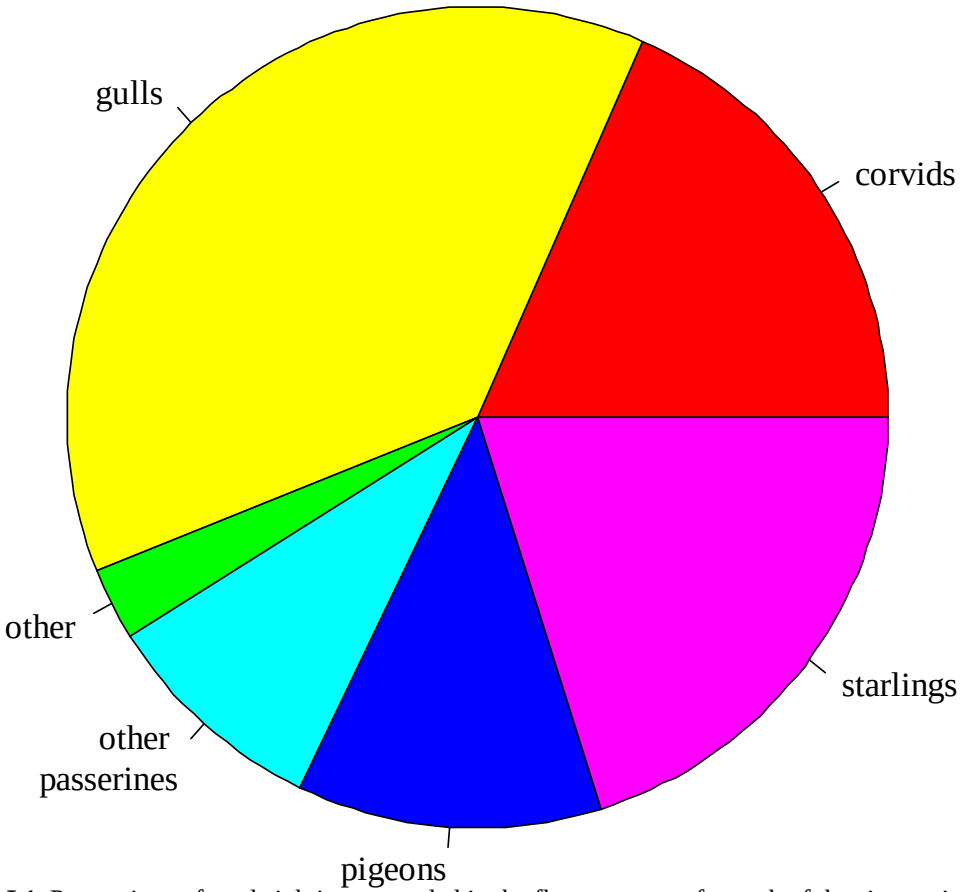

Figure I.1. Proportions of total sightings recorded in the flyover survey for each of the six species categories (see methods for species categories).

Overall, a total of 54 species were recorded across the 22 farms during the flyover survey, including black-headed gull, blackbird, blue tit, bullfinch, buzzard, carrion crow, chaffinch, collared dove, common gull, dunnock, Egyptian goose, feral pigeon, fieldfare, golden plover, goldfinch, great spotted woodpecker, great tit, green sandpiper, green woodpecker, greenfinch, grey heron, grey partridge, grey wagtail, house sparrow, jackdaw, jay, kestrel, lapwing, lesser black-backed gull, linnet, little egret, long-tailed tit, magpie, mallard, meadow pipit, mistle thrush, pheasant, pied wagtail, raven, red kite, redwing, robin, rook, shelduck, skylark, snipe, song thrush, sparrowhawk, starling, stock dove, tree sparrow, woodpigeon, wren and yellowhammer. Figure I.2 displays the number of sightings for each of the six bird groups at each of the farms.

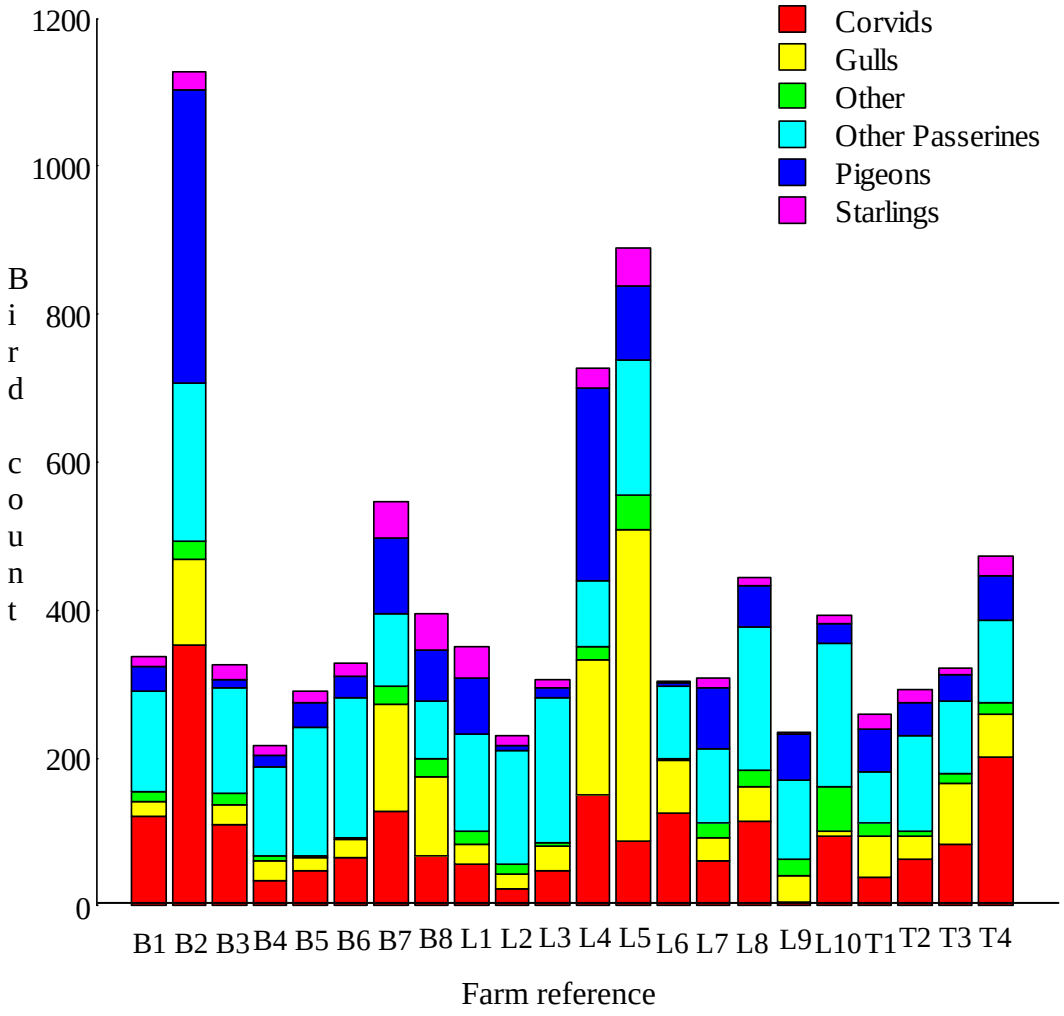

Figure I.2. Raw counts of total sightings recorded in the fly-over survey and walk-around surveys at each farm for each of the six species categories.

Considering both large-scale flight analysis and perimeter surveys together, a mean of 413 (SE 48.48) birds were seen over the course of the 80-minute period; Farms B2, L4 and L5 farms had markedly higher activity than the other farms in the study (Figure I.2) with 30% of total overall sightings.

1.3.2 large-scale flight analysis i: species summary

Table I.1 displays the mean observed proportion of extrapolated flight lines inside the poultry area/total detection area ("Observed") versus the proportion inside the poultry area expected by chance if flights were random with respect to the poultry area ("Expected"). Species that occurred on fewer than 3 sites were excluded from this analysis. A preference index was calculated as Observed/Expected (O/E); the species highlighted in bold with a O/E score greater than one, on average, spent more time flying over the poultry areas than was expected by chance if the birds were flying in random directions with respect to the presence of the focal poultry field. Black-headed gull, yellowhammer, song thrush, goldfinch, carrion crow, other finches, lesser black-backed gull, pied wagtail, collared dove, chaffinch, starling, common gull, unidentified corvids, magpie, green woodpecker, meadow pipit, mallard, jackdaw, redwing, great spotted woodpecker, greenfinch, linnet, skylark, feral pigeon and mistle thrush all fell into this category.

Corvids, starlings and other passerines were more likely to fly over than outside the poultry areas than would be expected by chance (mean±SE, corvids: observed = 0.149±0.002, expected = 0.119±0.001; starlings: 0.161±0.002, 0.115±0.001; other passerines: 0.138±0.002, 0.098±0.001). Conversely, gulls, pigeons and all other species were less likely to be seen flying over the poultry fields than expected by chance (mean±SE, gulls: observed = 0.104±0.001, expected = 0.146±0.001; pigeons: 0.084±0.002, 0.094±0.001; all other species: 0.039±0.003, 0.091±0.002).

Table I.1. Observed and expected proportions of extrapolated flight lines in the poultry area/outside poultry area for all common species. Observed = mean observed proportion; Expected = mean proportions if flights are random with respect to poultry area and O/E = observed/expected. See methods for explanation. Species in bold are those that flew over poultry areas more than expected by chance.

Species	Observed	Expected	O/E
Jay	0.0008	0.1004	0.0079
Lapwing	0.0044	0.0711	0.0614
Stock Dove	0.0186	0.1787	0.1042
Great Tit	0.0312	0.1305	0.2391
Robin	0.0184	0.0553	0.3337
Fieldfare	0.0757	0.1533	0.4935
Long-tailed Tit	0.0999	0.1791	0.5579
Rook	0.0512	0.0908	0.5643
Blue Tit	0.0890	0.1486	0.5989
Unidentified Gull	0.0978	0.1512	0.6470
Blackbird	0.0781	0.0954	0.8188
Kestrel	0.0936	0.1109	0.8437
Woodpigeon	0.0810	0.0917	0.8833
Pheasant	0.0504	0.0535	0.9423
Sparrowhawk	0.1577	0.1670	0.9446
Buzzard	0.0981	0.0987	0.9935
Black-headed Gull	**0.1201**	**0.1121**	**1.0712**
Yellowhammer	**0.0443**	**0.0401**	**1.1043**
Song Thrush	**0.1046**	**0.0898**	**1.1651**
Goldfinch	**0.1177**	**0.0944**	**1.2469**
Carrion Crow	**0.1405**	**0.1117**	**1.2582**
Unidentified Finch	**0.1472**	**0.1170**	**1.2584**
Lesser Black-backed Gull	**0.1923**	**0.1509**	**1.2742**
Pied Wagtail	**0.1448**	**0.1127**	**1.2844**
Collared Dove	**0.1008**	**0.0739**	**1.3638**
Chaffinch	**0.1021**	**0.0731**	**1.3957**
Starling	**0.1610**	**0.1151**	**1.3992**
Common Gull	**0.2051**	**0.1440**	**1.4238**
Corvid	**0.2361**	**0.1647**	**1.4332**
Magpie	**0.1869**	**0.1251**	**1.4943**
Green Woodpecker	**0.1842**	**0.1213**	**1.5185**
Meadow Pipit	**0.1527**	**0.0991**	**1.5415**
Mallard	**0.1669**	**0.1064**	**1.5688**
Jackdaw	**0.1748**	**0.1092**	**1.6014**
Redwing	**0.1814**	**0.1103**	**1.6442**
Great Spotted Woodpecker	**0.1658**	**0.0987**	**1.6789**
Greenfinch	**0.1050**	**0.0584**	**1.7992**
Linnet	**0.2124**	**0.1110**	**1.9144**
Skylark	**0.1511**	**0.0774**	**1.9522**
Feral Pigeon	**0.1772**	**0.0866**	**2.0453**

1.3.3 large-scale flight analysis i: farm summary

We calculated the mean Jacobs' preference index (a standard ecological measure for the quantitative preference for a habitat type relative to the other habitats available) for each species group at each farm and used these indexes as dependent variables in a series of regression tests to establish the most important farm-specific factors that determine observed proportion of flight lines inside poultry farms. Farm size, proportion of fallow habitat and degree of uniformity in direction of flight were used as explanatory variables. Farm size was calculated using GIS software as the area of the entire farm. The proportion of fallow habitat was calculated as the sum of rough grass, set aside and fallow land within the farm as a proportion of the total area. Fallow land with a high diversity of grasses and weeds is known to support higher numbers of bird densities (Atkinson et al. 2002; Henderson et al. 2000), so may explain a higher number of flights in the direction to and from the poultry area. Uniformity of flight was included because more uniformly directional flights across poultry fields could indicate an influence of habitat features operating on bird behaviour at a higher spatial scale than that immediately in and around the poultry area (e.g. birds making strongly uniform flights towards a shared communal roost site). None of the variables we considered explained a significant proportion of variation in the response (Table I.2; all *P*-values > 0.05). Considering poultry type as an explanatory variable in separate tests, birds in the "other passerines" group were more likely than expected to fly over broiler farms than layer and turkey farms (F=3.82; P=0.040); for all other species this effect was not significant (P>0.05).

Table I.2. The relationship between percentage fallow ground, farm size and uniformity of flight direction with the proportion of extrapolated flight lines that crossed the farm (n=22).

	Gulls		Corvids		Starlings		Pigeons		Other Passerines		Other Species	
Source of variation	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
% Fallow	1.19	0.288	0.36	0.557	0.77	0.392	0.80	0.381	0.25	0.622	1.89	0.194
Farm size	0.38	0.545	0.12	0.736	0.88	0.360	1.55	0.228	2.35	0.141	2.96	0.109
Uniformity	0.31	0.583	0.20	0.664	<0.01	0.994	<0.01	0.990	0.04	0.850	0.31	0.588

Considering raw counts from both large-scale flight analysis and perimeter surveys together for species groups at each farm and controlling for the effect of farm area as a covariate, corvids, pigeons and other passerines were all more abundant on farms with a higher proportion of fallow habitat (Figure I.3; pigeons: F=8.78, P=0.008; other passerines: F=21.72, P<0.001; and other species: F=18.08, P<0.001). The relationship between habitat and abundance was not significant for gull species (F=0.01, P =0.939); corvids (F=1.21, P =0.286); or starlings (F=0.35, P=0.562) however. There was no detectable difference between the different poultry types (broiler, layer and turkey) in the raw counts for any species groups (P <0.05)

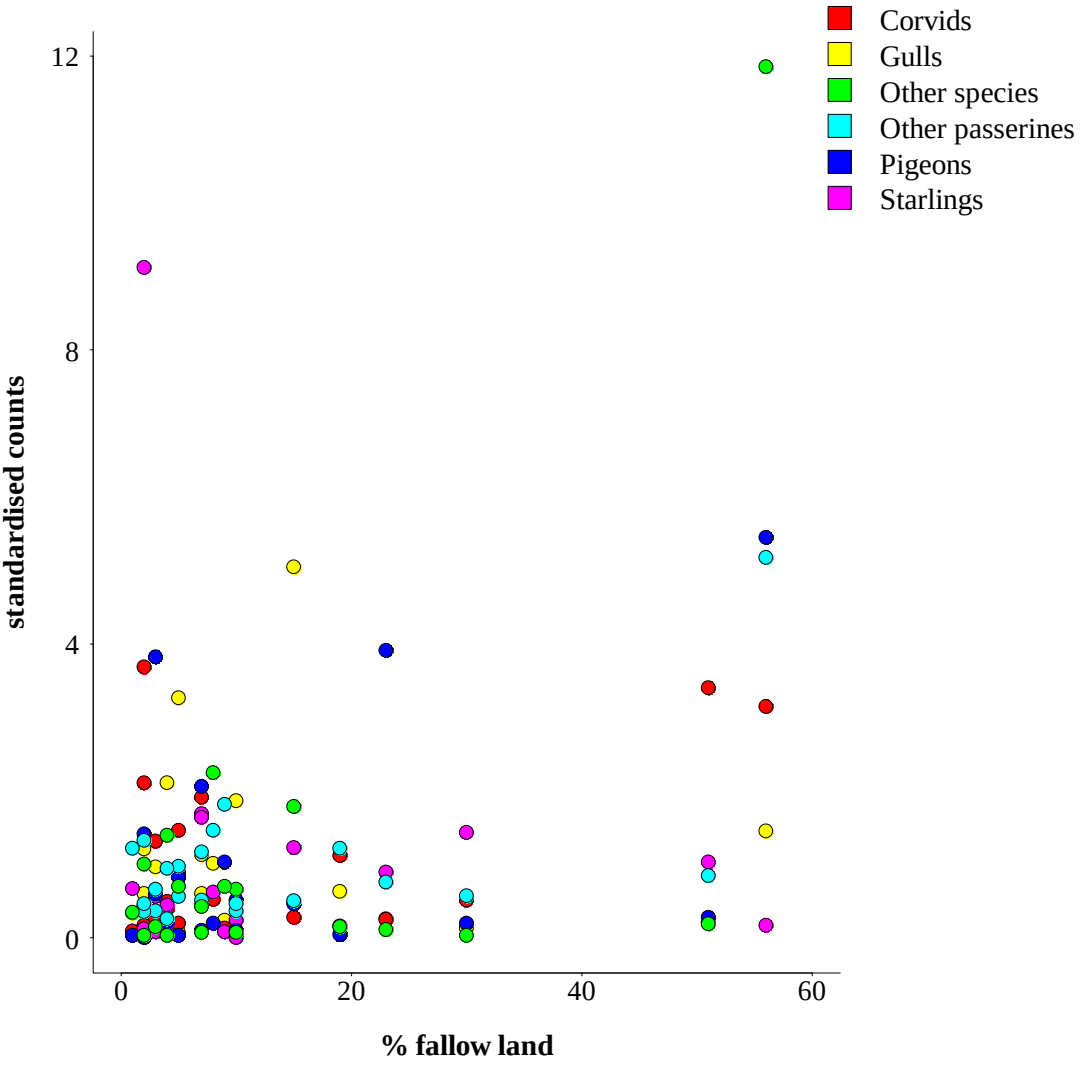

Figure I.3. Standardised raw counts (counts/mean count) versus percentage of fallow land for each of the 6 species groups.

1.3.4 within farm habitat use analysis

The proportion of the area of available habitat of each type was compared to the proportion of time spent in them by each species group. Gulls were excluded from the analysis because they only appeared during the fine-scale habitat survey on three sites. Table I.3a ranks the habitats in order of preference, as calculated by the mean time spent/mean available area across all groups. Wild birds spent more time using tall trees and other perches relative to the area they occupied (Table I.3a) and also appeared to be attracted to bulk feed bins. All groups consistently spent proportionally less time in short grass, concrete/gravel/tarmac and newly planted tree areas than their availability predicted. Table I.3b shows the mean percentage area of each of the habitat classes and the mean time spent in each of these habitats broken down into species groups.

Table I.3a.The preference index as calculated as the mean time spent in/mean area available of each habitat averaged across all species groups.

Habitat	Preference
Man made perch	17.04
Feeder	5.16
Trees > 4m high	3.30
Hedge	3.19
Mud and puddles	3.09
Non-poultry building	1.95
Trees < 4m high	1.85
Fenced poultry area	1.23
Fallow land	0.89
Short grass	0.18
Newly planted tree area	0.13
Concrete/Gravel/Tarmac	0.10

Table I.3b.The mean percentage time spent in each habitat and mean percentage area that the habitat occupies for each species group. *P* value is derived from a series of t-tests, if $P < 0.05$, the species was considered as exhibiting a significant preference or avoidance of that habitat.

Species Group	Habitat	% Time	% Area	*P*	Preferred/Avoided
Corvid	Fenced poultry area	4.33	9.86	0.392	NA
Corvid	Fallow land	6.52	12.55	0.26	NA
Corvid	Feeder	0.26	0.43	0.443	NA
Corvid	Short grass	9.17	47.43	<0.001	avoided
Corvid	Concrete/Gravel/Tarmac	0	3.59	0.018	avoided
Corvid	Hedge	5.25	2.43	0.352	NA
Corvid	Man-made perch	8.87	0.59	0.172	NA
Corvid	Mud and puddles	0.27	1.7	0.049	avoided
Corvid	Newly planted tree area	2.33	5.64	0.306	NA
Corvid	Non-poultry building	3.5	2.86	0.706	NA
Corvid	Trees < 4m high	8.33	4.43	0.476	NA
Corvid	Trees > 4m high	51.18	8.48	0.001	preferred
Other species	Fenced poultry area	12.5	9.86	0.748	NA
Other species	Fallow land	36.18	12.55	0.33	NA
Other species	Feeder	0	0.43	<0.001	avoided
Other species	Short grass	25.66	47.43	0.308	NA
Other species	Concrete/Gravel/Tarmac	0	3.59	0.105	NA
Other species	Hedge	0	2.43	0.001	avoided
Other species	Man-made perch	0.66	0.59	0.967	NA
Other species	Mud and puddles	0	1.7	0.081	NA
Other species	Newly planted tree area	0	5.64	0.05	NA
Other species	Non-poultry building	0	2.86	0.137	NA
Other species	Trees < 4m high	0	4.43	0.055	NA
Other species	Trees > 4m high	25	8.48	0.287	NA
Other passerine	Fenced poultry area	21.67	9.86	0.015	preferred
Other passerine	Fallow land	11.67	12.55	0.877	NA
Other passerine	Feeder	0.14	0.43	0.012	avoided
Other passerine	Short grass	5.62	47.43	<0.001	avoided
Other passerine	Concrete/Gravel/Tarmac	1.71	3.59	0.195	NA
Other passerine	Hedge	18.57	2.43	0.001	preferred
Other passerine	Man-made perch	8.11	0.59	0.031	preferred
Other passerine	Mud and puddles	5.26	1.7	0.193	NA
Other passerine	Newly planted tree area	0.24	5.64	0.01	avoided
Other passerine	Non-poultry building	4.88	2.86	0.487	NA
Other passerine	Trees < 4m high	5.23	4.43	0.76	NA
Other passerine	Trees > 4m high	16.91	8.48	0.114	NA
Pigeon	Poultry coop area	10.08	9.86	0.721	NA
Pigeon	Fallow land	1.3	12.55	0.03	avoided
Pigeon	Feeder/Silo	0.3	0.43	0.631	NA
Pigeon	Short grass	1.9	47.43	<0.001	avoided
Pigeon	Concrete/Gravel/Tarmac	0	3.59	0.133	NA
Pigeon	Hedge	14.43	2.43	0.235	NA
Pigeon	Man made perch	1.67	0.59	0.453	NA
Pigeon	Mud and puddles	8.08	1.7	0.479	NA
Pigeon	Newly planted tree area	0	5.64	0.058	NA
Pigeon	Non-poultry building	18.58	2.86	0.156	NA
Pigeon	Trees < 4m high	18	4.43	0.223	NA
Pigeon	Trees > 4m high	25.67	8.48	0.079	NA
Starling	Poultry coop area	12.09	9.86	0.774	NA
Starling	Fallow land	0	12.55	0.042	avoided
Starling	Feeder/Silo	10.4	0.43	0.244	NA
Starling	Short grass	0.75	47.43	<0.001	avoided
Starling	Concrete/Gravel/Tarmac	0	3.59	0.015	avoided
Starling	Hedge	0.53	2.43	0.011	avoided
Starling	Man made perch	30.95	0.59	0.051	NA
Starling	Mud and puddles	12.65	1.7	0.313	NA
Starling	Newly planted tree area	0.96	5.64	0.232	NA
Starling	Non-poultry building	0.89	2.86	0.302	NA
Starling	Trees < 4m high	9.43	4.43	0.649	NA
Starling	Trees > 4m high	21.36	8.48	0.133	NA

1.4 Discussion

There was marked variation in bird abundance between the farms we visited; three farms in particular had very high numbers of birds overall (Farms B2, L4 and L5). Pigeons and "other passerines" and "other species" were more abundant on farms with a high proportion of rough/fallow land, which is unsurprising as these habitats usually support a higher diversity of insect and seed food for many species (Corbet 1995; Vickery et al. 2001). However, this correlation was not significant for starlings, gulls and corvids, which were the three most common groups overall, making up over 75% of all birds recorded. Furthermore, the results of the fine-scale habitat survey revealed that few species groups strongly selected fallow land and overall it seemed that this habitat was close to neutral in terms of avoidance/preference. This result may reflect a slight bias towards sampling in areas of the farm where there was little or no fallow land for birds to choose (near the centre of poultry areas), but could also be a result of birds selecting other specific habitat factors that happen to co-vary with proportion of fallow land.

None of the factors we considered predicted the likelihood that birds seen flying near the farms would cross into the farm area. Gulls were the group of species most commonly seen flying over or near the farms, yet they very rarely spent any time on the ground in the poultry areas, with only three instances recorded in 44 hours of recording. They were also one of the groups that were slightly less likely to fly over farms than expected by chance. This suggests that gulls, a key AI risk group that might have been attracted to free-range poultry, could be attracted to features of surrounding habitat rather than attributes of the farms themselves. There was no evidence that this group was attracted to poultry fields in practice.

It is possible that large-scale factors over and above those within the farms may explain the abundance of the most common species. One likely factor that could have explained the very high abundance of gulls and corvids on some sites is the presence of nearby pig farms and rubbish tips that tend to support very high densities of these species (Horton et al. 1983; Baglione & Canestrari 2009). Farms L4 and L5 had the second and third highest bird counts respectively and both these sites were near landfill sites or rubbish tips. High densities of gulls and corvids were also apparent on farms where nearby fields were being sprayed with fertiliser or other agricultural work was being undertaken; for example Farm B2 had the highest bird abundance overall and was surrounded on all sides by stubble fields and freshly ploughed land; these habitats are likely to provide a productive food source for granivorous and insectivorous birds, respectively. We could not demonstrate such effects of larger spatial scale effects on bird abundance statistically within the remit of this project, given the small numbers of known farms with these features, but further research into the specific effects of wider landscape features on bird abundance on poultry farms would be a valuable undertaking.

Corvids and "other passerines" appeared to fly towards poultry farms more than was expected by chance (Table I.2). For the "other passerine" group, such an effect may be enhanced on sites with a high prevalence of rich foraging habitat in the form of fallow ground or rough grass, given the correlation between abundance and presence of this habitat. More focused work would be required to reveal the detail of habitat preferences that lead these species to be attracted to particular features of poultry farms.

The fine scale habitat usage survey revealed apparently consistent preferences for perching features, including tall trees, for all groups of species (Table I.3a). This was expected because birds are known to select high vantage points for perching and such sites typically make up only a very small area, leading to high selection on the basis of the area measure used here. Short grass, newly planted tree areas and hard ground were consistently avoided, presumably because they provide poor feeding grounds for most species. Some species groups appeared to exert strong preferences for bulk feed bins at some sites, perhaps because they had access to spilt poultry food there (as observed at a few sites: see Module III). However, this effect was not significant overall, probably because the bins on all farms were closed, preventing access to food for wild birds. Only three sites showed obvious signs of food having been spilt, some of the silos may just have acted as further perching areas and, as one site manager commented, food dust going into the air and landing on the feeder, could possibly have attracted some wild birds.

1.5 Conclusions

1.5.1 general conclusions

- The field survey results showed that few species representing higher risks of AI transmission used poultry farms, with the exception of gulls, which were the group most commonly seen flying over farms, but were rarely observed on the ground and there was no evidence that they were attracted to poultry fields in practice. The absolute level of risk of AI transmission from wild birds, even if the virus were present in the local populations of the higher risk species, therefore appears to be low.

- The results suggest that some species ("other passerines", "other species" and pigeons) may be attracted to areas of fallow land and most groups tend to avoid hard ground and short grass, but this pattern was only apparent in one analysis. Fallow (rough) land will often contain high densities of seeding grasses and weeds, providing a food resource for seed-eating species, and patchy vegetation of varying heights, promoting both the abundance and accessibility to birds of insect and soil invertebrates. (Predatory species will then also be attracted to where their prey species are.) This suggests that more active management of this land, such as the maintenance of a uniform, short, grass sward would reduce risks of wild bird contact with poultry. However, the apparent inconsistency between the large-scale and fine-scale surveys in the relationship between fallow land and bird numbers suggests that focused work on the specific features of fallow land, or those features that tend to co-exist with this habitat, that attract higher AI risk species is needed to confirm that this management will be effective.

- Within farms, reducing the number of trees and other perches will almost certainly reduce wild bird abundance overall. However, these trees provide both a degree of protection for poultry from wild predators and enrichment of their environment, encouraging poultry to range, so there could be a trade-off between a *possible* risk and a *known* benefit here. Note that the planting of trees/shrubs is becoming standard practice to encourage poultry better to utilise the range area. A pragmatic compromise might be to limit plantings to shrubs, which would provide shade without attracting corvids, where the AI risk is relatively high, i.e. on turkey farms.

- On some farms, there was evidence that opportunistic wild birds were feeding on spilt poultry food. More effective avoidance of grain spillage around bulk feed bins is likely to reduce this potential source of contact with wild species.

- This pilot study has suggested the possibility that wider countryside effects may be more significant than those operating inside poultry farms. It is actually quite likely that the quality of a poultry farm, as perceived by wild birds, may depend on the matrix of habitats that it exists within. Farms that are surrounded by poor habitat may be more attractive than those near good quality feeding areas. There is certainly a need for more research to confirm the relative influence of the surrounding environment (Yasué et al. 2006), because this could reveal whether risks of AI transmission could be reduced by siting farms in particular landscape contexts and not in others. One very clear example of this is that poultry farms surrounded by high quality feeding grounds for certain species, such as pig farms and rubbish tips, are likely to see higher numbers of wild birds flying over them on a daily basis.

- It is important to note that this study was conducted at only one time of year and with only two fieldwork-days being spent at each farm. This means that this project could not provide a comprehensive assessment of year-round interactions between wild birds and poultry and that it is likely that the results were influenced by particular events (e.g. weather conditions or the visiting of study farms during field visits by species that are not usually present) whose effects would be averaged out or appropriately quantified by conducting repeat visits. Similarly, single visits are likely to miss rare events, which could be particularly important in the context of AI infection, because it could only take one visit to a farm by an infected individual of a risk species to infect a poultry flock. In general, this means that conclusions of this pilot study should be treated as preliminary; definitive messages about wild birds use of free-range poultry farms could only be obtained from a more intensive study, which the results here would facilitate and inform.

1.5.2 species group summaries

1.5.2.1 Gulls

All gull species recorded on the study farms are listed as “higher risk” for transmitting AI to poultry (as direct carriers and potential “bridge” species: Veen et al. 2007). Gulls were the group seen most commonly around poultry farms, although evidence suggests that they rarely foraged on the ground and actually tended slightly to avoid poultry areas overall, so risk from transmitting AI through defecation or respiratory contact may well be minimal. There was anecdotal evidence to suggest that surrounding agricultural fields and the presence of other favourable habitats such as the presence of rubbish sites may strongly dictate gull abundance.

1.5.2.2 Corvids (crow family species)

80% of corvid species recorded on poultry farms are in the higher risk category (Veen et al. 2007) for transmitting AI to poultry as potential “bridge” species. Note, however, that there is little migration of corvids to or from Britain, so their potential to act as a direct carrier of AI from overseas is more limited than that of some gulls, for example. Corvids as a group were common around poultry farms and evidence suggested that they were likely to be attracted to these areas, being often recorded as foraging or perched within or close to farms. Anecdotal evidence suggested that agricultural work and presence of pig farms or rubbish

tips might partly explain the variation in abundance of most species in this group. Within poultry areas, corvids were consistently recorded perched on tall objects such as trees and wires. A risk of transmission of AI from the droppings of perched corvids landing in the poultry area is plausible and risk from direct contact with poultry is reasonable. Limiting the number of vantage points in the form of trees and other perches could help to reduce the potential AI risk from corvids.

1.5.2.3 Starling

Starlings are classified as a higher risk species (Veen et al. 2007), as well as an unlikely but potential bridge species. Starlings were very common indeed around poultry farms and seemed to be attracted to poultry areas. More research is needed to uncover the specific features that attract this species; however it was noted that starlings appeared to be the most responsive species, rapidly taking advantage of any spilled poultry feed on the small number of sites where this occurred. Risk of transmission of AI from direct contact or from defecation is possible. More successful containment of poultry food would help reduce any AI risk from starlings.

1.5.2.4 Other passerines

A quarter of the species recorded in this group were in the higher risk category of Veen et al. (2007) and were also "unlikely but potential bridge species". Although other passerines were not particularly common relative to larger species, several belonging to this group appeared to be attracted to poultry farms, especially to areas with a high proportion of fallow land, but also to the inner parts of the poultry areas themselves including the buildings, mud and puddles and perches. Passerine species are often more common in areas with a proportion of hedges (with a few exceptions, e.g. skylark) and this was apparent from the results of this study. Reducing vertical perch features and hedges is likely to reduce the numbers of passerine birds and so reduce any AI risk posed by such species but, because the absolute risk of AI transmission by this route is low, the benefits of removing such habitat features may well be outweighed by the other benefits gained by their retention.

1.5.2.5 Pigeons

All the pigeon/dove species recorded were in the higher risk category of Veen et al. (2007) and are considered unlikely but potential bridge species. Woodpigeons, in particular, were very common in and around farms but tended to avoid poultry areas unless there was a high proportion of quality foraging habitat in the form of rough grasslands/fallow land. Regular management of grass would be likely to deter pigeons and reduce the minimal AI risk of pigeons to poultry.

1.5.2.6 Other species

This group included the higher risk waterfowl species (risk from direct contact and as a bridge species: Veen et al. 2007), waders and raptors. Very few individuals belonging to this group were recorded in any of the surveys, although they tended to be more common in areas with a high proportion of fallow land, a pattern that was also apparent from the fine-scale habitat analysis. Reducing the amount of this habitat could potentially reduce the AI risk from these species. It is important to note, however, as with other elements of risk management recommended by this study, that the risks are all relative to a low absolute level of risk: fundamentally, it is unlikely that an infected wild bird would arrive in the vicinity of a poultry farm, simply because infections are very rare and are likely to decrease infected birds' mobility. In addition, different poultry species have different susceptibilities to AI, so

it would make sense to focus habitat mitigation measures, such as farm locations with respect to water bodies, on more susceptible poultry farms, namely turkey ones.

MODULE II. PREDICTING THE PERIODS OF GREATEST RISK OF EXPOSURE OF POULTRY TO HPAI H5N1 FROM MIGRANT WILD BIRDS IN THE UK

2.1 Introduction

Highly pathogenic Avian Influenza H5N1 virus (hereafter referred to HPAI) poses a serious potential risk to domestic poultry, with infection of a flock leading to high mortality and subsequent culling. Avoidance of infection in the first place is clearly vital therefore. One of the possible routes by which HPAI can reach the UK is via wild birds, many species of which migrate long distances between northern or eastern breeding grounds and to wintering areas in the UK. Not all species use the same migration strategies however, and a great deal of research has revealed detailed patterns of movements and occurrence of different species of wild birds. Note that many bird species also migrate to the UK in the spring to breed, but these birds typically spend the winter in Africa or southern Europe, regions where HPAI has not been identified as a major problem. Most of the species involved are also not ground-feeding species that are likely to come into direct contact with poultry in the UK or elsewhere. This report concentrates, therefore, on birds that visit the UK in the winter.

If HPAI virus is transported to the UK by migrating wild birds, there is clearly still a further step involved before the virus could be transmitted to domestic poultry. Most wild birds do not frequent poultry farms and so direct transmission is highly unlikely. Stepwise transmission via "bridge" species may be more likely, however. For example, a wild duck could bring a virus from Russia to the UK, but it may take a local crow to transport it the last few kilometres from the duck's winter quarters to a poultry farm.

Clearly, the factors involved are complex. However, although outbreaks in the last 20 years in the UK have predominated in housed flocks, it seems self-evident that free-range poultry are likely to be at higher risk of contracting a disease from wildlife than are permanently housed birds. Given this, the current report was requested to identify the time of year at which migration of key species of wild birds into the UK was the greatest, as it may be possible, in some cases, to house free-range birds for a short period.

The European Union has identified a number of wild bird species as posing a potentially higher risk of moving HPAI H5N1 across Europe (Veen *et al.* 2007). It was felt most useful to concentrate on these species for the purposes of this report. Some of these species are highly migratory and only occur in the UK during specific times of the year. Other species comprise a mixture of individuals, some of which are resident year-round in Britain and others which migrate from elsewhere at certain times of year. Some species on the EU list are indeed highly migratory but do not pass through the UK or only occur in small numbers.

The EU listed species are:

Mute Swan *Cygnus olor*
White-fronted Goose *Anser albifrons*
Greylag Goose *Anser anser*
Red-breasted Goose *Branta ruficollis*
Eurasian Wigeon *Anas penelope*
Gadwall *Anas strepera*
Common Teal *Anas crecca*
Mallard *Anas platyrhynchos*
Northern Pintail *Anas acuta*
Garganey *Anas querquedula*
Northern Shoveler *Anas clypeata*
Red-crested Pochard *Netta rufina*
Common Pochard *Aythya ferina*
Tufted Duck *Aythya fuligula*
Great Cormorant *Phalacrocorax carbo*
Common Coot *Fulica atra*
Northern Lapwing *Vanellus vanellus*
Ruff *Philomachus pugnax*

Black-tailed Godwit *Limosa limosa* Black Tern *Chlidonias niger*
Black-headed Gull *Chroicephalus ridibundus*

2.2 Data sources

In order to identify times of peak migration of wild birds into Britain, when free range domestic birds might be at greater risk of exposure to migrant birds, three key sources of information were consulted. These are three schemes managed by the British Trust for Ornithology (BTO), with the majority of the data collection being carried out by thousands of skilled volunteer observers.

1 The National Ringing Scheme (www.bto.org/ringing) holds records of the movements of over half a million ringed birds. Recoveries of ringed birds provide an indication of where birds moving to and from the UK have originated from or are going to and when movements are likely to occur (based on when and where ringed birds are recovered and/or were ringed). Many ringing recoveries, especially for wildfowl, are likely to be as a result of birds being killed by hunters and are therefore biased somewhat by patterns of hunting activity. However, as long as this is considered as a factor, ringing data provides valuable information on the origins and timing of birds migrating to Britain and Ireland.

2 The Wetland Bird Survey (WeBS) (www.bto.org/webs) monitors waterbirds on about 3,000 wetlands in the UK. These counts are carried out every month and so can provide information about the proportion of the population that is in Britain throughout the year, and on when population increases of migrants generally occur. These surveys are primarily conducted on the more major wetland and estuarine areas, and provide an index of population changes between years, and during the year. For the purposes of this study, data have been summarised both at a UK-wide level and at the level of the constituent countries of the UK. The data used are population indices for each month based on a five-year average. WeBS is a partnership between the BTO, Royal Society for the Protection of Birds (RSPB) and Joint Nature Conservation Committee (JNCC), in association with the Wildfowl & Wetlands Trust (WWT).

3 BirdTrack is a live online bird recording system (www.bto.org/birdtrack) that enables assessments of the proportion of submitted bird lists containing a given species. These data are summarised at a weekly resolution, and reflect how frequently a species is seen (rather than acting as an indication of absolute numbers of birds). It thus gives good indications of first arrivals of birds. Data are in the form of average reporting rates week-by-week and are available at both UK-wide and a regional level, therefore potentially revealing variation in species influxes in different parts of the UK. BirdTrack is a partnership between the BTO and the RSPB.

2.3 Species Accounts

2.3.1 Mute Swan (*Cygnus Olor*)

Mute Swans are a common breeding bird in Britain and Ireland, occurring on wide range of aquatic habitats from lakes and rivers to coastal inlets.

2.3.1.1 Ringing Scheme

Mute Swans occurring in the UK are generally sedentary, which is reflected in the very similar breeding and non-breeding distributions of ringed birds. Localised movements do occur to freshwater marshes, agricultural land and to coastal waters, the latter especially during cold weather. During very severe cold weather ringing recoveries have shown that some swans move to coastal areas in the south of England from the Netherlands, southern Denmark and northern France, with British ringed birds also occasionally moving away from England into these countries. However, such movements are very much the exception rather than the norm.

2.3.1.2 WeBS

Overall in the UK, Mute Swan numbers increase between May and August, which reflects post-breeding increases in the population boosted by that year's young. The population then declines during the autumn and winter due to mortality (mainly of that year's immature birds). Patterns across England, Northern Ireland, Scotland and Wales are all similar and consistent with the UK-wide pattern.

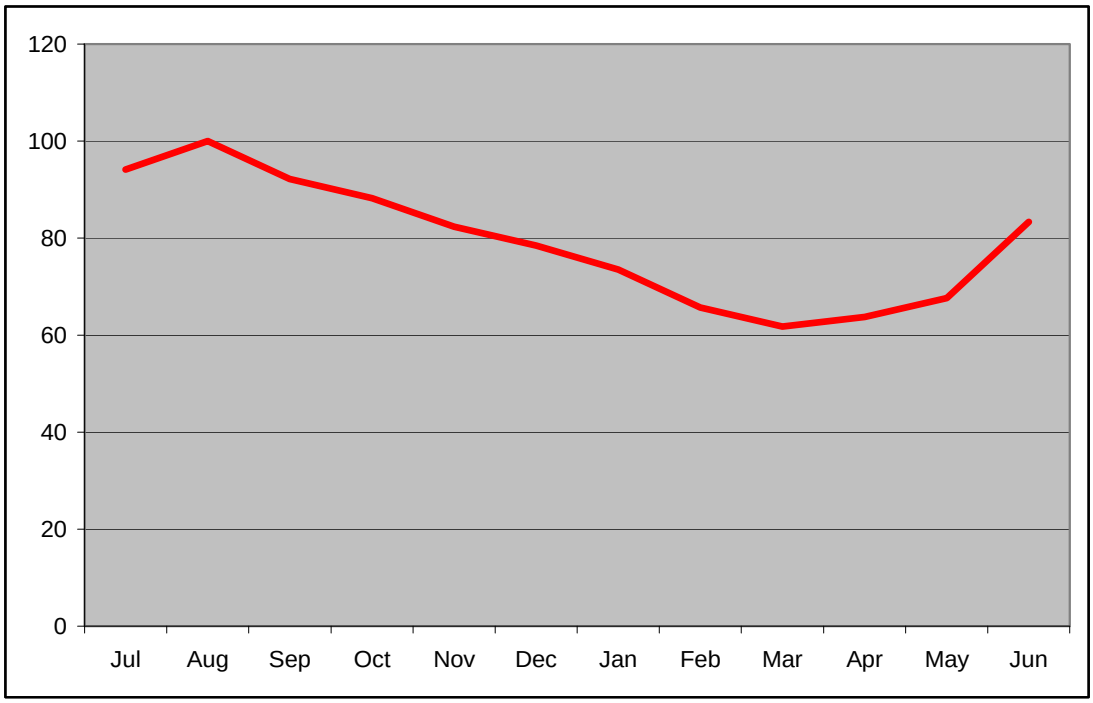

Figure II.1 WeBS monthly indices for Mute Swan – UK average for 2003/04 to 2007/08.

2.3.1.3 BirdTrack

BirdTrack results show a gradual increase in Mute Swan sightings from weeks 26 to 37 (late June to mid-September), consistent with the post-breeding increase in numbers. The decrease in sightings from weeks 20 to 23 (mid-May to early June) is probably due to some birds being on nests and thus less visible. Changes in numbers of reports of this species are probably not related to large scale movements. No UK region shows any notably different pattern.

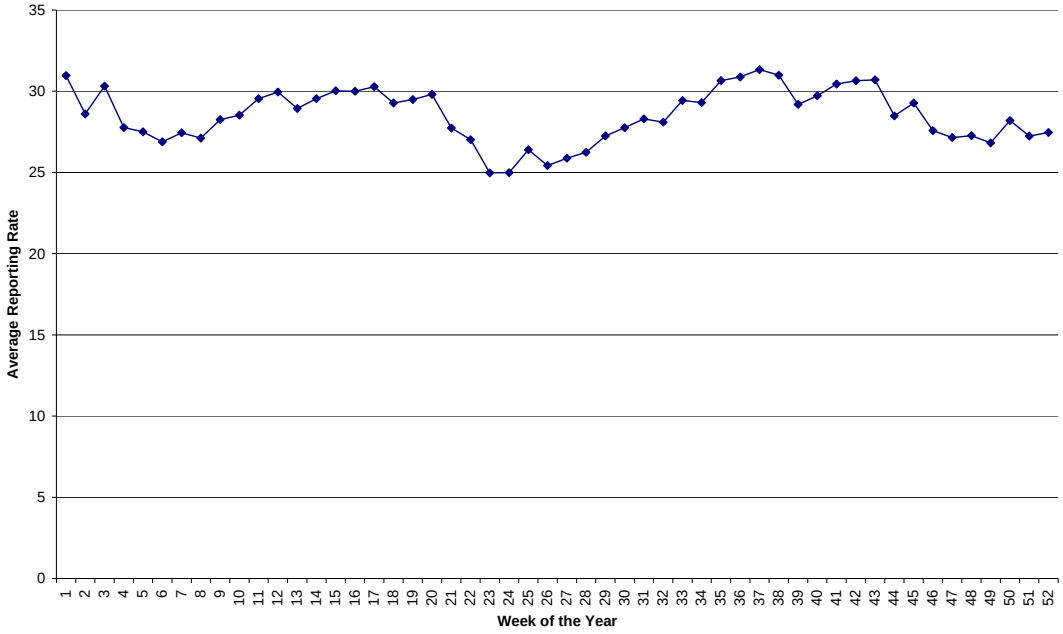

Figure II.2 Average BirdTrack reporting rate for Mute Swans throughout the year, including sightings from across Britain and Ireland.

2.3.2 White-Fronted Goose (*Anser Albifrons*)

There are two separate sub-species that migrate to the UK, these being the Greenland White-fronted Goose (*Anser albifrons flavirostris*) and the European White-fronted Goose (*Anser albifrons albifrons*). As the former only passes through Greenland and Iceland, where HPAI is absent (and likely to remain so), only the European subspecies is considered further.

2.3.2.1 Ringing Scheme

European White-fronted Geese are highly migratory, occurring in the UK only during the winter, mostly on semi-natural grassland close to the coast. Ringing recoveries and information from birds with neck collars (which allow individuals to be identified) show that European White-fronted Geese migrate to the UK from Russia. This sub-species arrives in the UK late in the autumn, from November, and the peak arrival time actually occurs in late January or early February. Numbers have decline in recent years and now only small numbers occur in winter, in a few areas of southern England (mostly around the coast from Norfolk to Kent, as well as on the Severn Estuary in Gloucestershire). European White-fronted Geese leave England and start their return to northern Russia during March.

2.3.2.2 WeBS

WeBS data for the European White-fronted Goose show that birds start to arrive in small numbers in November but the main arrival is mid-winter, during January and February and then numbers drop sharply in March. These data are mainly based on birds in England, so no regional variation is investigated.

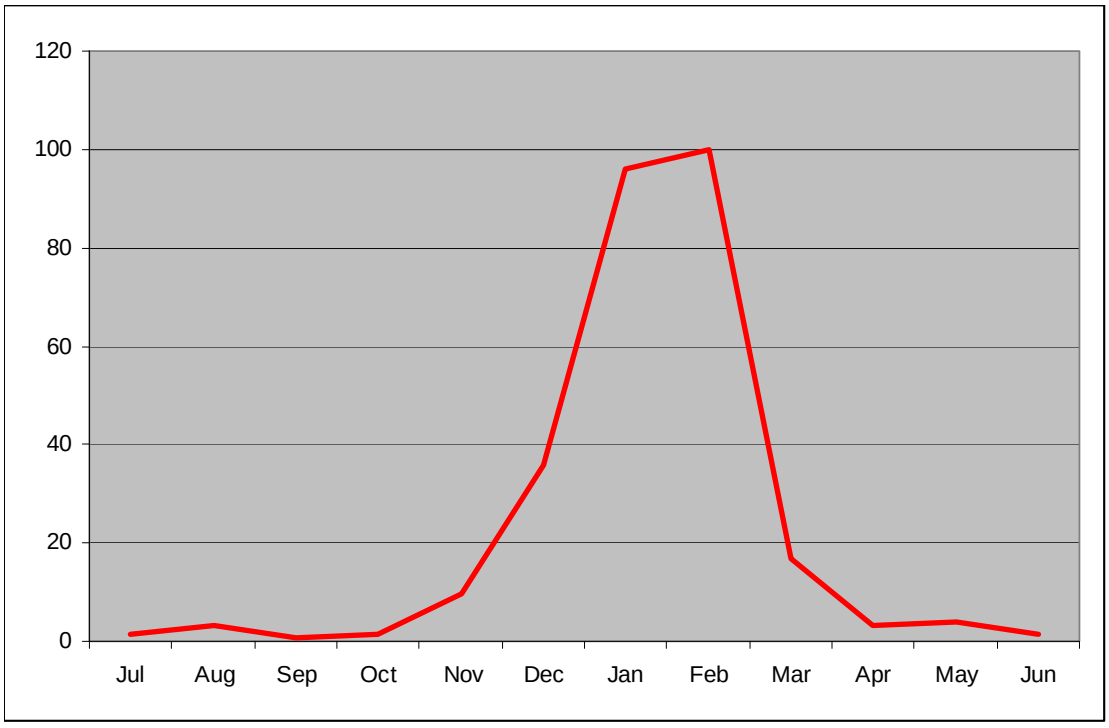

Figure II.3 WeBS monthly indices for European White-fronted Goose – UK average for 2003/04 to 2007/08.

2.3.2.3 BirdTrack

In most areas, sightings of European White-fronted Geese are infrequent, as indicated by the low average BirdTrack reporting rate; this is a relatively uncommon bird in the UK. Only data from England are considered, as virtually no birds occur away from here. Although not entirely clear-cut the main influx of birds into England appears to occur in week 1 and also weeks 6 and 8; this is consistent with the arrival in January and February and suggests birds are moving into England at these times. Birds appear to be leaving the England mainly between weeks 10 and 12 (March) as indicated by the decline in sightings during this time, as birds return to breeding areas in Russia.

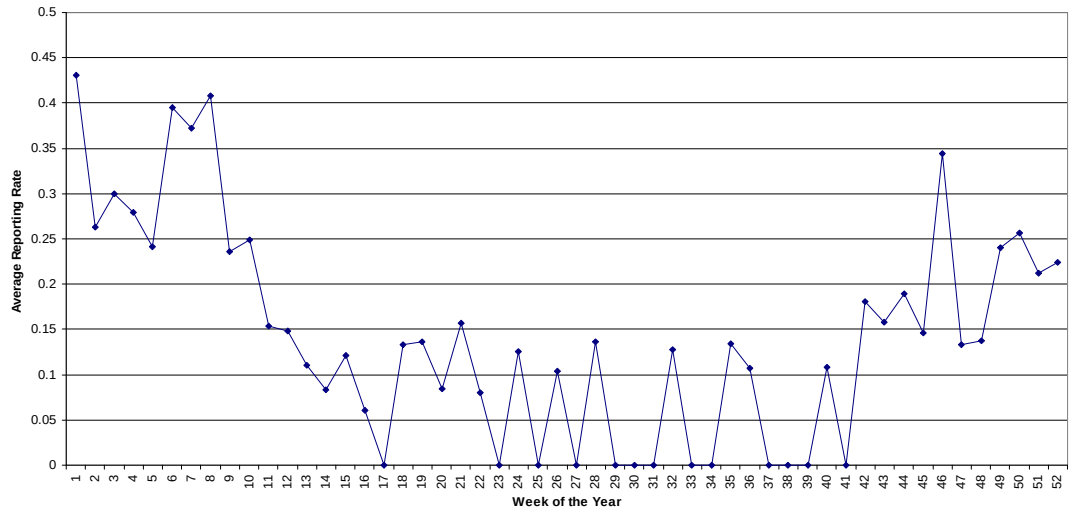

Figure II.4 Average BirdTrack reporting rate for European White-fronted Geese throughout the year, only including sightings from England.

2.3.3 Greylag Goose (*Anser Anser*)

2.3.3.1 Ringing Scheme

The Greylag Goose is common in the UK, and is found in many wetland habitats. The UK population is made up of a combination of three different populations. Firstly, there is the common and widespread re-established Greylag Goose associated with rivers, lakes, reservoirs and gravel-pits surrounded by parkland or agricultural land providing year-round feeding opportunities. This population is introduced, and breeds and over-winters in much of lowland England, Wales and south-east Scotland, and does not migrate; only local movements occur. A second population is mainly found in northern and western Scotland, especially the Hebrides, and is associated with lochs and peat bogs; this population is native and is also essentially non-migratory, making only local movements throughout the year. Finally, a third population breeds in Iceland and migrates into the UK, mainly Scotland, between late September and early November. These birds are often found in low-lying and agricultural parts of Scotland, with the majority now wintering in Orkney; they return to Iceland from mid March into April.

2.3.3.2 WeBS

Monthly indices are only available for the re-established Greylag Goose population and show a similar pattern to Mute Swan, with a post-breeding peak in late summer, followed by a steady decline through the winter due to mortality. The native Scottish population is likely to show the same pattern. Peak numbers of the migratory Icelandic population are in the UK from November to February.

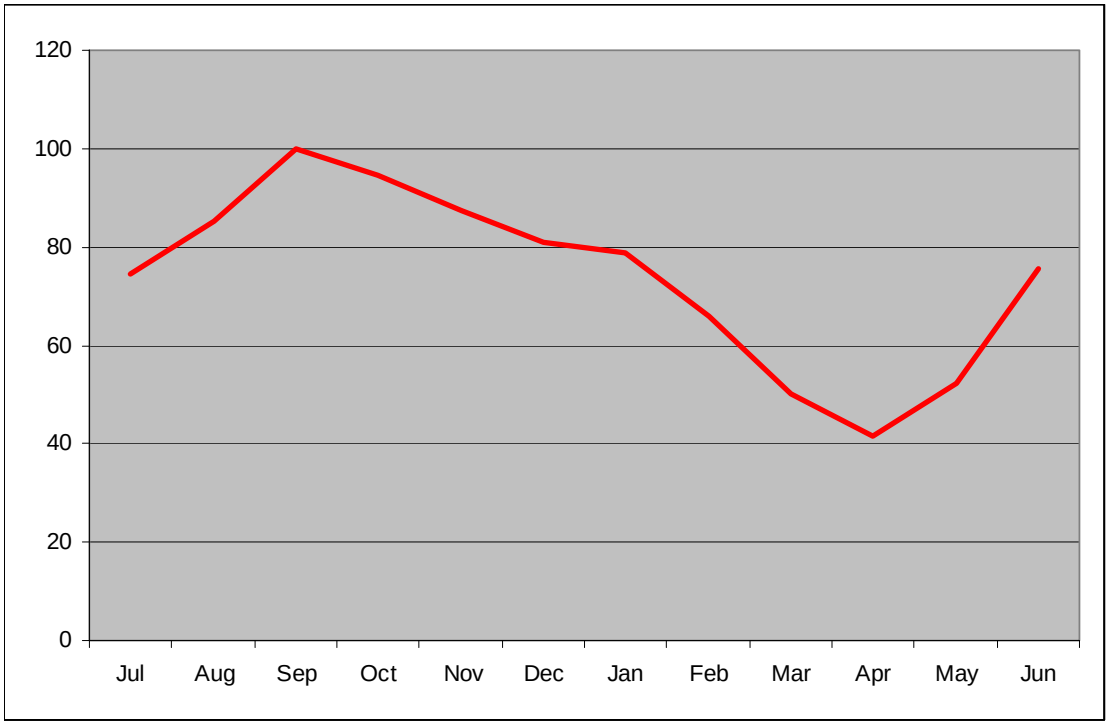

Figure II.5 WeBS monthly indices for re-established Greylag Goose – UK average for 2003/04 to 2007/08.

2.3.3.3 BirdTrack

The overall pattern in reporting rates for Greylag Geese in Britain and Ireland is fairly constant throughout the year, reflecting the fact that this is a common and widespread species. There are no patterns of increase or decrease that are likely to be associated with birds migrating into or leaving the UK, or with large-scale bird movements. In Scotland where Icelandic Greylag Geese come to spend the winter, and thus where reporting rates are most likely to reflect migratory movements there is also no pattern in reporting rates, presumably because in Scotland the population is made up of a mixture of both migratory and resident birds.

2.3.4 Red-Breasted Goose (*Branta Ruficollis*)

The UK is outside the usual geographical range of this species, which migrates from Siberia to eastern Europe, wintering mostly around the Black Sea; it is only a rare vagrant here. Therefore, its migratory movements are not relevant for this report.

2.3.5 Eurasian Wigeon (*Anas Penelope*)

Wigeon are a highly migratory species of duck with main breeding grounds across northern Europe and Asia. They are most common in the UK as a wintering species occurring on estuaries, coastal marshes, freshwater and brackish lagoons, and a wide range of inland waterbodies, especially where birds are able to graze.

2.3.5.1 Ringing Scheme

The main departure from the breeding grounds occurs in September, and Wigeon arrive at their wintering grounds mainly in October and November. The origin of ringed birds suggests that Wigeon over--wintering in the UK originate from a wide area including European Russia, Baltic areas and Iceland. Wigeon leave for their breeding grounds during March and April; there are fewer ringing recoveries in the UK for this period suggesting that Wigeon take a more southerly route than that taken in autumn.

2.3.5.2 WeBS

Data collected from WeBS surveys shows that across the UK the greatest proportion of the over-wintering population of Wigeon is present during January. The most rapid increase in population occurs from September to November, with numbers increasing a slower rate from November to January. This suggests that the largest movements of Wigeon into the UK are occurring during September and October. Wigeon numbers decrease greatly between January and March reflecting the return to the breeding grounds. These patterns are largely consistent across the constituent countries of the UK. Although peak populations occur in October in Northern Ireland and Scotland and in November in Wales, the main period of population increase, indicative of migratory movements remains during September and October.

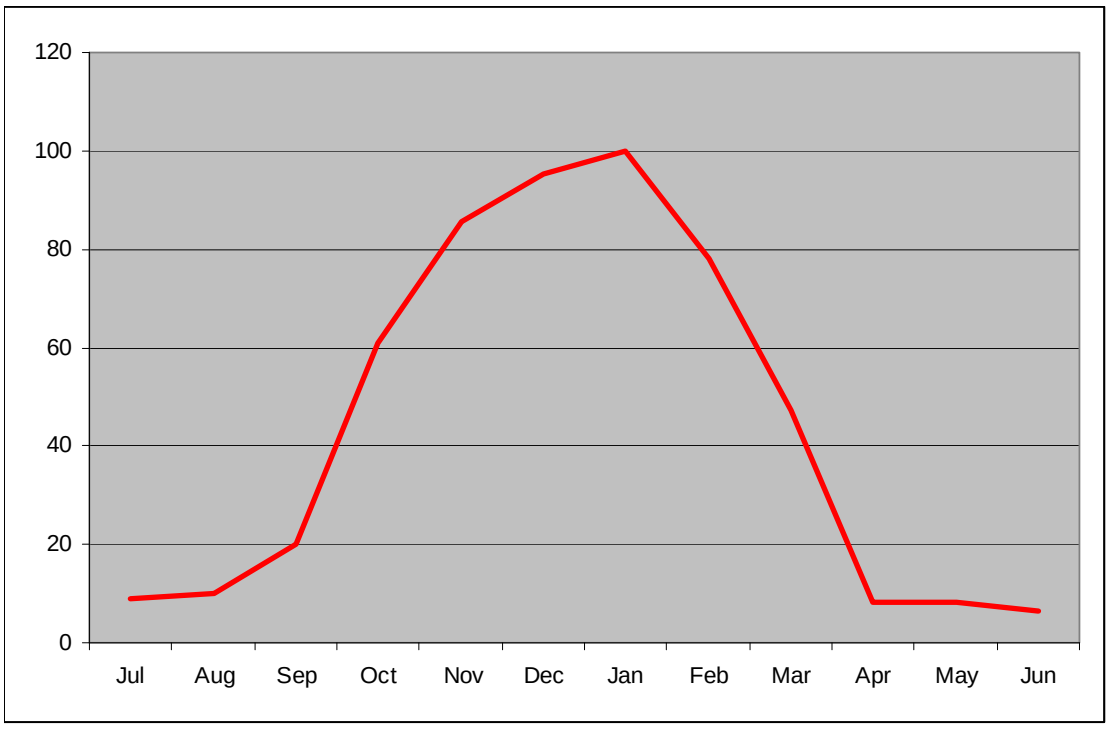

Figure II.6 WeBS monthly indices for Wigeon – UK average for 2003/04 to 2007/08.

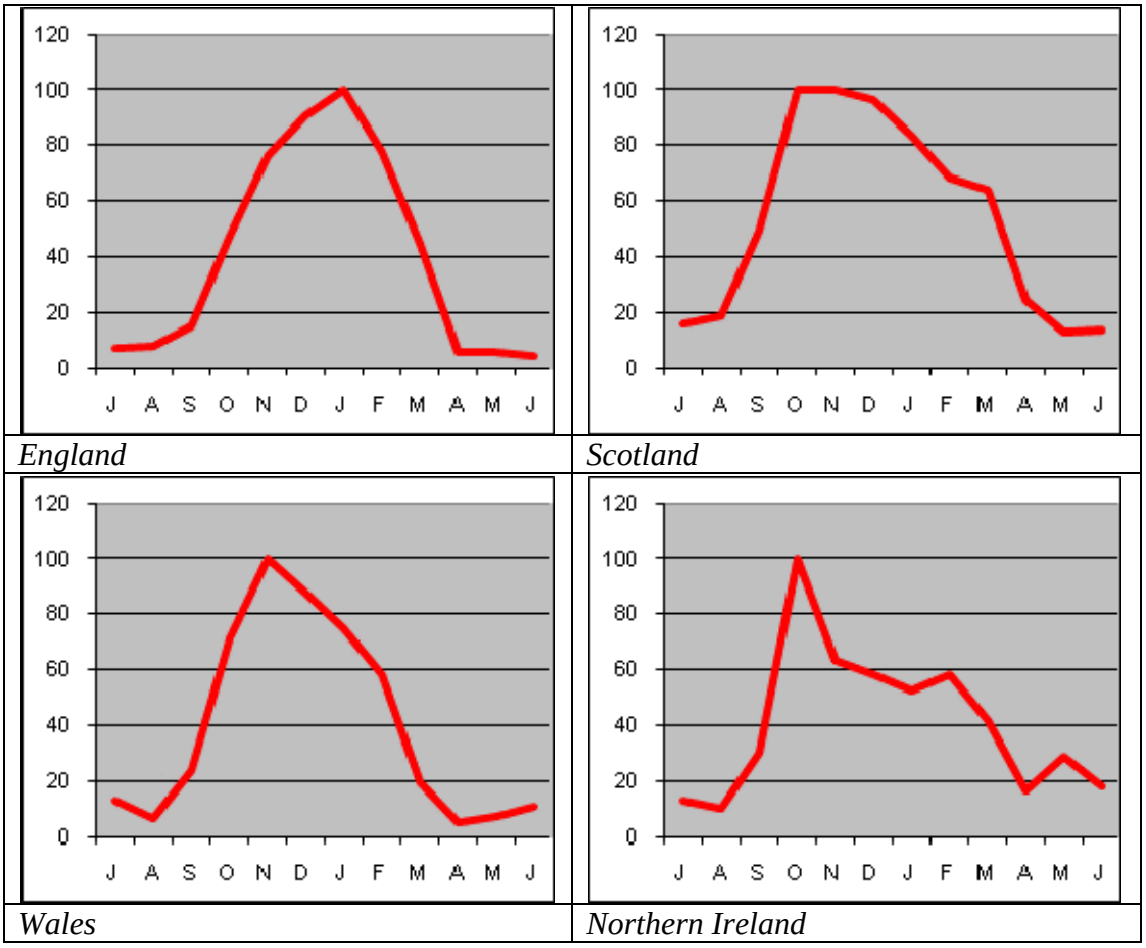

Figure II.7 Individual country WeBS monthly indices for Wigeon – average for 2003/04 to 2007/08.

2.3.5.3 BirdTrack

Across the UK sightings increased from August onwards and reports reached 50% of their maximum and increased greatly between weeks 36 and 37, which is from early to mid September, indicating an influx of Wigeon at this time. Wigeon were reported most often in mid October. This appears to be reasonably consistent between the different UK regions with no area showing a particular influx of Wigeon occurring much earlier or later in the year, with the exception of Northern Ireland, with the peak increase reported at week 44 (from the end of October to early November). Reports of Wigeon start to decrease in mid February, indicating the return migration to breeding grounds; the most rapid period of decrease occurs between weeks 13 and 15 indicating that many birds are migrating from the end of March to mid-April. Again this is similar across regions.

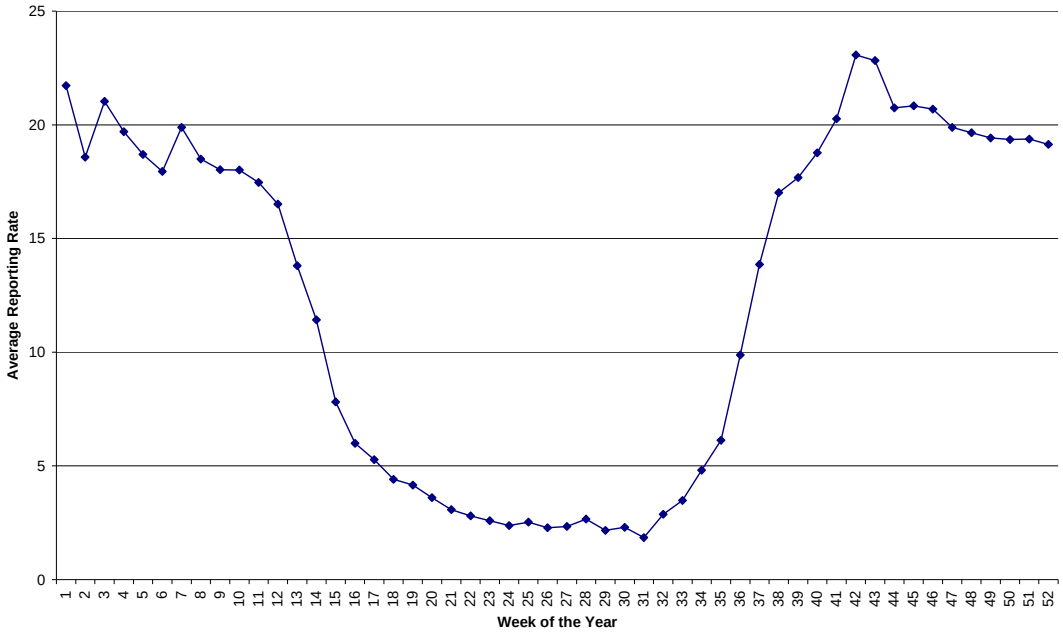

Figure II.8 Average BirdTrack reporting rate for Wigeon throughout the year, including sightings from across Britain and Ireland.

2.3.6 Gadwall (*Anas Strepera*)

Gadwall are an herbivorous duck species, associated with wetlands, ponds and grassland lakes.

2.3.6.1 Ringing Scheme

There is only limited ringing data available but this suggests a complex pattern of seasonal movement to and from Britain and Ireland. There is a small breeding population in Britain and Ireland, mainly in the south and east; these birds are either resident in Britain or move south to France, Spain and North Africa during the winter. Recoveries of ringed birds within Britain and Ireland during the autumn and winter show that some birds disperse during the autumn, for example Gadwall breeding in Scotland appear to over-winter mainly in Ireland. During the autumn and winter further birds arrive into the UK from Poland, the Baltic States, Northern Russia, Iceland, Denmark, and northern Germany; some of these stop off in Britain and Ireland before continuing south, whilst others remain throughout the winter.

2.3.6.2 WeBS

WeBS data from the UK show that Gadwall numbers decline most rapidly between February and March, as many birds leave the UK to breed elsewhere. The population gradually increases from May to December, resulting from a combination of breeding birds producing offspring, and birds entering the UK having bred elsewhere. When considering the constituent countries of the UK all broadly follow this pattern with the exception of Scotland, where the population peaks in September and then is much lower throughout the winter. It is likely that fewer birds breed or over-winter as far north as Scotland, the September peak may mark a time when Gadwall are dispersing and migrating through Scotland.

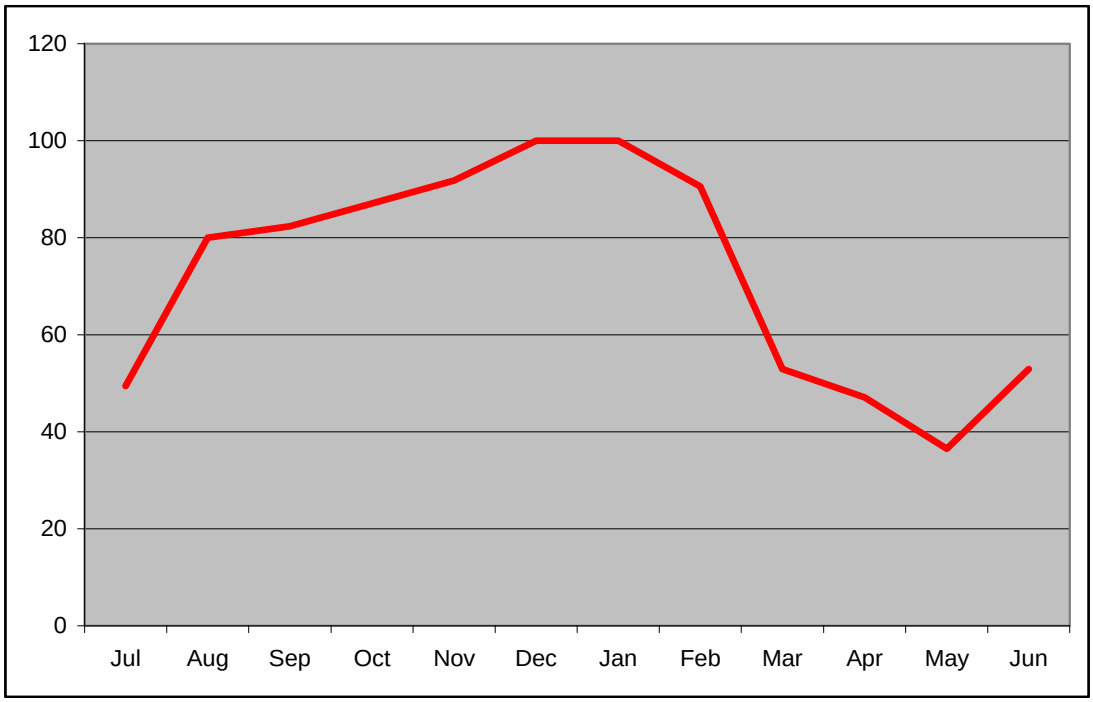

Figure II.9 WeBS monthly indices for Gadwall – UK average for 2003/04 to 2007/08.

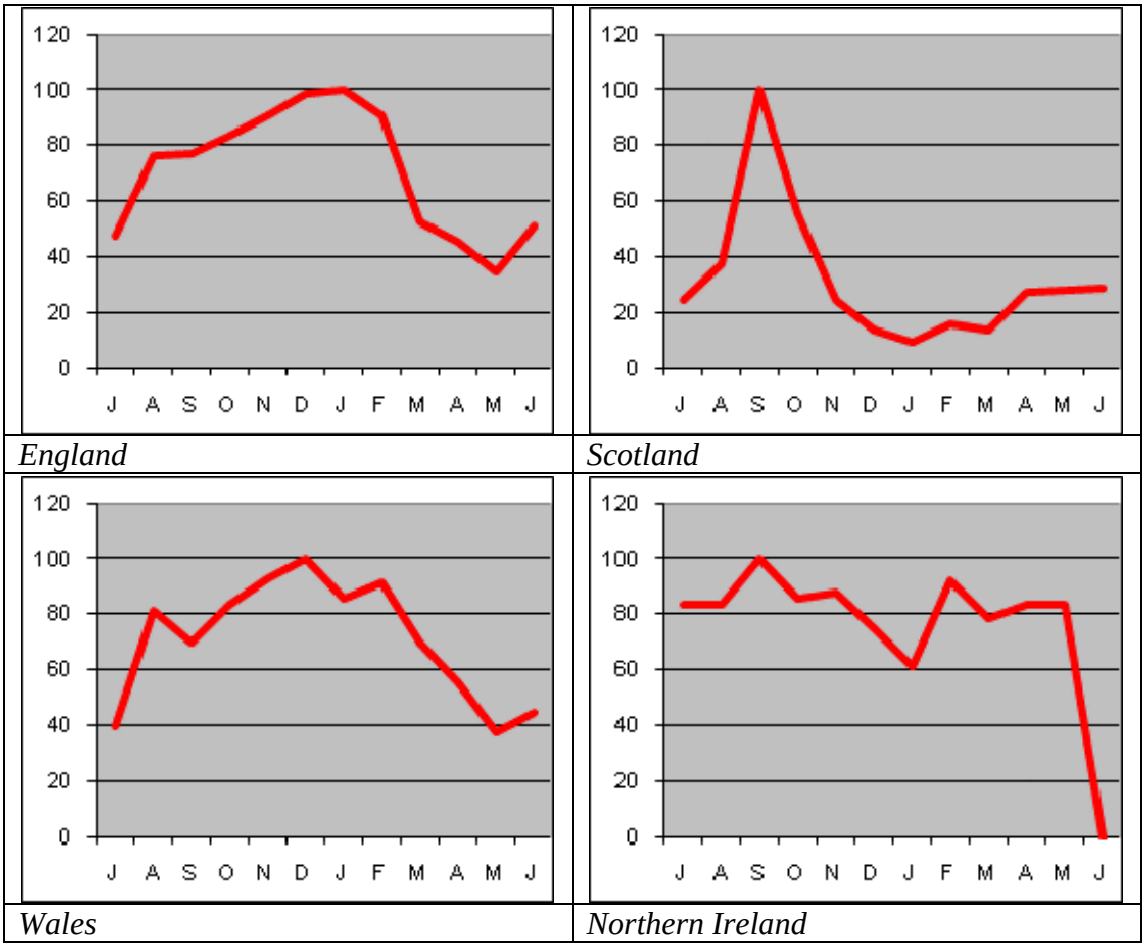

Figure II.10 Individual country WeBS monthly indices for Gadwall – average for 2003/04 to 2007/08.

2.3.6.3 BirdTrack

BirdTrack data show an increase in reports of Gadwall between weeks 29 and 36, with the most rapid increase occurring between weeks 31 and 33 (early to mid-August), consistent with a post-breeding increase in numbers and may also mark the beginning of dispersal and migration to and from Britain and Ireland. Numbers reach a peak in late December and early January. A rapid decrease then occurs between weeks 20 and 24 (mid-May and June) as the breeding season begins and birds become less visible. This pattern is consistent across the regions of England and in Wales. Reports in Scotland also show less of a pattern, but have tendency to increase from late summer to early winter, possibly due to the migration of birds through Scotland to more southerly areas.

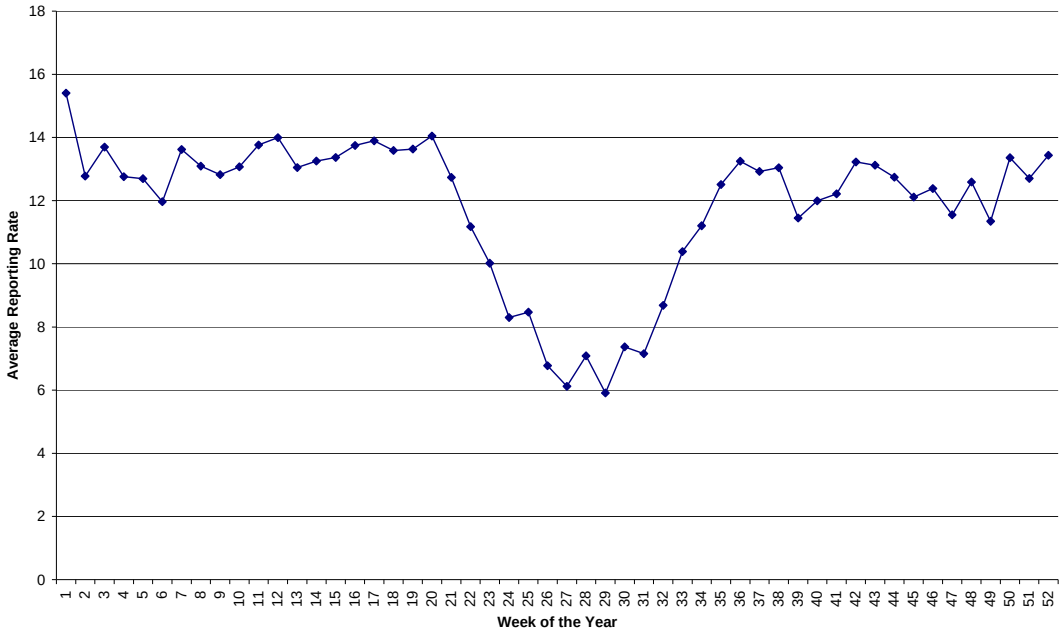

Figure II.11 Average BirdTrack reporting rate for Gadwall throughout the year, including sightings from across Britain and Ireland

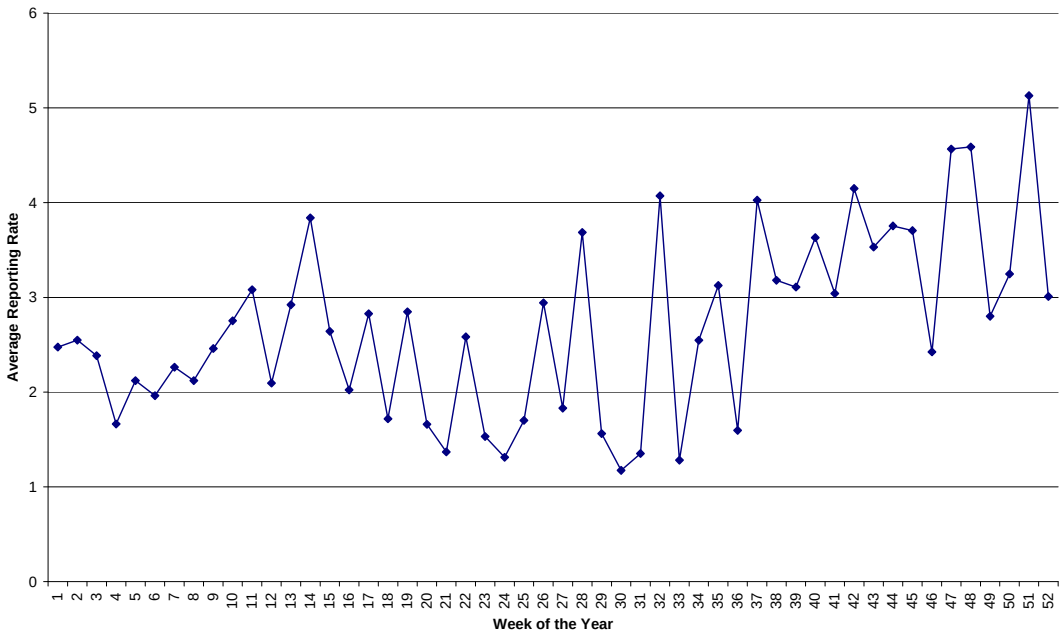

Figure II.12 Average BirdTrack reporting rate for Gadwall throughout the year in Scotland only.

2.3.6.4 Summary

Gadwall are widespread in wetlands throughout England, although less so elsewhere in Britain and Ireland. Numbers increase in the summer due to breeding productivity of resident birds, and increase further as the autumn progresses and foreign-bred birds arrive. The arrival of birds from overseas is protracted, occurring between August and December.

2.3.7 Common Teal (*Anas Crecca*)

Common Teal is the smallest species of dabbling duck and birds are found in a variety of wetland habitats, including large lakes, shallow pools, flooded areas, and sheltered estuaries. Only a relatively small number of Teal breed in Britain and Ireland but approximately 200,000 individuals spend the winter here.

2.3.7.1 Ringing Scheme

There is an extended arrival period from late summer through into November; ringing recoveries show that birds come from breeding grounds in Iceland, Scandinavia and Siberia. Teal leave Britain and Ireland from late February into May. During the winter within Britain and Ireland Teal are mostly fairly sedentary but may move further depending on weather conditions; during very cold weather birds in Britain and Ireland may move on to Spain and France. The small breeding population is mainly found in northern and western Scotland, and in the winter these birds move south, mostly within Britain.

2.3.7.2 WeBS

Across the UK the Teal population reaches its peak in January, with some variation between constituent countries (October for Scotland, December for Wales and Northern Ireland, January for England). The main increase in the population, across all countries, occurs from August to October as birds enter the UK and the main decrease is from January to March and April as birds leave for their breeding grounds.

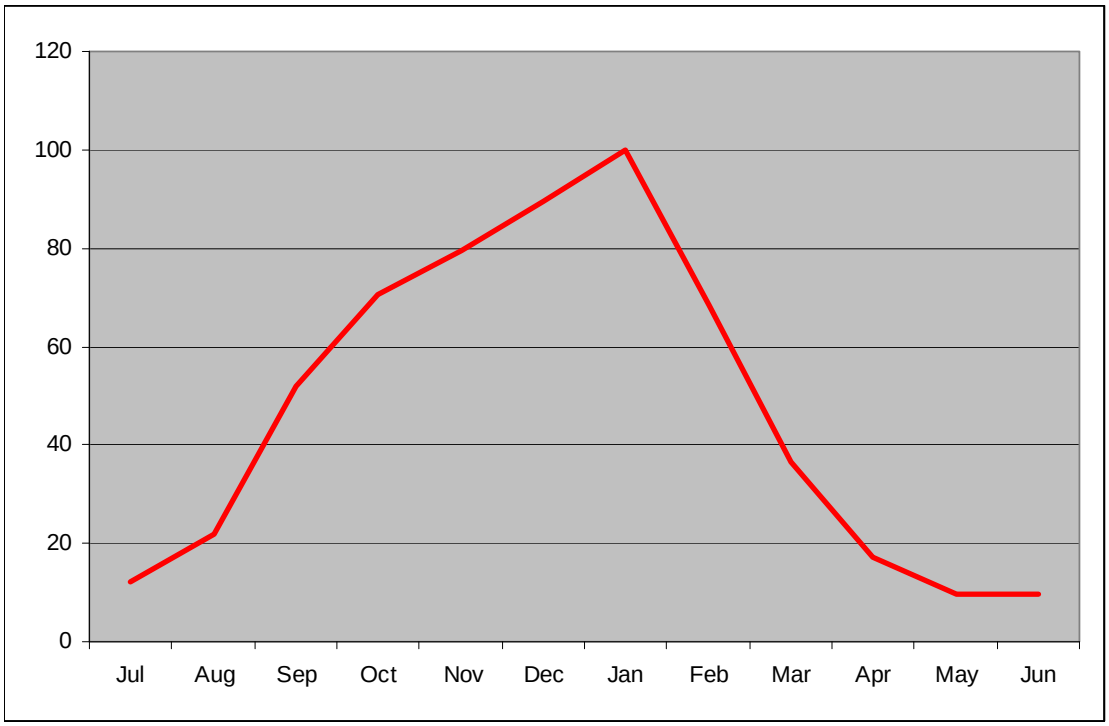

Figure II.13 WeBS monthly indices for Teal – UK average for 2003/04 to 2007/08.

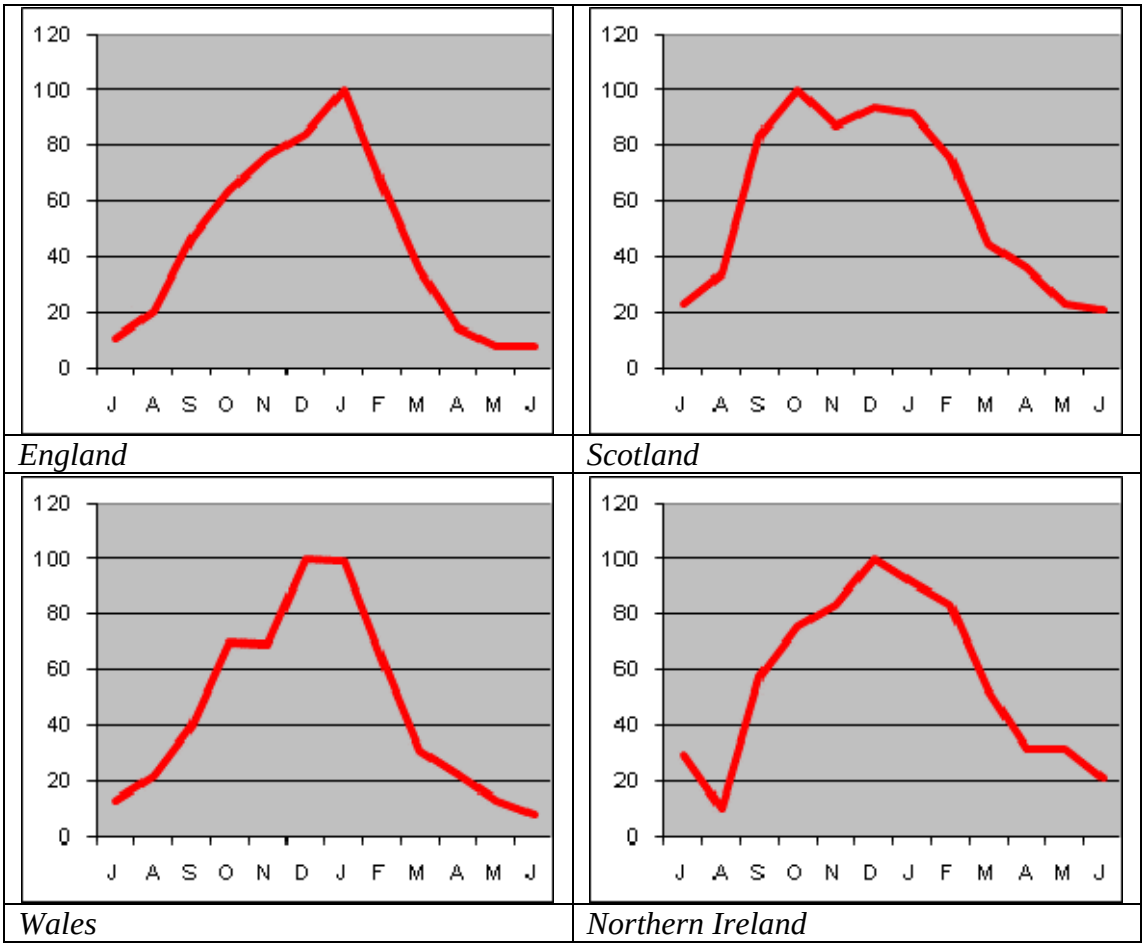

Figure II.14 Individual country WeBS monthly indices for Teal– average for 2003/04 to 2007/08.

2.3.7.3 BirdTrack

Reports of Teal across Britain and Ireland increase mainly between weeks 32 to 38 (July to September). It seems that the main influx of Teal varies slightly between England and Scotland, with Scotland being later. At a finer scale regions within England are very similar. Wales, Ireland and Northern Ireland are similar to England and north and south Scotland are very similar. The main decrease in reports of Teal occurs from weeks 12 to 19 (mid-March to mid-May) indicating the return migration to breeding grounds, with most birds gone by late April. This departure pattern is similar across the UK.

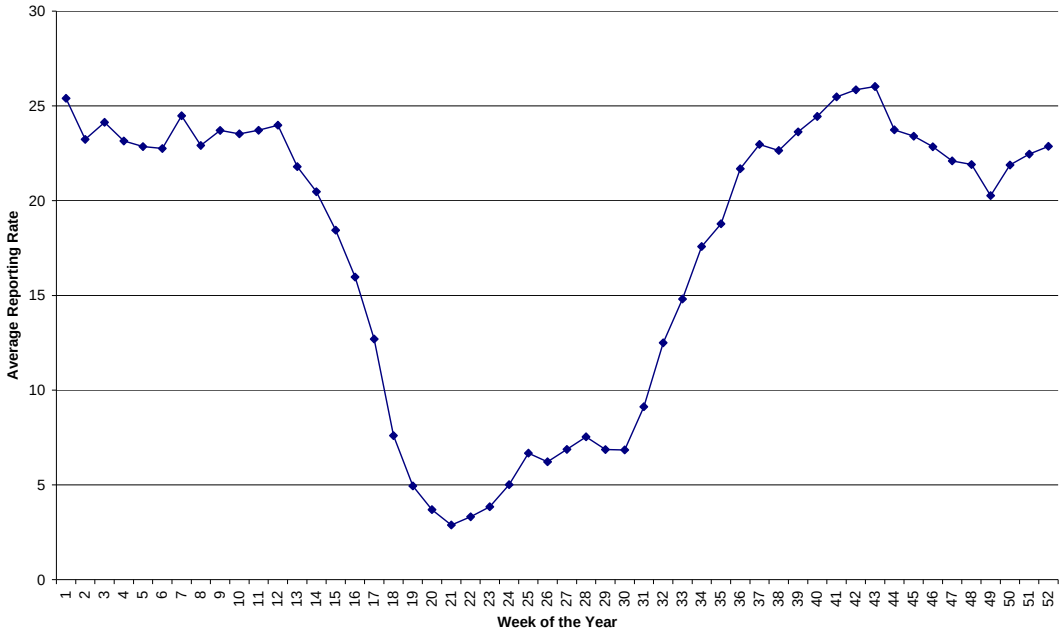

Figure II.15 Average BirdTrack reporting rate for Teal throughout the year, including sightings from across Britain and Ireland.

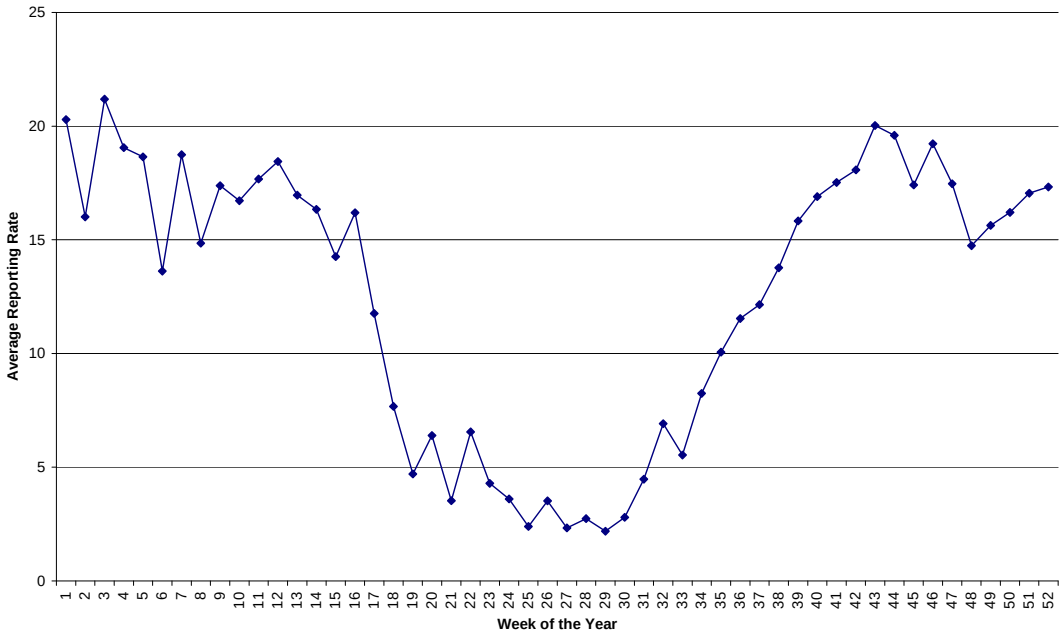

Figure II.16 Average BirdTrack reporting rate for Teal throughout the year, including sightings from Scotland only.

2.3.8 Mallard (*Anas Platyrhynchos*)

The Mallard is the world's most common species of dabbling duck, and it is found in a wide range of wetland habitats in Britain and Ireland.

2.3.8.1 Ringing Scheme

The breeding population in Britain and Ireland is largely sedentary with little regular migration to other countries, although some movements do occur, most commonly to France. Recoveries of ringed birds show that dispersal distances within UK are only short. During the winter the breeding population is supplemented by continental migrants from a wide area including Fennoscandia, Russia, Poland, Denmark, Germany, the Netherlands, Belgium and France (although numbers of such winter immigrants have been declining in numbers for some years now). Birds arrive through autumn and leave during spring. Some birds move west across Britain to Ireland, stopping in England before moving on.

2.3.8.2 WeBS

WeBS counts show that the population of Mallard in the UK decreases from January to March. This may be due in part to immigrant birds leaving the UK, but is also likely to be as a result of resident birds dispersing from larger lakes to smaller ponds (where they are less likely to be counted by WeBS). There is an increase between May and September, due mostly to breeding productivity, as well as some birds arriving from overseas in the autumn. However, numbers do not increase later in the autumn and winter, suggesting that immigration is fairly small. Considering countries within the UK separately, Scotland and England are similar to the national picture, but in Wales and Northern Ireland there is a decrease from September. This is probably because post-breeding mortality is less balanced by immigration in these most westerly areas.

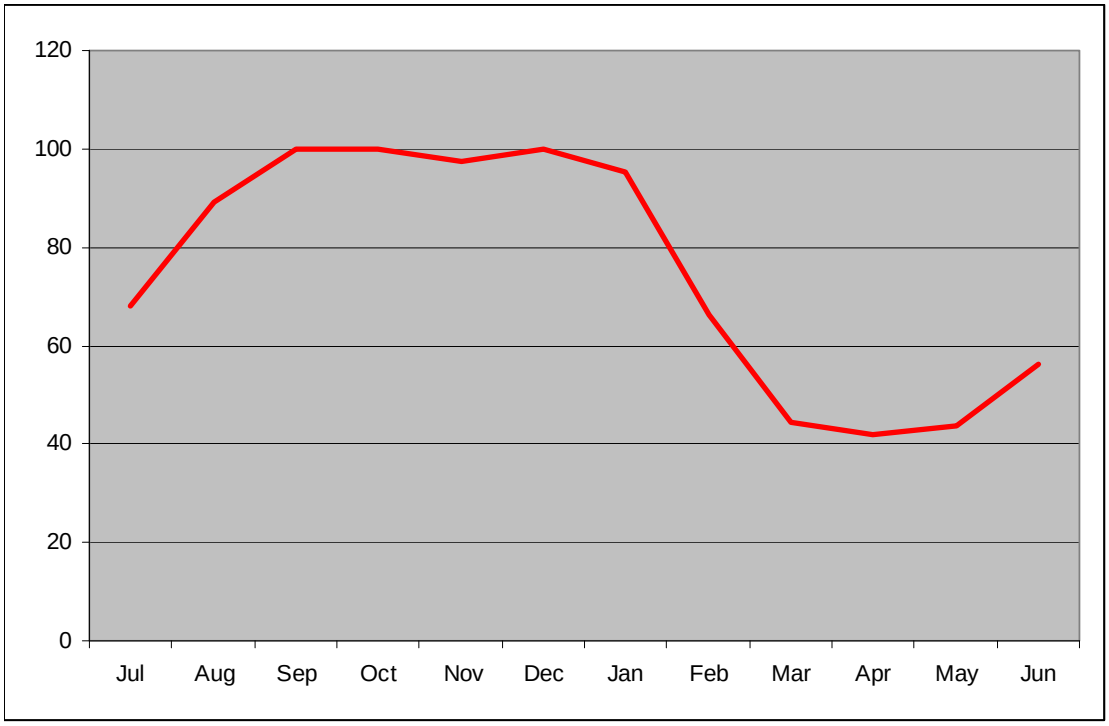

Figure II.17 WeBS monthly indices for Mallard – UK average for 2003/04 to 2007/08.

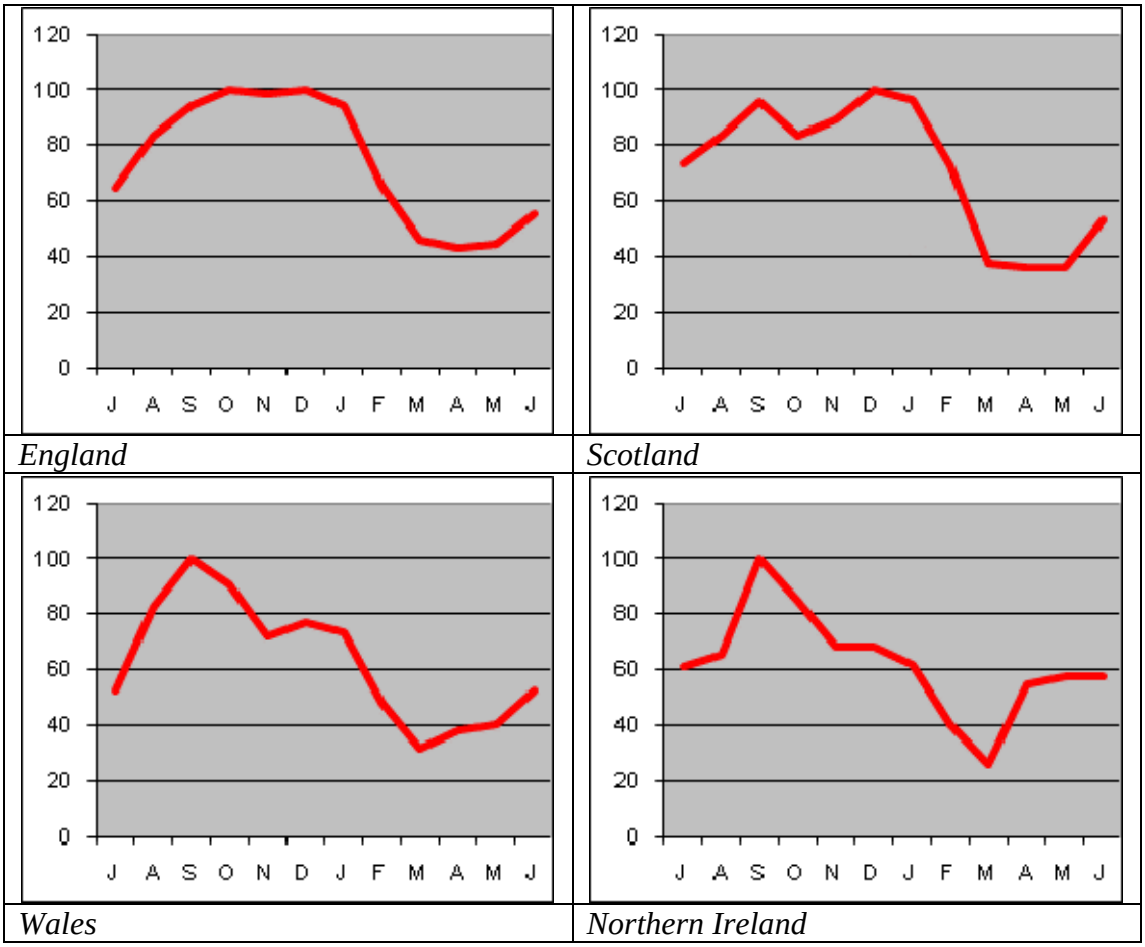

Figure II.18 Individual country WeBS monthly indices for Mallard – average for 2003/04 to 2007/08.

2.3.8.3 BirdTrack

Reports of Mallard sightings are fairly constant throughout the year, consistent with this being a ubiquitous and easy to see species. There is a gradual increase in sightings in late winter and early spring and then a gradual decrease as nesting commences. However there are no large short-term influxes or decreases in sightings, indicative of large scale arrivals and departures; these are probably difficult to detect or pin-point using BirdTrack data for this species. Regions within the UK are very similar to the overall UK pattern, however in Wales sightings peak in mid-September.

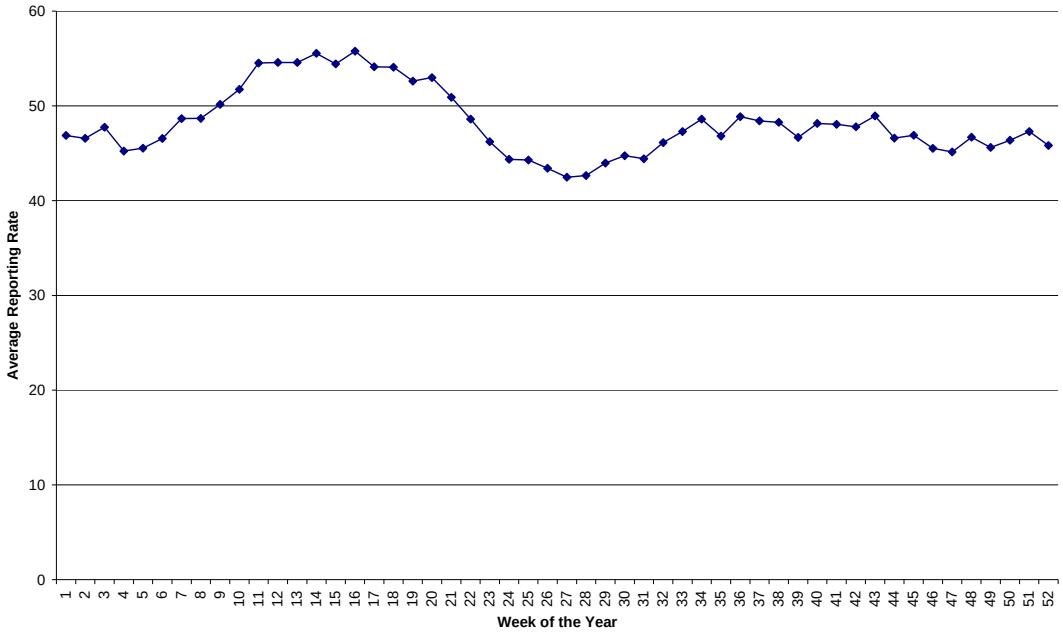

Figure II.19 Average BirdTrack reporting rate for Mallard throughout the year, including sightings from across Britain and Ireland

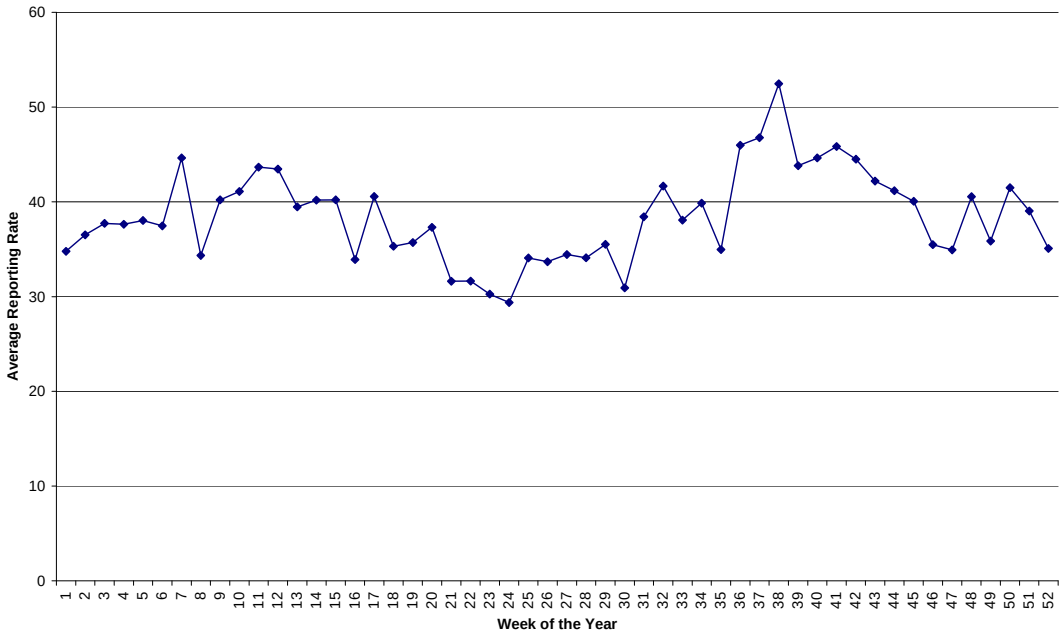

Figure II.20 Average BirdTrack reporting rate for Mallard throughout the year, including sightings from Wales only.

2.3.9 Northern Pintail (*Anas acuta*)

Pintail are a species of dabbling duck mainly found as an over-wintering species in Britain. During the winter Pintail principally use sheltered estuaries, but are also found on freshwater, especially in areas where rivers flood adjacent fields.

2.3.9.1 Ringing Scheme

Britain holds a tiny breeding population which appears to remain in Britain throughout the year, although there is only a small amount of ringing data to support this. Elsewhere, Pintail have a very wide breeding and over-wintering range. Those wintering in or passing through Britain and Ireland breed in Iceland, Fennoscandia, the Baltic States, and the Russian Federation. Some birds use Britain and Ireland as a stopping point before going south into the Mediterranean and West Africa, others remain in the UK. Pintail leave Britain and Ireland to return to breeding areas in the spring.

2.3.9.2 WeBS

WeBS data show that the population of Pintail increases most rapidly between September and November indicating that this is when birds migrate into the UK. Numbers then decrease again rapidly from February to March and into April as the majority of birds leave for their breeding grounds outside the UK. This pattern is generally consistent across all the constituent countries of the UK.

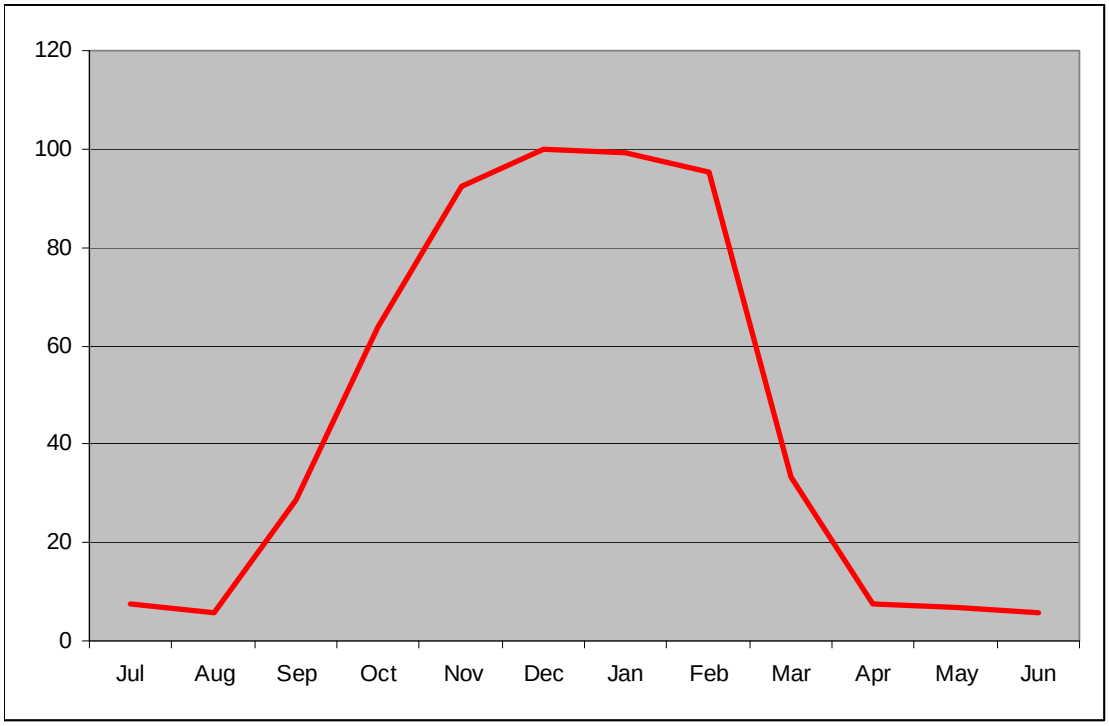

Figure II.21 WeBS monthly indices for Pintail – UK average for 2003/04 to 2007/08.

2.3.9.3 BirdTrack

Reports of Pintail increase from weeks 34 to weeks 43, with the most rapid increase occurring between weeks 35 and 37 (early to mid-September), indicating that this is a period when Pintail are arriving into the UK. The reporting rate peaks in January, and then starts to decrease from week 8 to week 24, with the most rapid decrease (when most departures are likely to be occurring) between weeks 12 and 16 (mid-March to mid-April). The very low reporting rate for this species during the spring and summer is indicative of this being a very rare breeding species in the UK. At a regional level the pattern is similar.

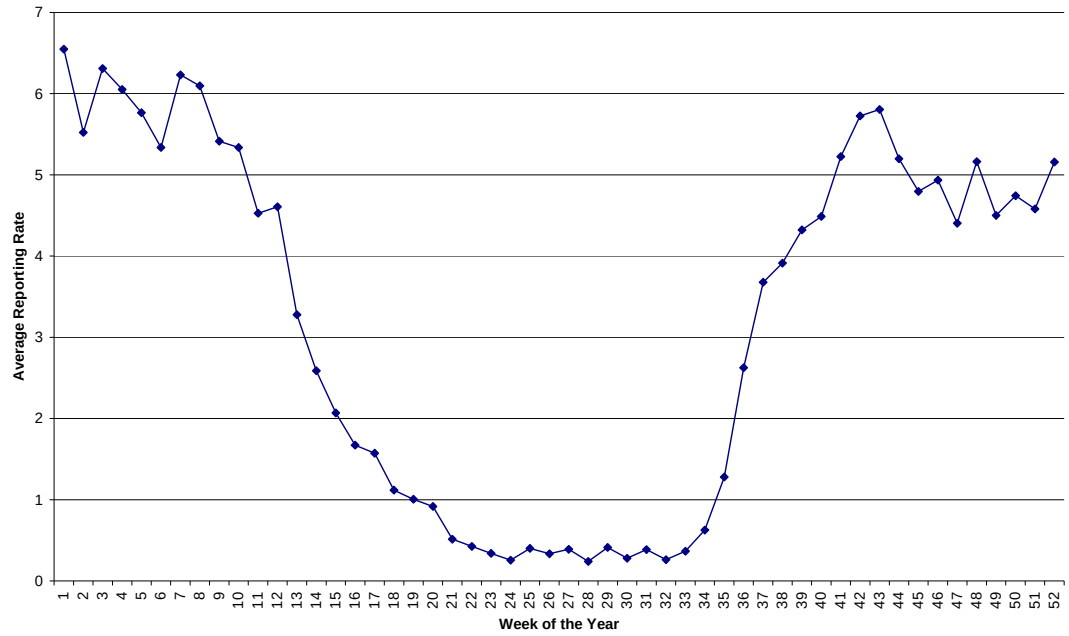

Figure II.22 Average BirdTrack reporting rate for Pintail throughout the year, including sightings from across Britain and Ireland

2.3.10 Garganey (*Anas querquedula*)

This species of duck is a summer visitor to Britain and Ireland, coming to breed only in small numbers in sheltered areas of fresh water.

2.3.10.1 Ringing Scheme

Birds come from wintering grounds in west Africa south of the Sahara (such as Senegal and The Gambia), and in the UK are mainly found in south eastern England. Ringing data is not extensive for this species, with most recoveries occurring in spring and autumn as this is when birds are moving into and out of the UK. Data are not sufficient to determine movements within the UK. In the autumn, some of the small numbers of birds present doubtless originate from breeding areas in eastern Europe, but ringing evidence is fairly limited.

2.3.10.2 WeBS

As this species is an uncommon summer visitor occurring in only very small numbers (for example a maximum count of 52 was recorded in May 2007), there are no year round WeBS indices. The highest numbers tend to be counted in May and August / September as birds enter and leave the UK.

2.3.10.3 BirdTrack

Reporting rates for this species are low, as it only occurs in very small numbers (especially away from England). Sightings peak in from weeks 18 to 20 (Early May) when birds enter the country, and then decrease as birds begin to breed or move on to breed in other countries and are less likely to be seen. Sightings then increase again from weeks 30 to 32 (late July and early August) and remain high into September, after which time birds leave the country. Numbers of this species in Britain and Ireland are so small they are unlikely to pose a significant threat.

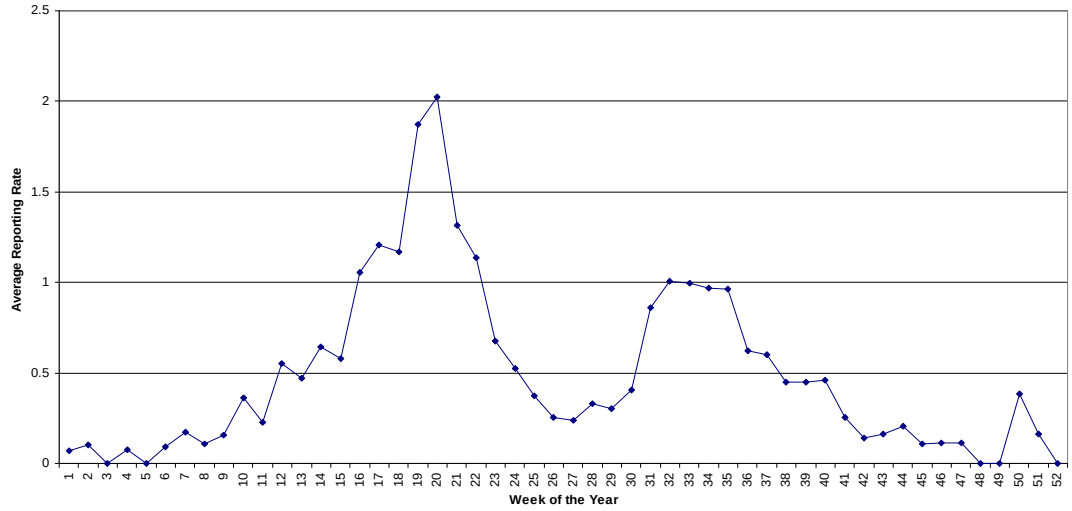

Figure II.23 Average BirdTrack reporting rate for Garganey throughout the year, including sightings from across Britain and Ireland

2.3.11 Northern Shoveler (*Anas clypeata*)

This highly migratory and widespread species of duck is found on shallow, highly productive fresh water habitats.

2.3.11.1 Ringing Scheme

There is a moderate breeding population (around 1000 birds) in Britain and Ireland, birds from which often move south to France and the Iberian Peninsula in the winter. The breeding population is supplemented by migratory birds in autumn and winter, which come from northwest Europe, Fennoscandia, the Baltic and Western Russia. Some Shoveler arrive in the UK in the autumn, then move further south during the winter as food resources become depleted; movements between sites during the non-breeding season are regular.

2.3.11.2 WeBS

UK-wide WeBS indices show that the population increases from July to September as Shoveler migrate into the UK. Following this early arrival, numbers then remain level from September to March, with the spring exodus mainly from March to May, as they return to breeding areas. When considering the constituent countries of the UK separately, Scotland shows peak in September and then a decline through the winter into spring. This may be because, further north, birds move southwards out of Scotland throughout the winter without incoming birds replacing them.

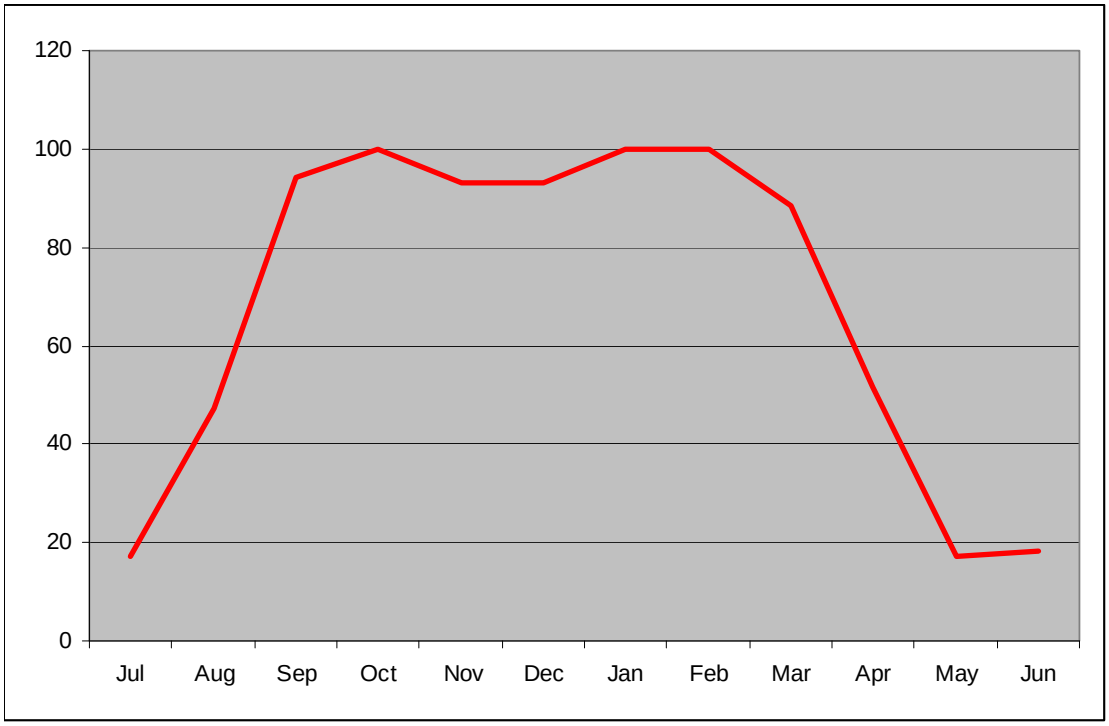

Figure II.24 WeBS monthly indices for Shoveler – UK average for 2003/04 to 2007/08.

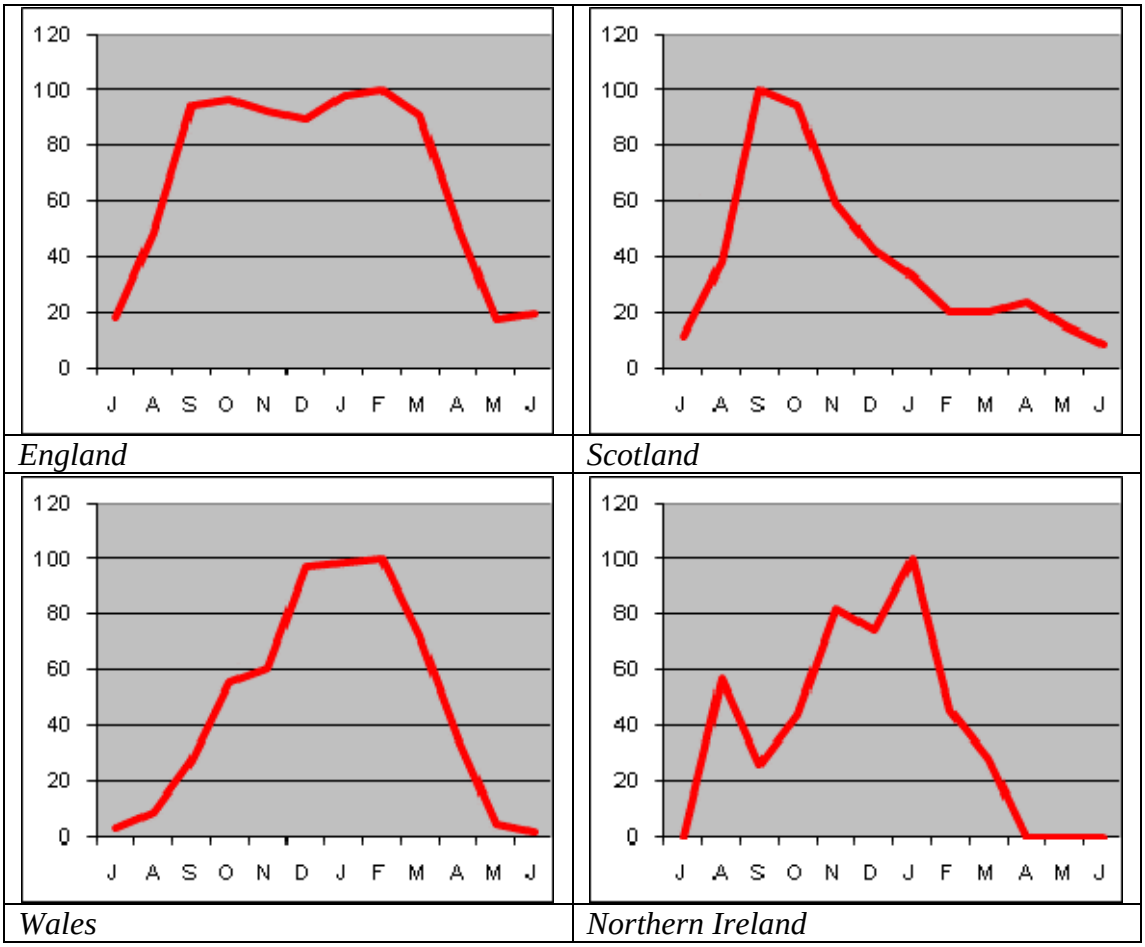

Figure II.25 Individual country WeBS monthly indices for Shoveler – average for 2003/04 to 2007/08.

2.3.11.3 BirdTrack

Reports of Shoveler show a less clear pattern of arrival and departure than some other species of migratory duck, and there are some regional differences. For the UK as a whole, reports increase quite rapidly over a period of several weeks in the late summer and autumn. This occurs mainly in August and September, with 50% of the peak population being reached in mid August (weeks 32 to 33). Reports gradually decrease in spring; perhaps weeks 16 to 18 (late April early May) show the period of most rapid decline in reports, when birds are mainly moving out of the UK. At a regional level, in the east of England the reporting rate does not decline in the spring (presumably as there are more breeding birds in this region). In Wales there is a very gradual decrease in reporting rates throughout winter and spring, but a sharp increase in weeks 35 to 37 (late August to early September) indicating a period when Shoveler are moving into Wales. In Scotland there is no clear pattern in reporting rates and in the northeast of England there is a less clear decease throughout the winter and spring and only a slight increase in reporting rates in weeks 32 to 35 (mid to late August). There are probably fewer birds further north throughout the year as Shoveler breed more commonly in southern Britain and have a southerly wintering distribution.

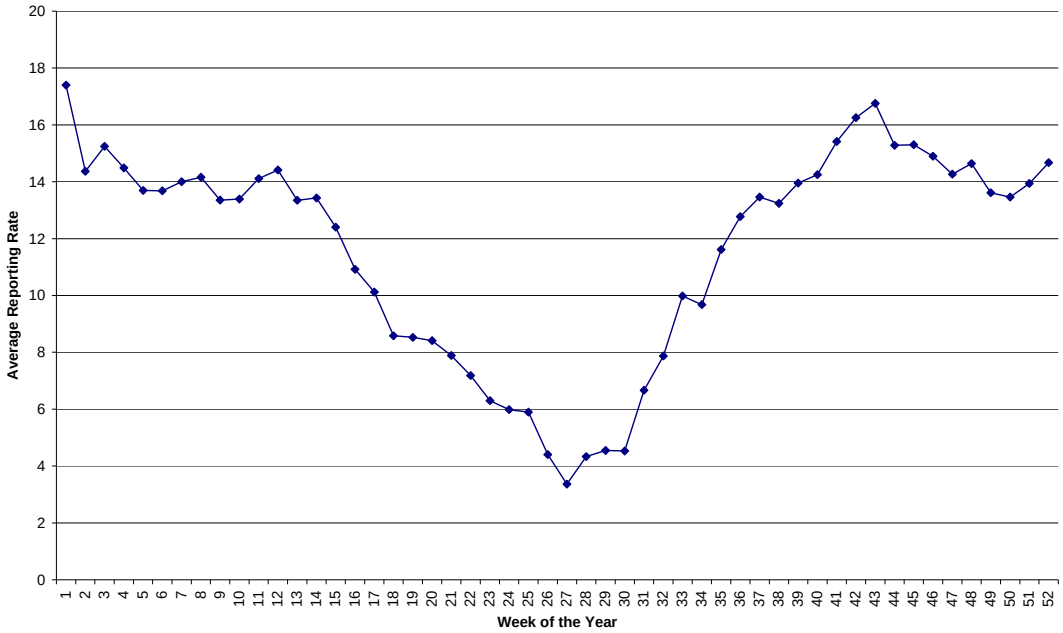

Figure II.26 Average BirdTrack reporting rate for Shoveler throughout the year, including sightings from across Britain and Ireland

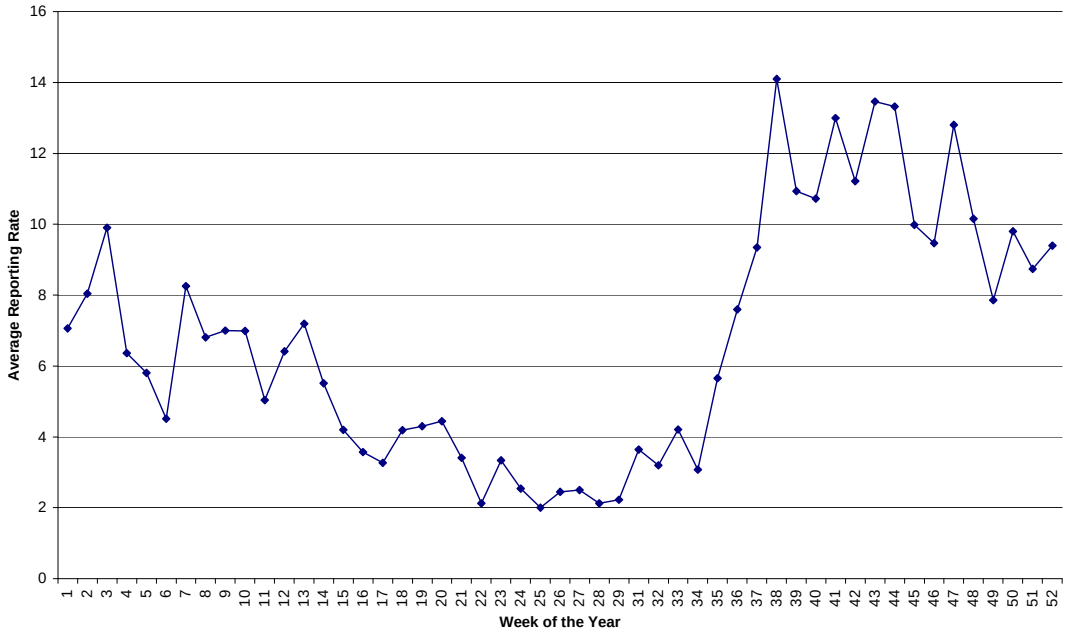

Figure II.27 Average BirdTrack reporting rate for Shoveler throughout the year, including sightings from Wales only.

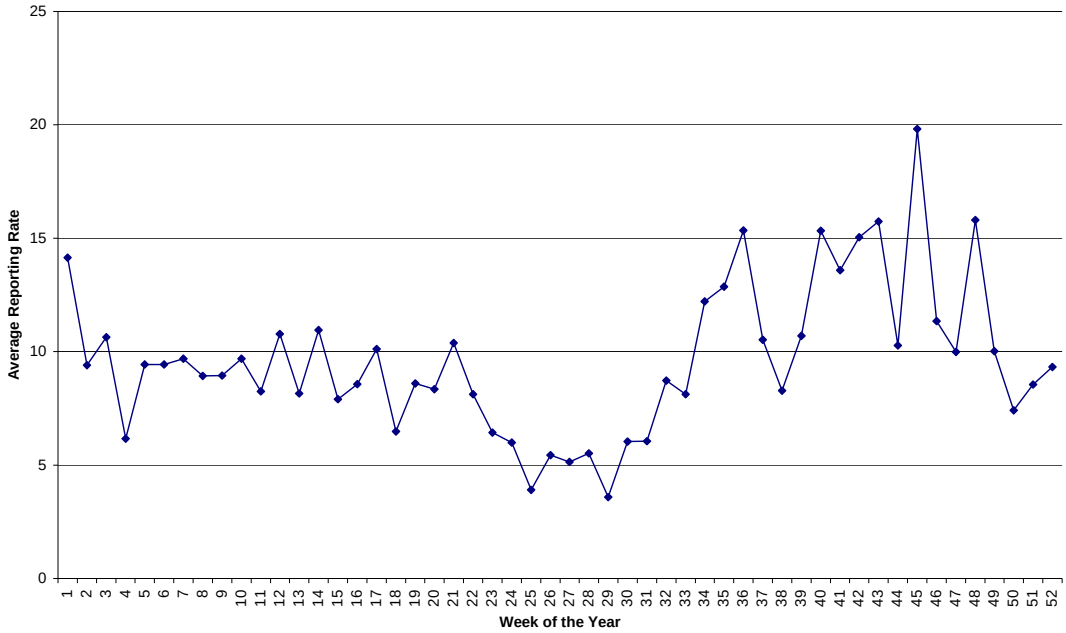

Figure II.28 Average BirdTrack reporting rate for Shoveler throughout the year, including sightings from north-east of England only.

2.3.12 Red-crested Pochard (*Netta rufina*)

This species of duck is present in the UK as a scarce and localised naturalised introduction, mostly found in the upper Thames valley where it is mainly sedentary. Therefore, its migratory movements are not considered further.

2.3.13 Common Pochard (*Aythya ferina*)

This migratory duck species breeds in nutrient-rich freshwater habitats, and only has a very small breeding population in Britain and Ireland. However, this is supplemented by a large and widespread over-wintering population, where it occurs mainly on large lakes and reservoirs.

2.3.13.1 Ringing Scheme

Ringing recoveries of birds in Britain and Ireland have been from Pochard ringed in countries such as Latvia, Denmark, the Czech Republic, Switzerland, Germany, the Netherlands, Russia, Poland and Finland as well as Spain and France. Pochard wintering in Britain come mainly from the Baltic countries, Eastern Europe and Russia. The main arrival time into Britain and Ireland is October to November, the timing of peak winter numbers varies across the UK from November to February, but most birds leave Britain and Ireland to return to their breeding grounds in March and early April.

2.3.13.2 WeBS

WeBS data for the UK show that there is an initial arrival of birds in August, when some arrive on certain (mostly English) waters to moult. Numbers then drop again in September, and the main increase in numbers of Pochard occurs from October to December, indicating that this is when most birds enter the UK. There is a sharp drop in numbers between February and March as birds leave the UK to breed elsewhere. The main difference between the constituent countries of the UK is that numbers peak in October in Scotland, suggesting that birds arrive here earlier than the rest of the UK.

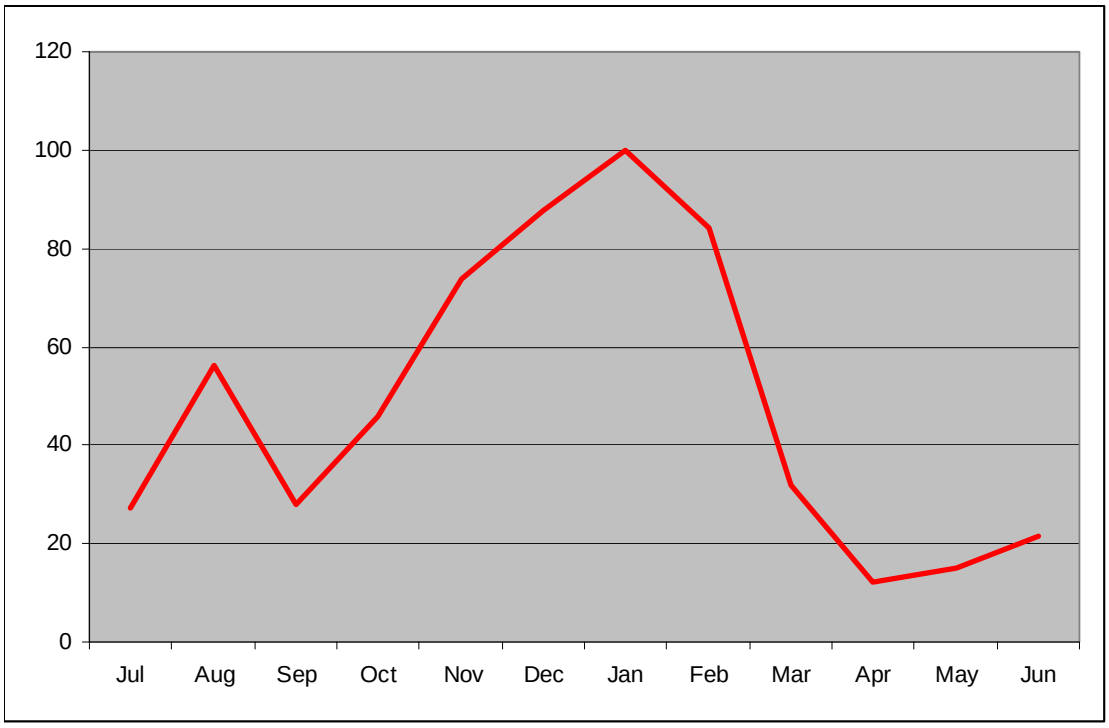

Figure II.29 WeBS monthly indices for Pochard – UK average for 2003/04 to 2007/08.

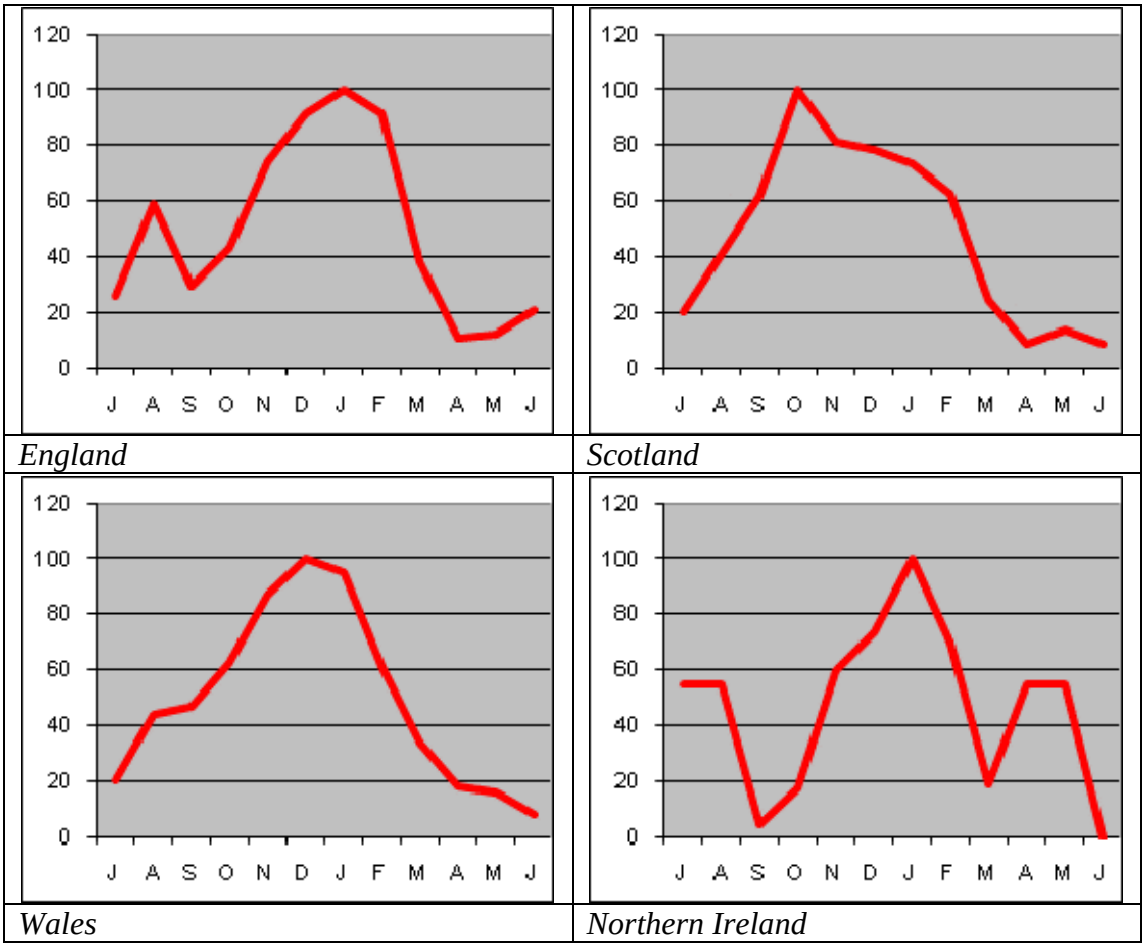

Figure II.30 Individual country WeBS monthly indices for Pochard – average for 2003/04 to 2007/08.

2.3.13.3 BirdTrack

Reports of Pochard across the UK show a rapid decrease between weeks 12 and 15 (mid-March to mid-April) indicating that this is the main period when birds leave the UK for their breeding grounds. Reports of Pochard increase gradually from late summer and through the winter until January. There is no clear influx in reports indicating a major period of arrival, (although there is a small jump in reports in early October), this may be due to there being an extended arrival period, and due to arrival time varying between different parts of the UK. However when regions are considered separately many show no clear pattern of arrival, perhaps as a result of numbers of Pochard increasing gradually throughout the autumn. The only exception to this is the West Midlands where reports increase rapidly between week 34 and 44 (Mid-August to November), with the largest increase between weeks 40 and 41 (the start of October); this may mark a period when more birds are moving into this region.

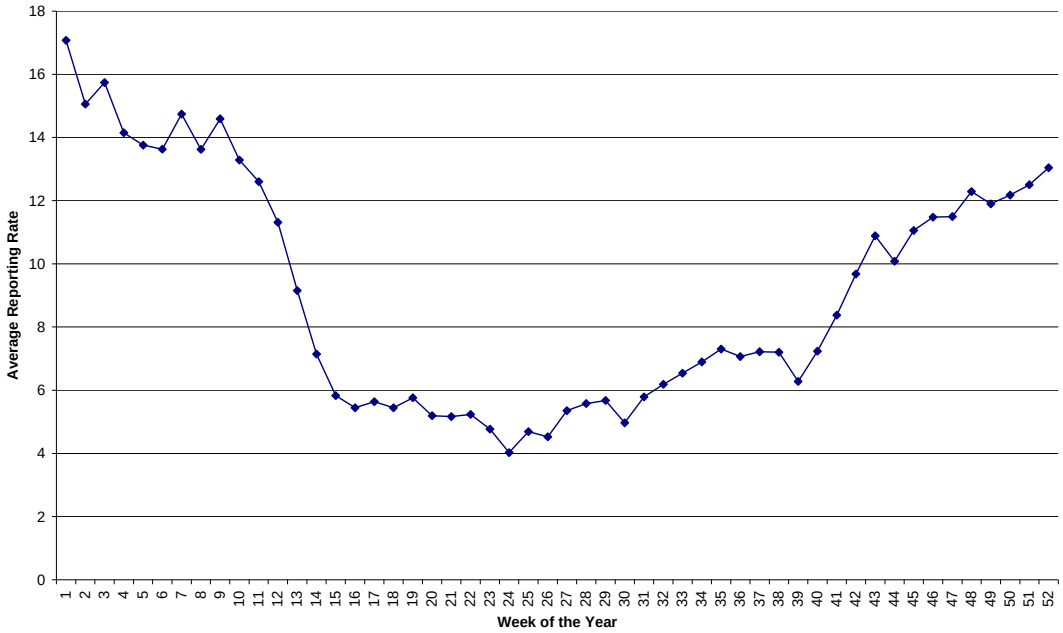

Figure II.31 Average BirdTrack reporting rate for Pochard throughout the year, including sightings from across Britain and Ireland

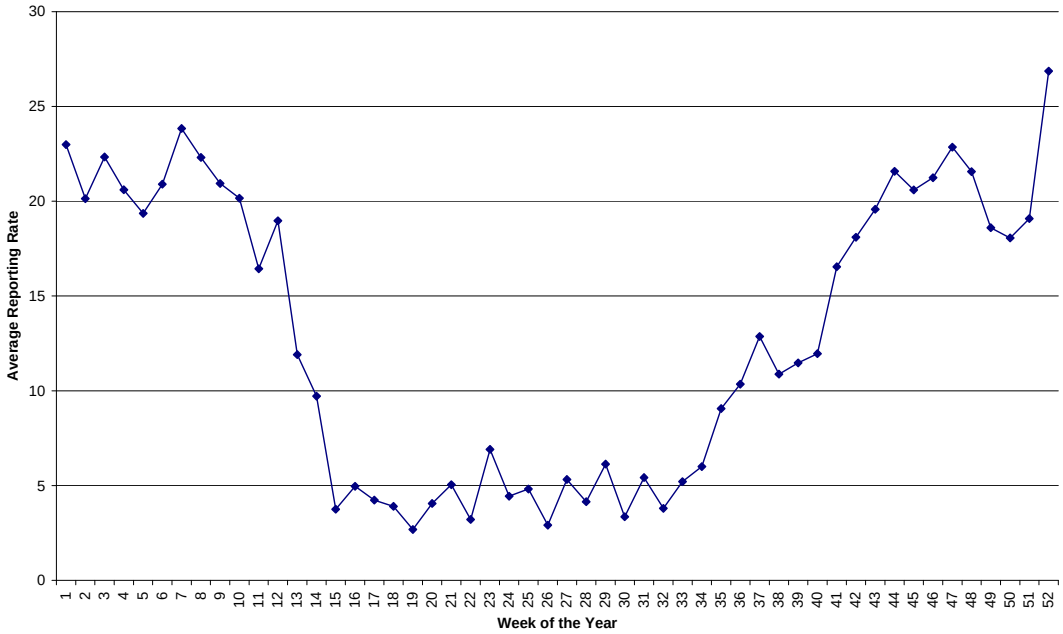

Figure II.32 Average BirdTrack reporting rate for Pochard throughout the year, including sightings from the West Midlands only.

2.3.14 Tufted Duck (*Aythya fuligula*)

This migratory diving duck is widespread and found on a range of wetland habitats.

2.3.14.1 Ringing Scheme

There is a sizeable breeding population present in Britain and Ireland, with some movement of birds after breeding; for example, Scottish birds often move to Ireland and birds breeding in southern England often move to the south-west, the midlands and into East Anglia, as well as some moving to Ireland and France. During late July and August some non-breeding birds from eastern and north-eastern Europe and Russia move into the UK to moult, leaving again once their moult is complete. Winter migrants arrive into the UK from their breeding grounds in European Russia, Fennoscandia and Iceland (birds mainly go to Ireland from Iceland), during October and into December and January. During the winter birds undertake smaller scale movements between sites within the UK, mainly staying within UK regions. Over-wintering migrants leave the Britain and Ireland mainly during April and May.

2.3.14.2 WeBS

For the UK overall, WeBS data show that numbers of Tufted Ducks increase between July and August, probably due to a combination of post-breeding increases and birds entering the UK to moult (see above). Numbers then decrease between August and September, and then gradually increase during the winter as birds migrate into the UK. Numbers then drop again between April and May as these birds leave the UK for their breeding grounds. In Northern Ireland there is a more marked drop in numbers in September and a sharper increase during the autumn and winter, indicating that there is a greater influx of migrant birds at this time compared to the rest of the UK (mostly to Lough Neagh). Northern Ireland also does not show such a sharp drop in numbers during the spring, possibly meaning birds return to their breeding grounds over a more extended time period.

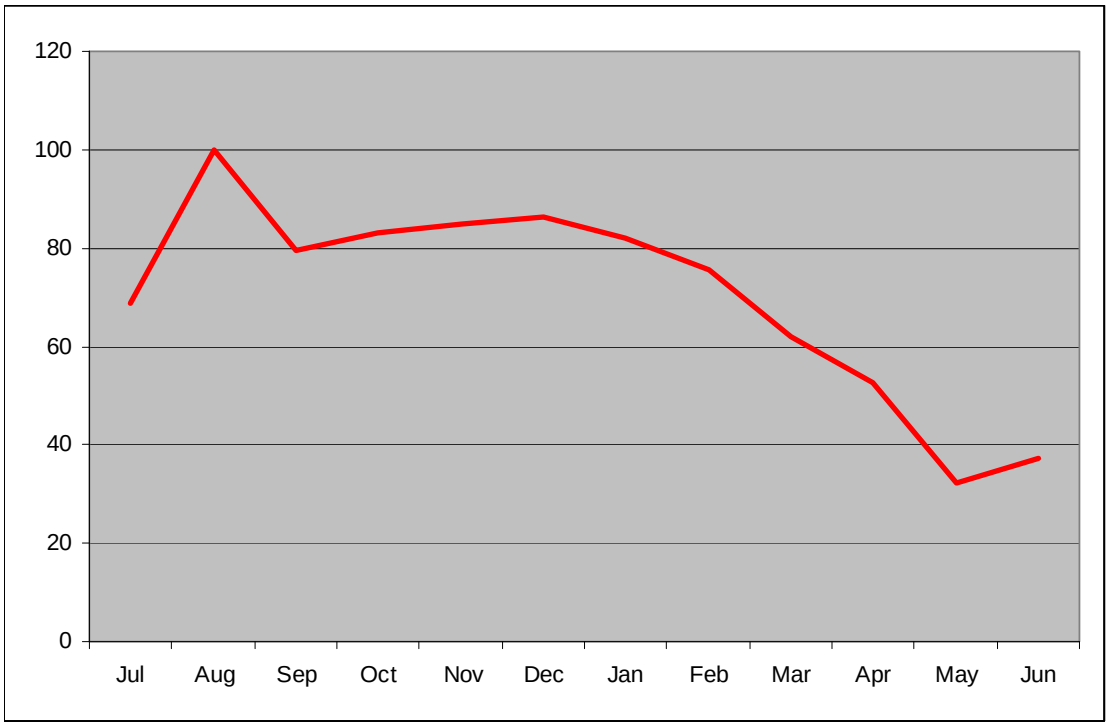

Figure II.33 WeBS monthly indices for Tufted Duck – UK average for 2003/04 to 2007/08.

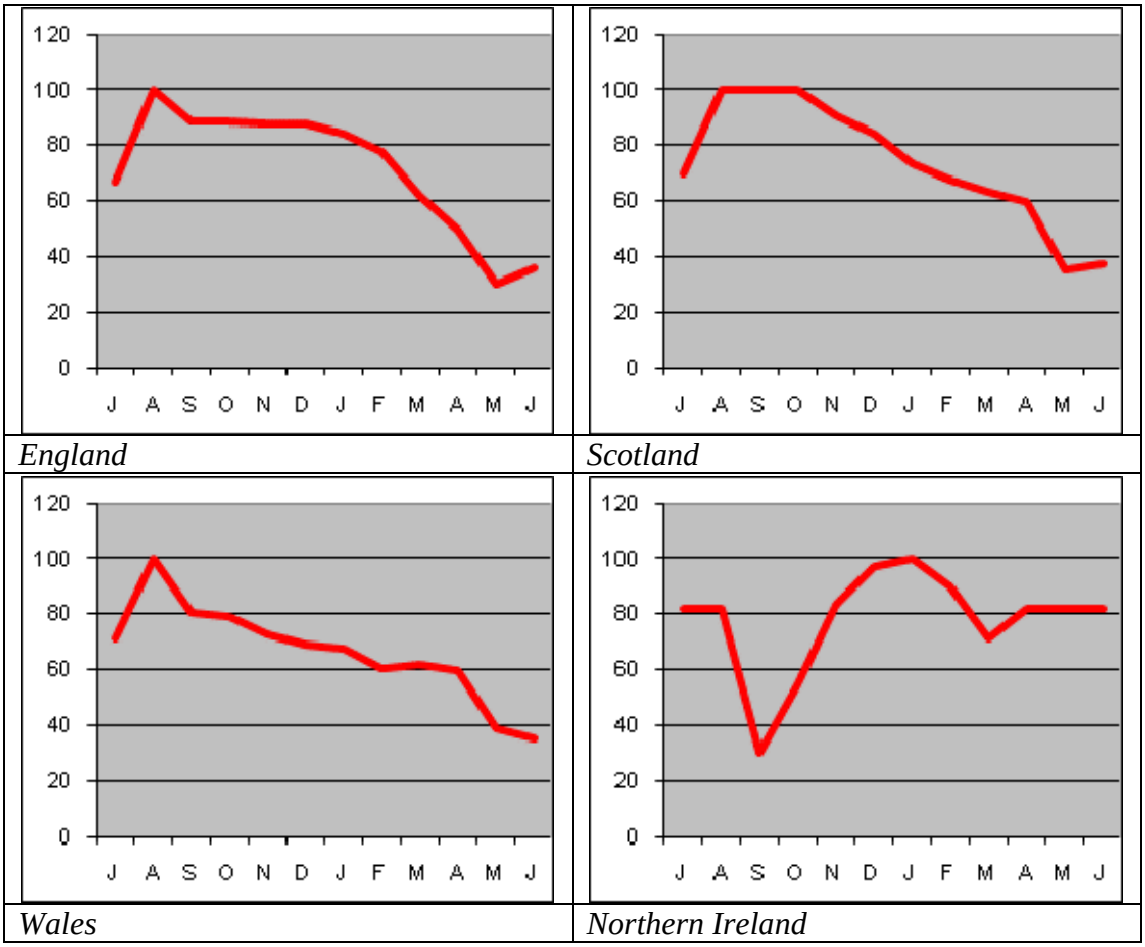

Figure II.34 Individual country WeBS monthly indices for Tufted Duck – average for 2003/04 to 2007/08.

2.3.14.3 BirdTrack

When considering the reporting rate of Tufted Ducks across the UK there is a gradual decrease in sightings from April into July, however there are no well defined periods where sighting increase or decrease rapidly. Tufted Ducks are present throughout much of the UK year-round, and so although numbers at many sites may increase in the winter, reporting rates do not. Additionally Tufted Ducks undertake migrations into the UK to moult and to spend the winter (from late summer into winter). For this reason BirdTrack reporting rates for Tufted Duck are of limited use when trying to track the timing of periods of movement of large numbers of Tufted Ducks into and out of the UK.

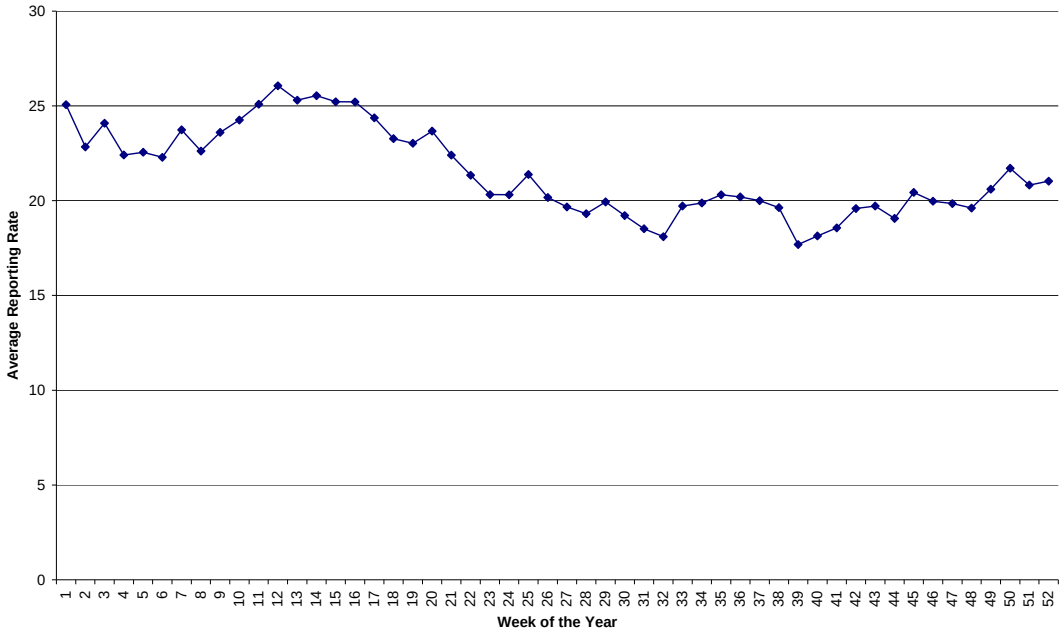

Figure II.35 Average BirdTrack reporting rate for Tufted Duck throughout the year, including sightings from across Britain and Ireland

2.3.15 Great Cormorant (*Phalacrocorax carbo*)

Cormorants are large fish-eating birds that are only partially migratory. In Britain Cormorants are most commonly found in coastal areas during the breeding period and over winter, although a small number use inland freshwater areas. Cormorants breed mainly in large coastal colonies on cliffs, although again small numbers breed on inland freshwater bodies.

2.3.15.1 Ringing Scheme

Dispersal of coastal breeders takes place from July onwards and ringing data suggest that British Cormorants generally remain relatively near their breeding colonies, although small numbers (mainly from the Republic of Ireland, southern Wales and south-west England) appear to move south to northern France and Portugal. After breeding some Cormorants remain within Britain but may move between the east and west coasts. Those that breed in the northern isles and in north Scotland do not commonly move further south than northern England. During the non-breeding season small numbers birds ringed in the Netherlands and Denmark have been recovered in Britain; these movements are mainly into the south east of England and are associated with birds using inland water bodies.

2.3.15.2 WeBS

WeBS data shows a post-breeding peak in numbers of Cormorants in September and October, with numbers increasing from July. This increase in numbers is probably due to breeding productivity and also dispersal of birds away from remote coastal cliff breeding locations (which are not necessarily covered by WeBS) to the more accessible coastal, estuarine and freshwater areas covered by WeBS counts. Numbers then decrease throughout winter and spring probably caused to some degree by mortality and birds returning to breeding areas. The constituent countries of the UK are consistent with this overall pattern, with Scotland showing the clearest peak in numbers in the autumn.

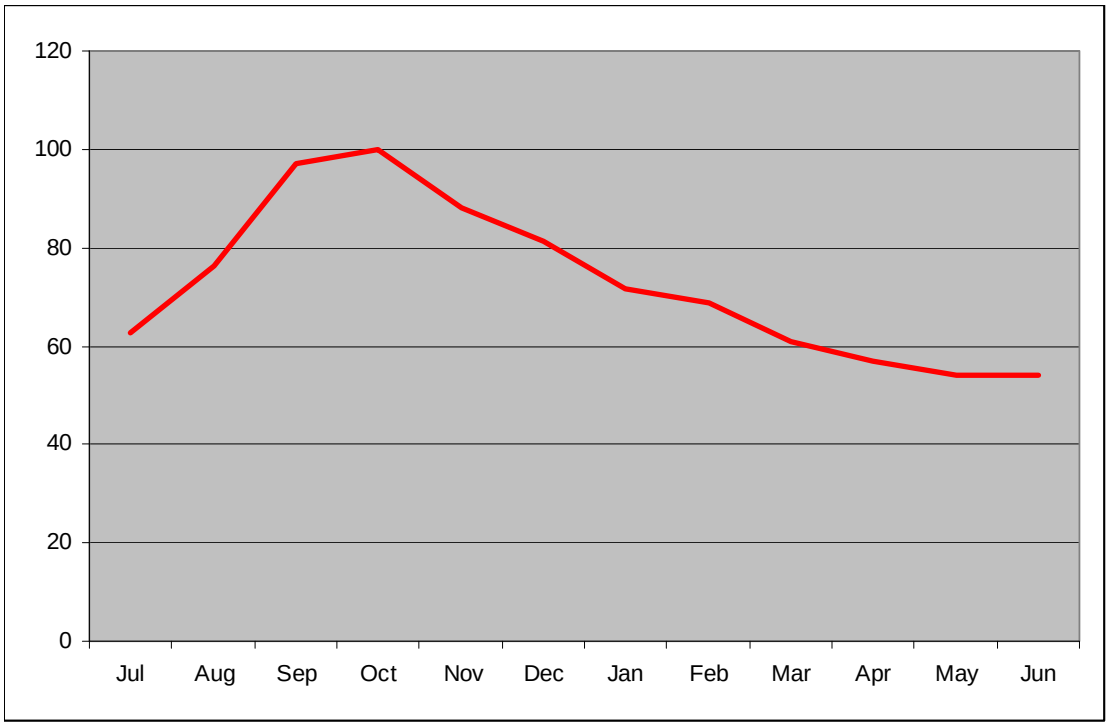

Figure II.36 WeBS monthly indices for Cormorant – UK average for 2003/04 to 2007/08.

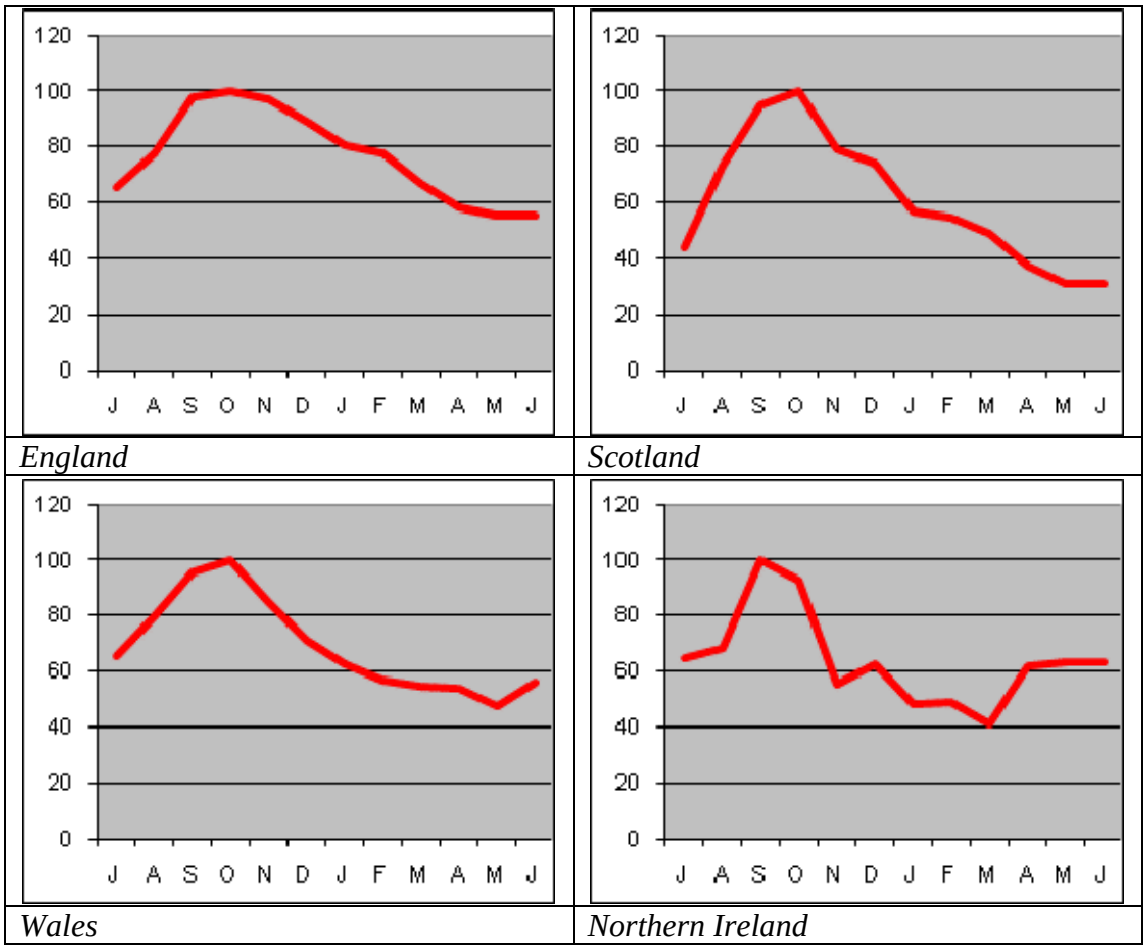

Figure II.37 Individual country WeBS monthly indices for Cormorant – average for 2003/04 to 2007/08.

2.3.15.3 BirdTrack

The main increase in sightings was from July to September (weeks 23 to 35), the most rapid increase in reports of Cormorants at end of July. This is consistent with post-breeding increase in numbers and the short-distance dispersal from breeding areas. Sightings show a very gradual decrease in spring, due to birds moving back to remote coastal breeding colonies. Across the regions of the UK, this pattern in fairly consistent.

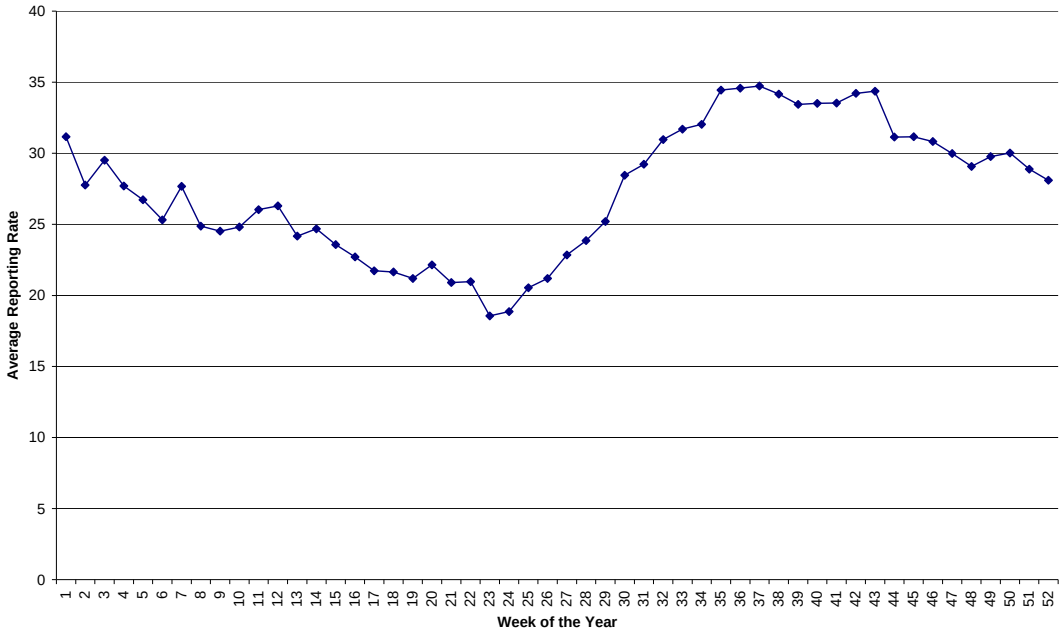

Figure II.38 Average BirdTrack reporting rate for Cormorant throughout the year, including sightings from across Britain and Ireland

2.3.16 Common Coot (*Fulica atra*)

Coot is a common bird on freshwater lakes, rivers and reservoirs throughout most of Britain and Ireland.

2.3.16.1 Ringing Scheme

There is a large breeding population which appears to be mostly sedentary. This breeding population is supplemented during the winter by winter immigrants, probably from eastern Europe and the Baltic states. Despite being a common species, it is difficult to catch and therefore there is only limited ringing information available. Coot clearly do migrate to and from Britain but little is know about the exact timing of movements, or if some birds are simply passing through or remain in Britain through the winter. Additionally, the extent to which birds move within Britain and Ireland is not clear. It is clear that movements occur at night however, as they are never observed moving by day.

2.3.16.2 WeBS

WeBS data for the UK show that numbers of Coot are highest in winter, although this increase in numbers is very gradual, occurring from June into November. This perhaps suggests it results from a mixture of both local breeding productivity and winter migrants. Numbers decrease gradually again from January into March and April indicating birds leaving to breed outside the UK (and also some birds dispersing to smaller waters in the UK that are less likely to be monitored by WeBS). This pattern is similar across England, Wales and Scotland; Northern Ireland has a less clear pattern of increase and decrease with the population being slightly higher than the rest of the year in September and decreasing from October through into February.

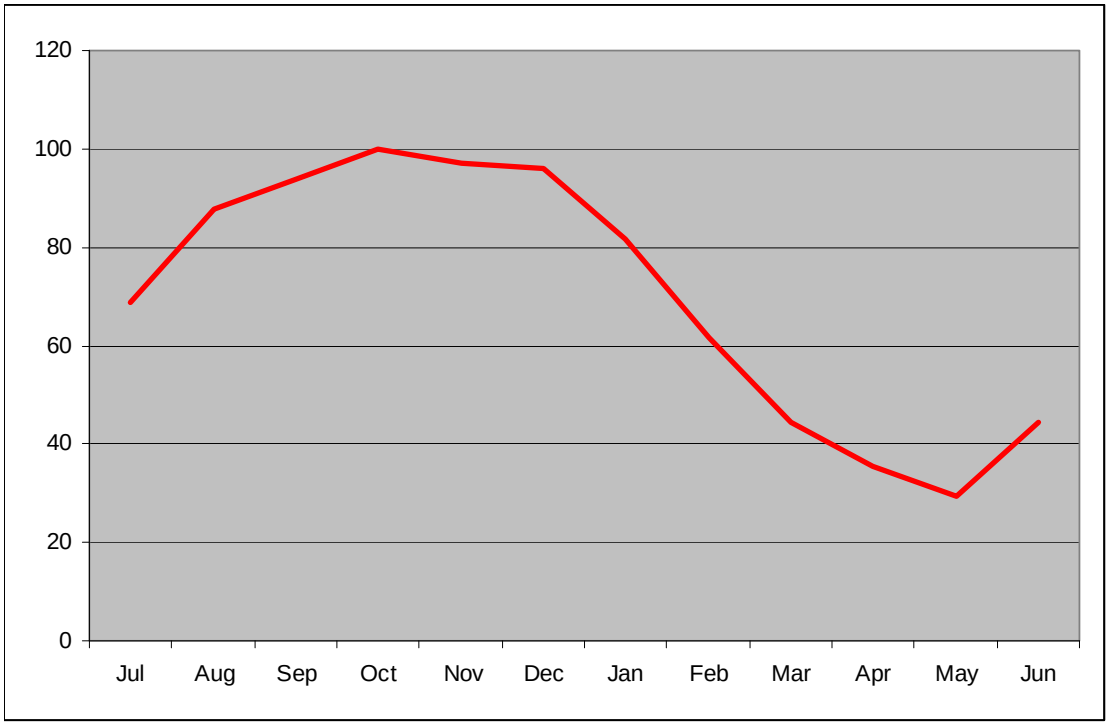

Figure II.39 WeBS monthly indices for Coot – UK average for 2003/04 to 2007/08.

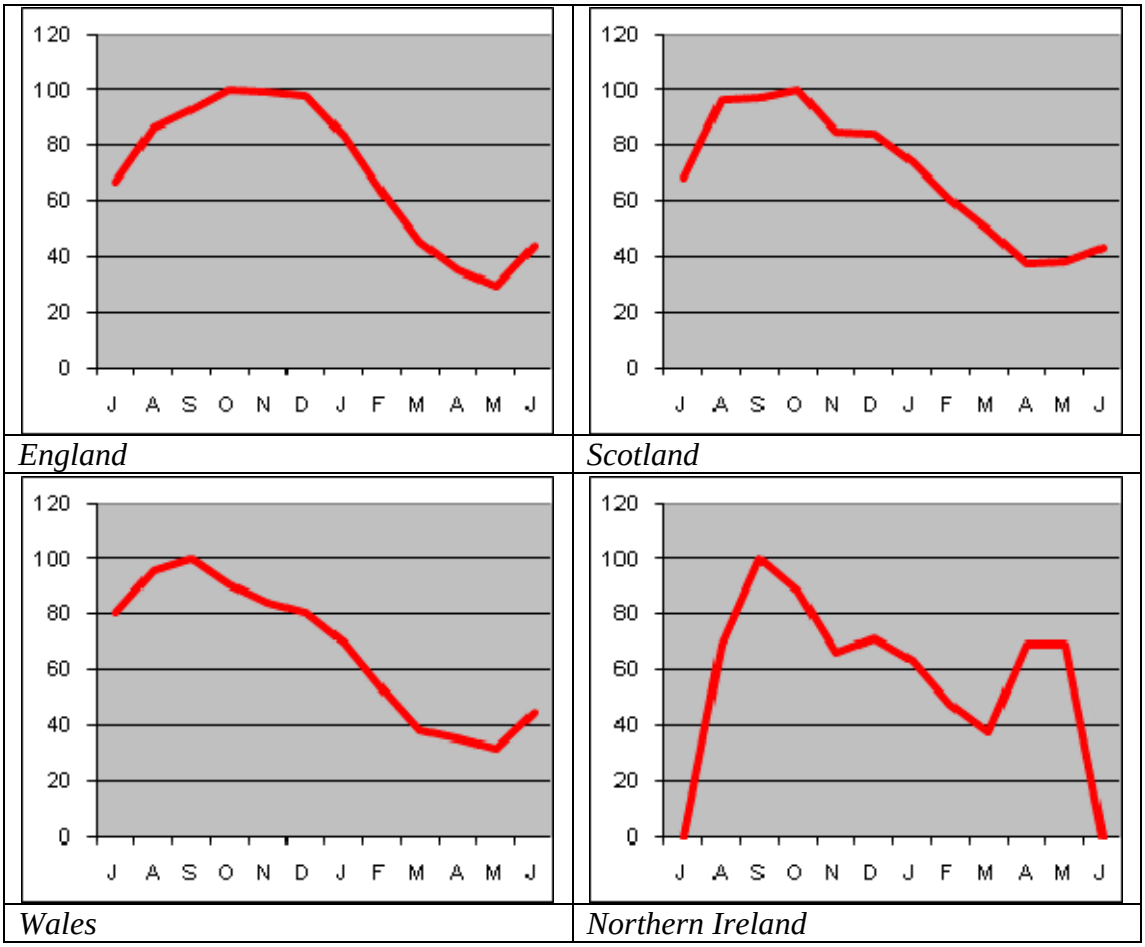

Figure II.40 Individual country WeBS monthly indices for Coot – average for 2003/04 to 2007/08.

2.3.16.3 BirdTrack

Sightings of Coot across the UK remain high throughout the year, with slight increases in the spring and summer, before and after breeding. In the case of this very common and widespread species, which is present year-round, BirdTrack does not really help to determine the timing or pattern of migration. There are also no clear regional differences.

2.3.17 Northern Lapwing (*Vanellus vanellus*)

The Lapwing is a relatively common, but declining, breeding wader in the UK, and is found on wide range of habitats including farmland, wetlands, coastal areas and uplands.

2.3.17.1 Ringing Scheme

In addition to the breeding population, birds migrate into the UK from continental Europe. Migrants start arriving as early as late May, but the main arrival time is between late September and early November. Lapwings over-winter on farmland, wetlands and on the coast. Ringing recoveries within the UK show that breeding Lapwings often move south within the UK during the autumn after breeding, and over-wintering birds may move in large numbers to coastal areas during cold weather.

2.3.17.2 WeBS

In the UK as a whole WeBS counts show that Lapwing numbers peak in December and January, with the main increase in numbers occurring during October and November. Numbers decrease again between and January and March. The increase is partially as a result of breeding birds congregating into flocks after the breeding season, but the main winter peak is clearly due to winter immigration. The pattern of increases and decreases in numbers counted is similar across the constituent countries of the UK.

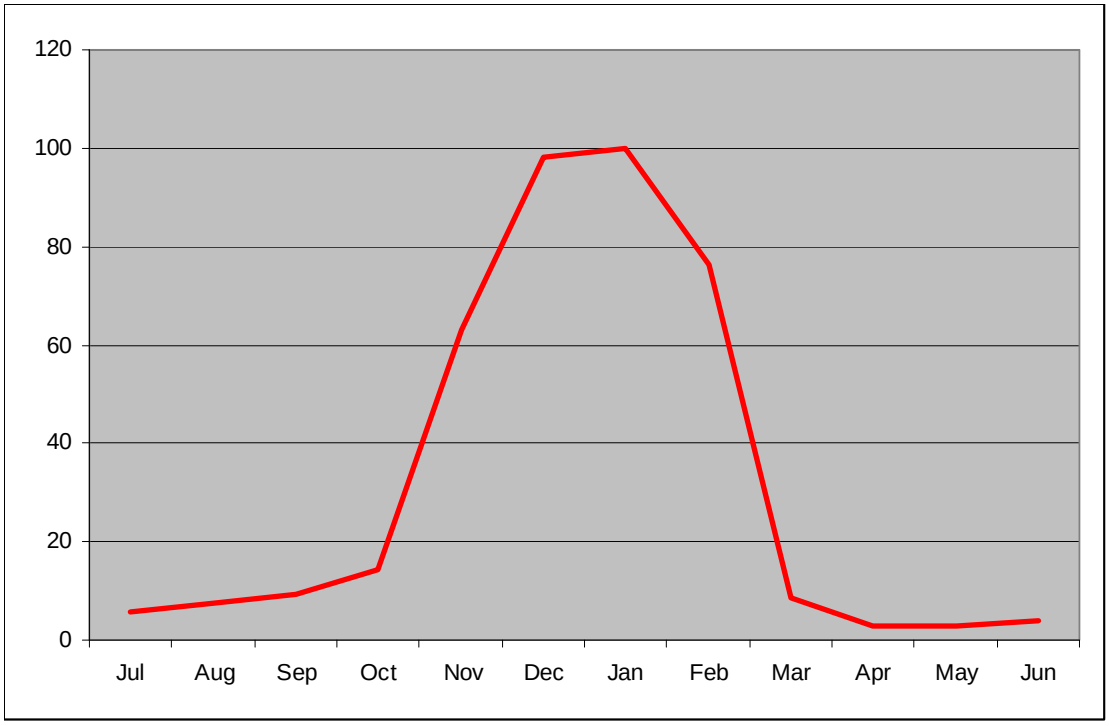

Figure II.41 WeBS monthly indices for Lapwing – UK average for 2003/04 to 2007/08.

2.3.17.3 BirdTrack

Overall in the UK reports of Lapwing sightings are evenly spread throughout the year, as the Lapwing is a widespread species. However, there are some regional differences in the reporting rate of Lapwings during the year. Fewer birds over-winter in the north, where Lapwing is more widely distributed as a breeding bird, so numbers increase in the spring and then decrease again during the winter; this broad pattern is seen in Scotland, and in the north-west and north-east of England where the main period of increase is weeks 8 to 11 (mid February to mid March). Fewer Lapwings breed the south west of England and Wales but birds migrate into these areas in the winter so numbers increase during the autumn and winter, the point where the reporting rate increases most – indicating an influx of sightings- is between weeks 50 and 52 (late December). In the south west there is also a sharp drop in reporting rates between weeks 7 and 9 (February) indicating that this is when Lapwings are leaving their wintering areas and migrating to breeding grounds. This pattern is also seen across Northern Ireland and Ireland, again because many birds move south and west into this area during the winter; here the main decrease in reports (as birds leave to breed) is as above, but the main period of increase occurs earlier between weeks 39 and 42 (late September to early October).

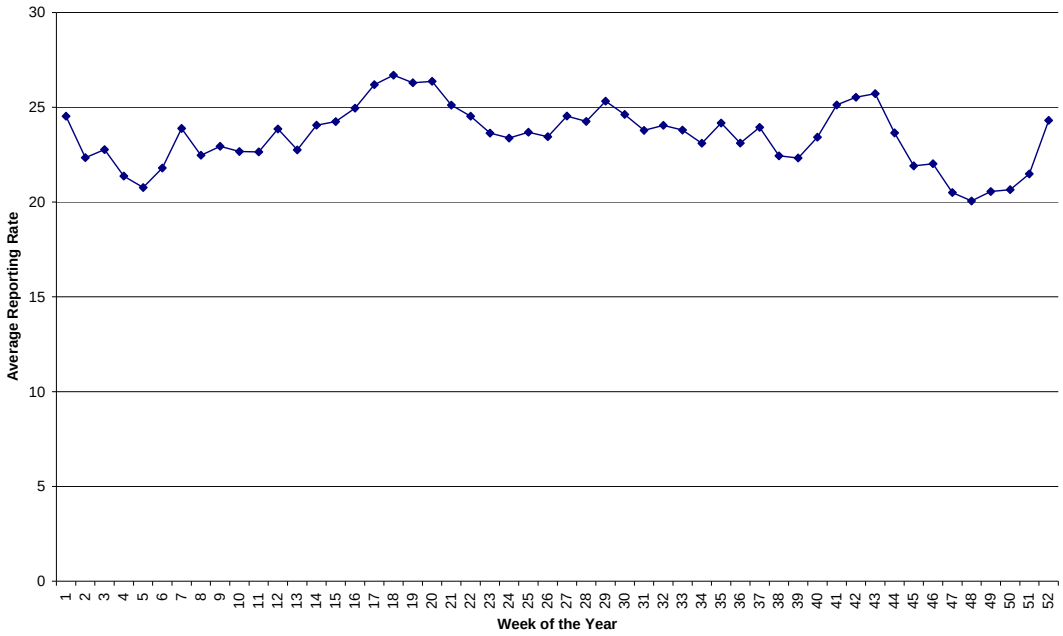

Figure II.42 Average BirdTrack reporting rate for Lapwing throughout the year, including sightings from across Britain and Ireland

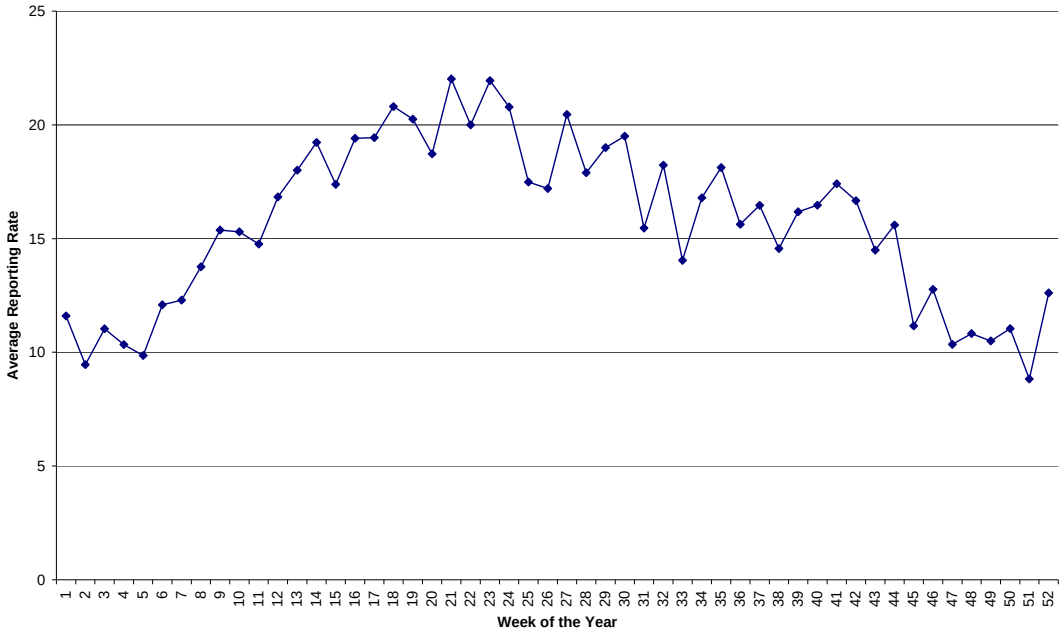

Figure II.43 Average BirdTrack reporting rate for Lapwing throughout the year, including sightings from Scotland only.

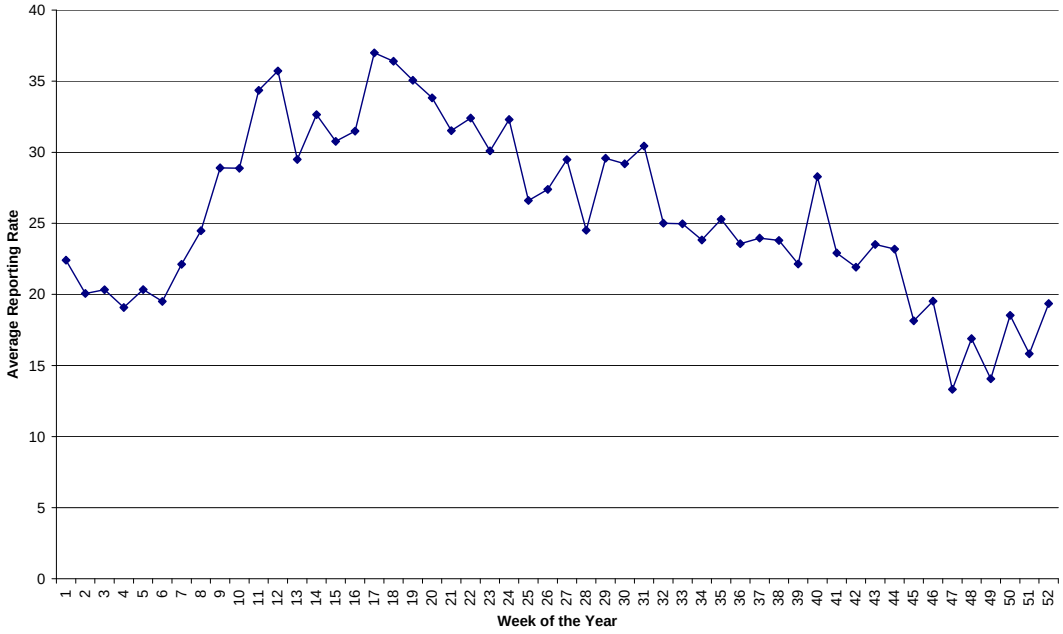

Figure II.44 Average BirdTrack reporting rate for Lapwing throughout the year, including sightings from the north-west of England only.

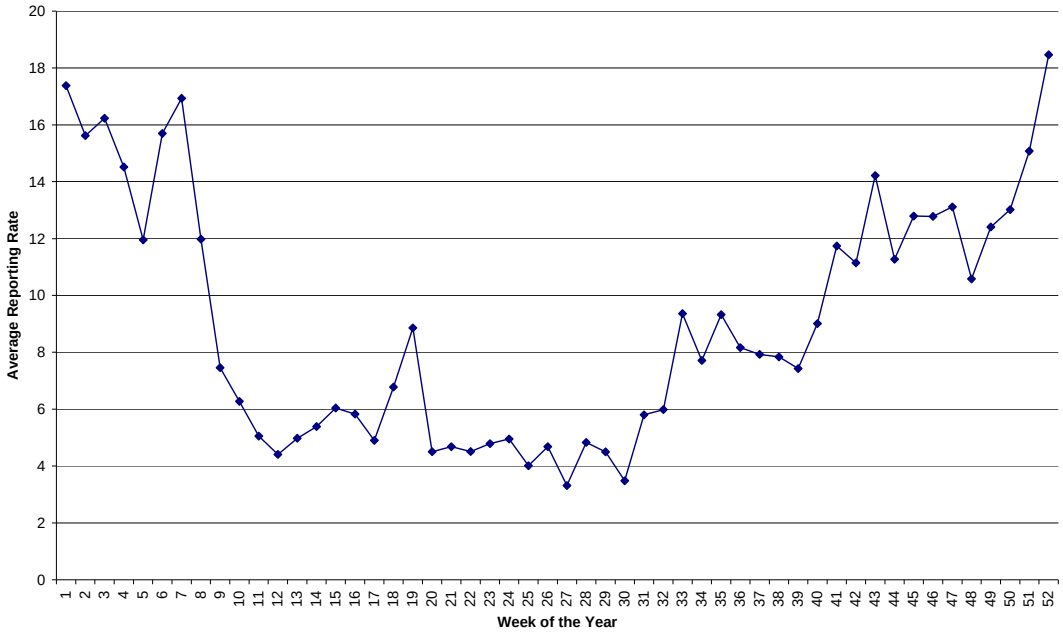

Figure II.45 Average BirdTrack reporting rate for Lapwing throughout the year, including sightings from the south-west of England only.

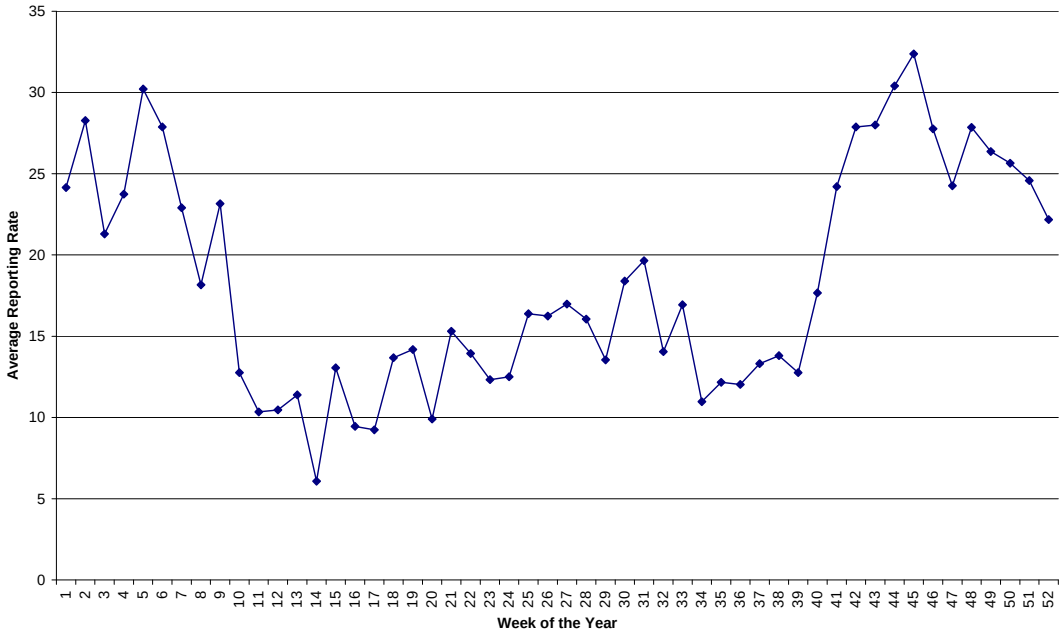

Figure II.46 Average BirdTrack reporting rate for Lapwing throughout the year, including sightings from Ireland only.

2.3.18 Ruff (*Philomachus pugnax*)

The Ruff is a species of wader which occurs widely but generally in small numbers, and prefers freshwater wetland habitats.

2.3.18.1 Ringing Scheme

Only small numbers of Ruff have been ringed, making ringing data limited. Most of the Ruff in seen in the UK are probably present on passage to more southerly over-wintering locations in Africa, there is a small fairly sedentary population that over-winter, and occasional breeding attempts. Birds that spend the winter in, or pass through, the UK clearly come from the large breeding populations in Fennoscandia and Russia. Birds arrive into and pass through the UK from July into October, some birds may arrive into the UK during the winter from continental Europe during cold weather. Fewer birds pass through the UK during the return spring migration as Ruff take a more easterly route back to their breeding grounds.

2.3.18.2 WeBS

In the UK numbers of Ruff are always relatively low throughout the year (for example the highest UK total count in 2007/08 was 558 birds), with the highest counts during WeBS surveys occurring in late winter. Following a pulse of migration in August, there is a secondary arrival between October and February as birds arrive into the UK to spend the winter. Numbers decrease mainly between March and April as Ruff return to their breeding grounds. As this species only occurs in small numbers it is not possible to compare the difference in WeBS data between UK countries

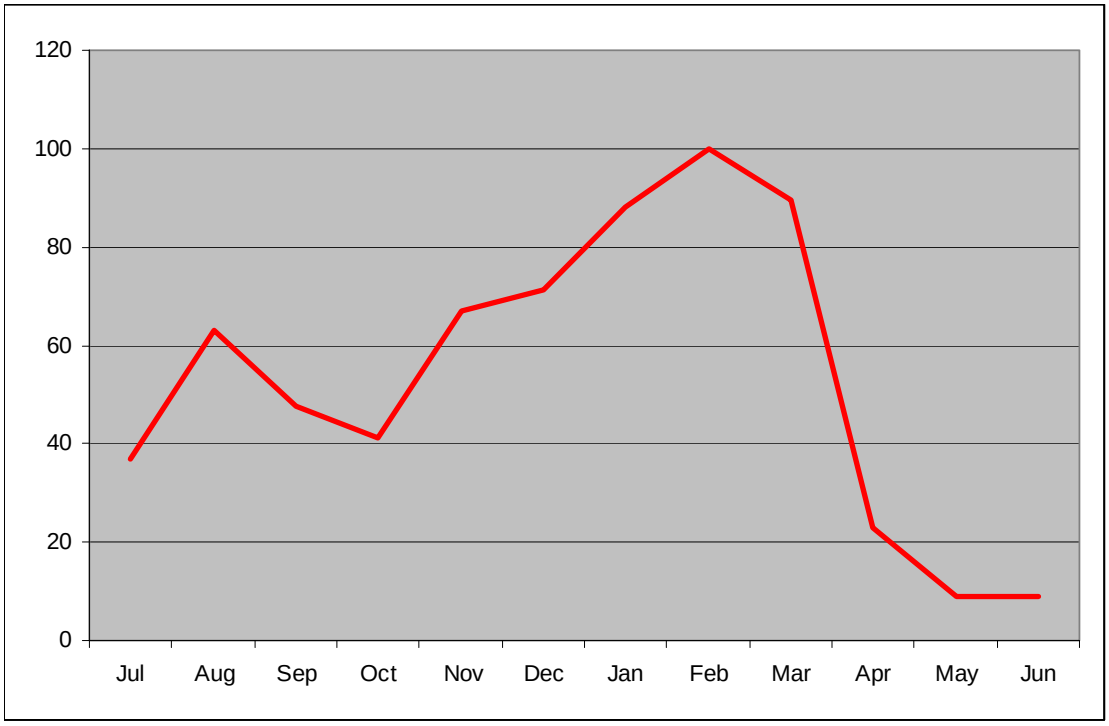

Figure II.47 WeBS monthly indices for Ruff – UK average for 2003/04 to 2007/08.

2.3.18.3 BirdTrack

Reporting rates are low for this species, therefore the UK is only considered overall and no regional trends are discussed (many regions have very few sightings). Throughout most of the year very few Ruff are reported, however the reporting rate increases rapidly from mid June to early September and then decreases rapidly from early September into November. This peak probably marks the period when many Ruff are passing through the UK to wintering areas elsewhere (with only small numbers staying in the UK for the winter) the peak point to this period of passage through the UK appears to be around week 36 which is the start of September. The reason for the contrast with the pattern shown by WeBS (see above) is that in the early autumn, Ruff occur at many sites in small numbers, leading to a higher BirdTrack reporting rate, whereas in the winter, larger numbers occur at just a few key locations.

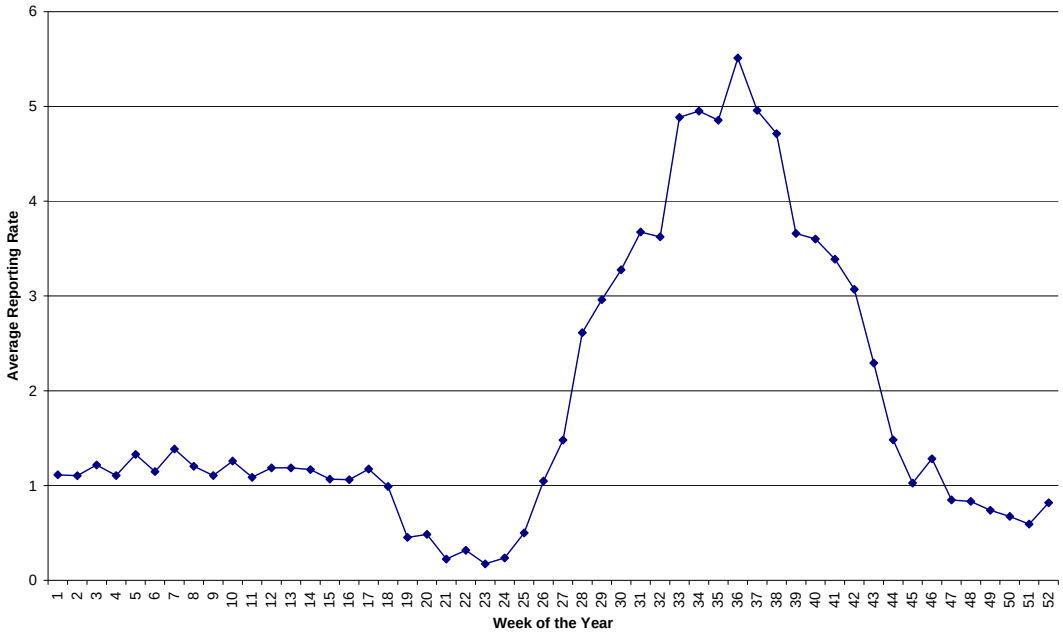

Figure II.48 Average BirdTrack reporting rate for Ruff throughout the year, including sightings from across Britain and Ireland.

2.3.19 Black-tailed Godwit (*Limosa limosa*)

The Black-tailed Godwit is a relatively common wader species, mainly seen in the UK during the winter. There are two subspecies occurring in the UK, one of which (*limosa*) breeds in tiny numbers, and the other (*islandica*) breeds mainly in Iceland but occurs in the autumn and winter in the UK..

2.3.18.1 Ringing Scheme

Birds start arriving after breeding, during July and August, often forming large flocks to moult. Some birds move further south, mostly to France, Spain and Portugal but some to north-west Africa. During the winter birds are found in smaller flocks, mostly on estuaries, although selected inland wetlands are also used. Birds regularly make local movements within winters between different sites in the UK. Black-tailed Godwits leave the UK to return to Iceland in April and May.

2.3.18.2 WeBS

WeBS data over the UK as a whole show that the main period arrival is early, between July and September, as birds arrive to moult. After the peak count in September, numbers decline a little then as the winter approaches, as some birds move south into France, Spain and Portugal. The UK pattern is heavily based on that of English birds; in Wales, Northern Ireland and, especially, Scotland there is an additional peak in numbers during April, marking the return migration of birds to Iceland.

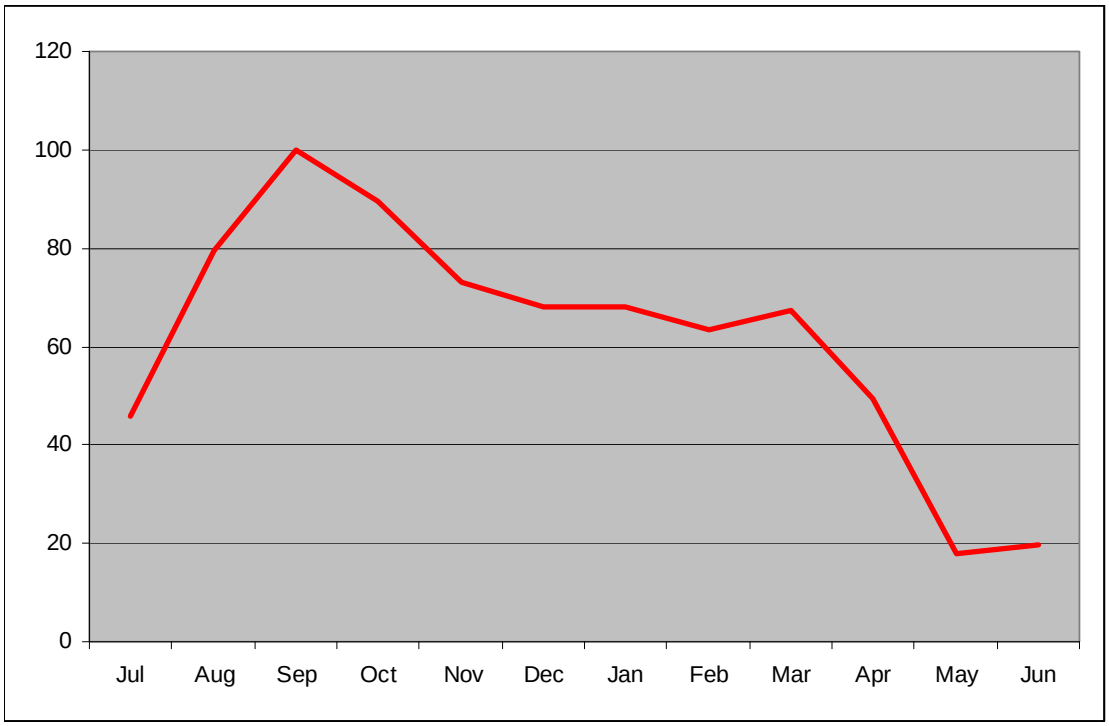

Figure II.49 WeBS monthly indices for Black-tailed Godwit – UK average for 2003/04 to 2007/08.

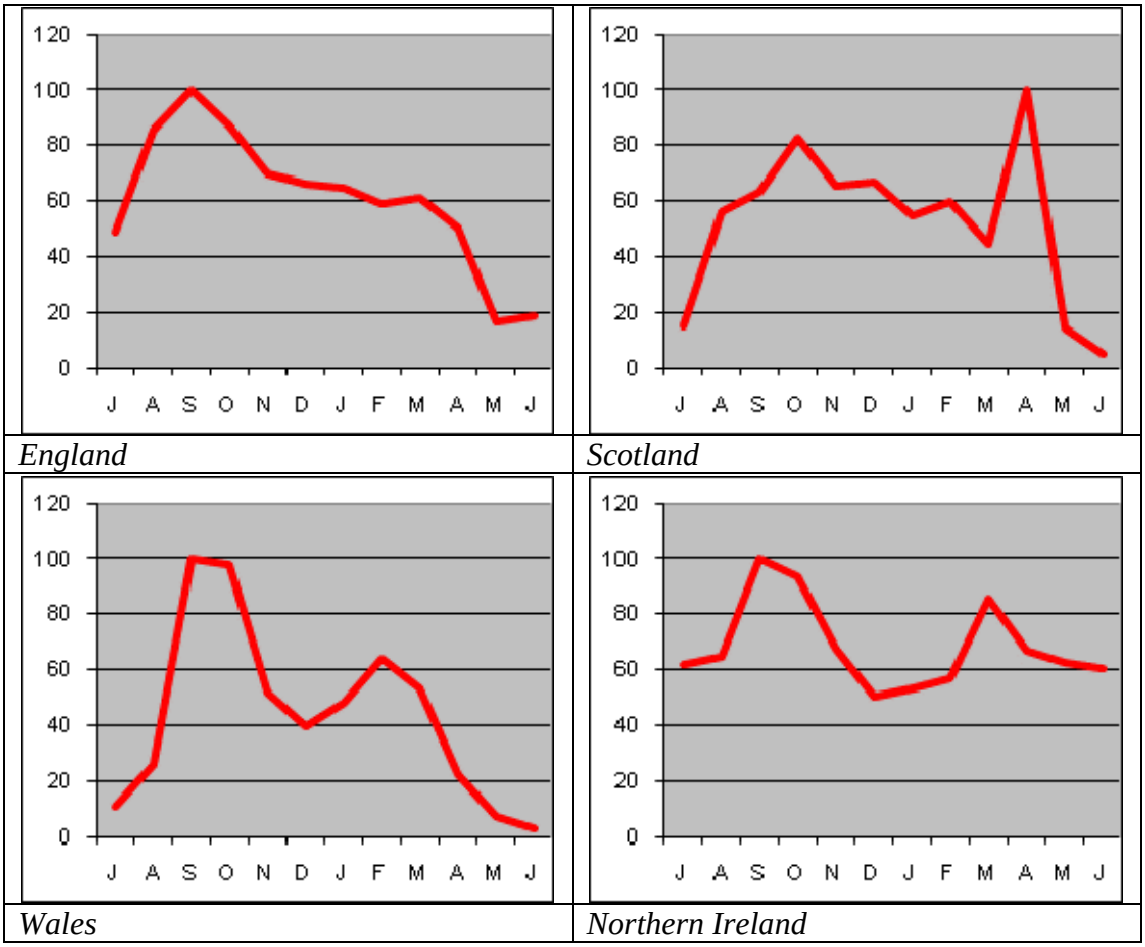

Figure II.50 Individual country WeBS monthly indices for Black-tailed Godwit – average for 2003/04 to 2007/08.

2.3.18.3 BirdTrack

Sightings of Black-tailed Godwits across the UK increase from June to September with the most rapid increase in sightings during late June and early July (weeks 26 to 28). This marks the period when birds are gathering in larger flocks on their return from breeding areas, but also when small numbers turn up widely if briefly at inland reservoirs and gravel pits on their way through the country – hence the higher reporting rate. Sightings decrease again from their peak in September into January, as birds settle into wintering flocks at key localities. This pattern is similar across most regions, with some regions not having enough data to detect any pattern.

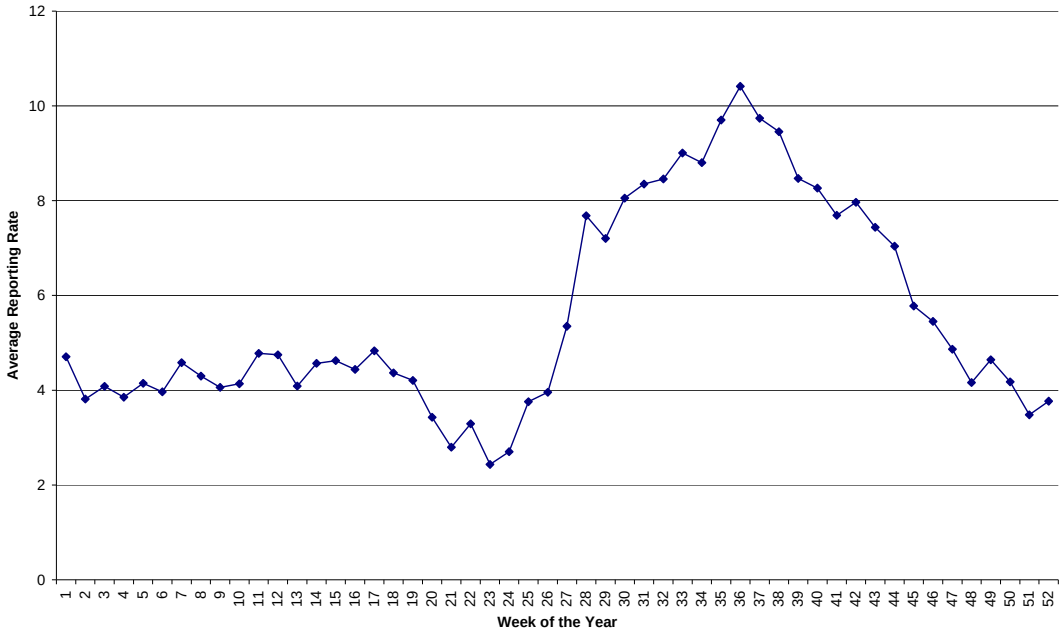

Figure II.51 Average BirdTrack reporting rate for Black-tailed Godwit throughout the year, including sightings from across Britain and Ireland.

2.3.20 Black-headed Gull (*Chroicephalus ridibundus*)

Black-headed Gulls are a common and (especially in the north) widespread breeding species in the UK. Additionally, migrant birds supplement this breeding population during the winter, when the UK holds very large numbers. Black-headed Gulls are found on a large range of habitats including coastal areas, rubbish dumps, sports fields, farmland, sewage works and urban areas

2.3.20.1 Ringing Scheme

Large numbers of this species have been ringed, and ringing locations and recoveries reveal a more or less UK-wide distribution during the breeding season. In the non-breeding season breeding season Black-head Gulls are still very widespread but are less common in the upland areas of northern England and Wales, and the highlands of Scotland. Birds start arriving into the UK during July through into late October from breeding grounds in northern Europe, particularly the Netherlands, Denmark, Fennoscandia, and the Baltic States. Birds also come from other countries including Russia, Germany, Poland, Belarus and the Czech Republic. The main departure time as birds leave the UK to return to these breeding areas is March. Ringing recoveries and re-sightings of colour-ringed birds show that breeding birds within the UK also move, often south and west to over-winter in different areas of the UK or in Ireland, France and Spain. Recoveries and re-sightings also show that during the winter Black-headed Gulls generally remain at one or two sites, not making large movements within the UK.

2.3.20.2 WeBS

WeBS counts do not cover a lot of the habitats used by Black-headed Gull. Therefore, WeBS only provides a rough indication of the way population sizes vary through the year. Nonetheless, it is clear that numbers of Black-headed Gulls are at their peak in January and February, with numbers increasing gradually through the autumn as birds enter the UK and decreasing during March as birds leave again.

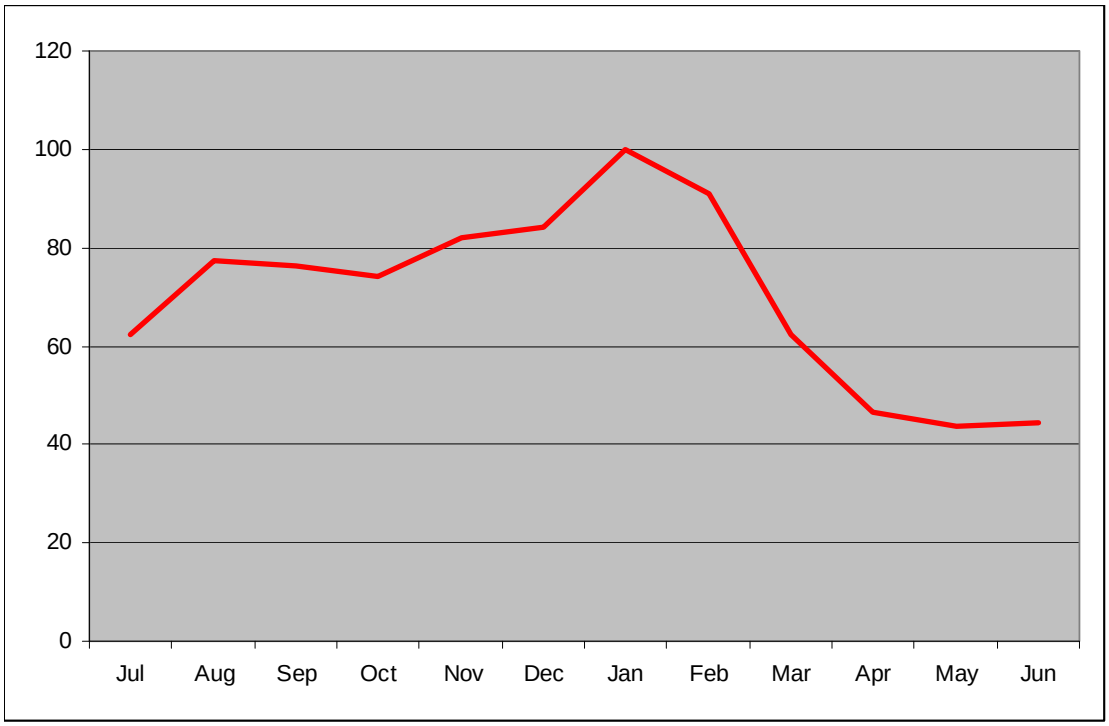

Figure II.52 WeBS monthly indices for Black-headed Gull – UK average for 2003/04 to 2007/08.

2.3.20.3 BirdTrack

The reporting rate of Black-headed Gull across the UK is fairly high throughout the year as expected for a common and widespread species. Sightings of Black-headed Gulls are lower during the spring and summer, when many birds have left the UK to breed. The reporting rate increases between weeks 24 and 29 (mid June to mid July) probably indicating that the main arrival of birds into the UK is occurring at the start of July. Sightings are high throughout the winter and then decrease again, mainly between weeks 11 and 14 (mid March to early April), as birds leave the UK and return to their breeding grounds in the rest of Europe. This pattern is consistent within the different regions of the UK, with the exception of northern Scotland. Here reporting rates increase during the spring between weeks 10 and 13 (early to late March) and then decrease again mainly between weeks 29 and 34 (mid July to mid August). This pattern is almost exactly the opposite of what occurs in the rest of the UK, it probably reflects the fact that few birds over-winter in the highlands of Scotland. The changes in the reporting rates are probably as a result of birds returning to breed from their wintering grounds further south in the UK (hence the spring increase in sightings) and then leaving again after breeding to winter further south (the decrease in sightings in the late summer).

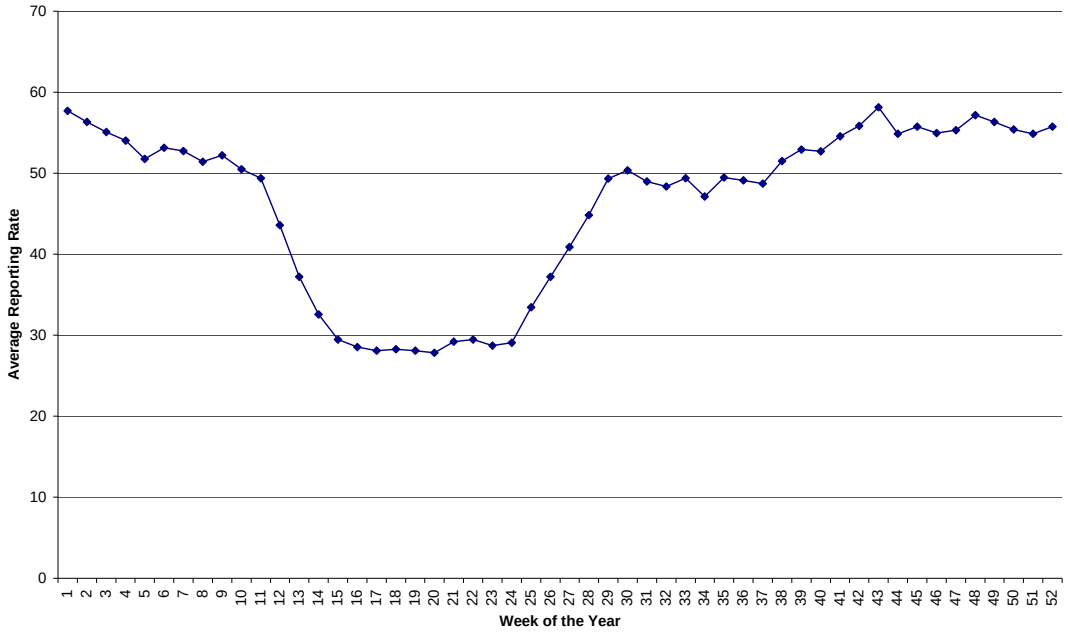

Figure II.53 Average BirdTrack reporting rate for Black-headed Gull throughout the year, including sightings from across Britain and Ireland

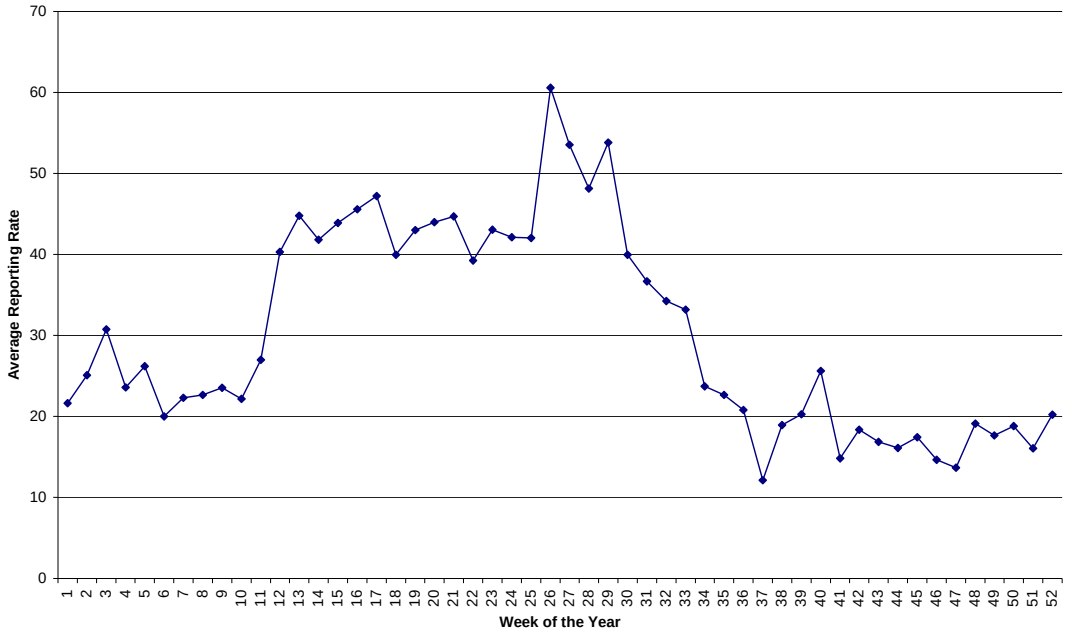

Figure II.54 Average BirdTrack reporting rate for Black-headed Gull throughout the year, including sightings from northern Scotland only.

2.3.21 Black Tern (*Chlidonias niger*)

Black Terns only occur in the UK during the spring and autumn on passage to and from their breeding grounds in eastern Europe and their over-wintering grounds in Africa. In the UK they are found almost entirely on inland wetlands, where they tend to stay for just a few days before moving on. The main periods of movement through the UK are in May and at the end of August. Birds mainly occur in the south and east of England with only small numbers in Scotland, and only small numbers are found at any one site (generally single figures at any given site). This is reflected in the lack of WeBS count data, with Black Terns only being seen rarely during these surveys. BirdTrack reporting rates reflect the spring and autumn passage, with peaks in weeks 19 (May) and 35 (the last week of August); again, because this species is not common reporting rates are low, and data are not available for every week of the year. As a result of the low numbers, it is not statistically practical for regional trends to be investigated.

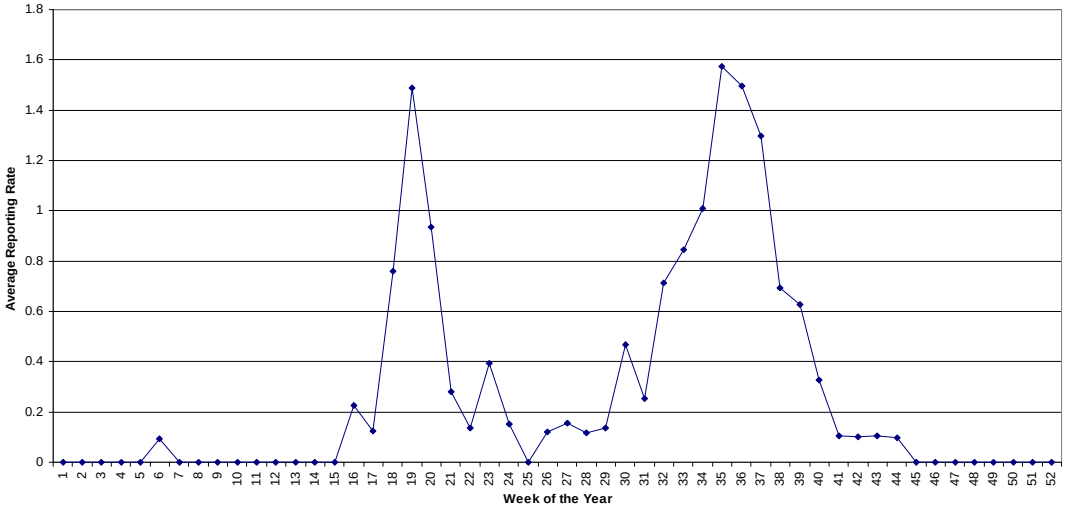

Figure II.55 Average BirdTrack reporting rate for Black Tern throughout the year, including sightings from across Britain and Ireland.

2.4 Summary

This part of the report aimed to identify the key periods of arrival into the UK of a selected species of wild birds that are considered the most likely to act as vectors bringing HPAI to the UK. As elsewhere in this report, only the autumn migration is considered, because spring migrants into the UK both come from areas where AI is no considered to be a problem and are almost all species that are unlikely to come into contact with poultry. The species accounts have summarised the available data. It is useful to summarise these findings further into a single table (Table II.1 below) showing not only key autumn arrival times, but also approximate numbers of birds involved, as the numbers differ by several orders of magnitude for different species. This could have a bearing on the weighting given to each species when considering the timing of possible housing of free-range poultry. The distribution of these incoming birds across the UK will also be important (and is considered in the risk mapping with respect to wild bird numbers that is applied in Module III). Note that, in the table, only the numbers of individuals arriving in the autumn from the east/north-east are considered; arrivals of some species from the north-west (Greenland/Iceland) are omitted as there is deemed to be negligible risk of HPAI transmission from this direction.

Consideration of the summary table shows that, although the selected species arrive in the UK throughout the autumn (and into the winter), the peak arrival period is September to November, with October probably seeing the largest numbers of birds arriving overall. It should be noted, however, that the review here reveals a wide range of migration strategies and timings across the different species. Without more detailed knowledge about the relative likelihood of any of these species to be carriers of HPAI, it is difficult to be more specific on the precise period of highest risk of transmission of HPAI into the UK by possible wild bird carriers. If such information subsequently comes to light, the summary presented here should enable this risk to be defined more precisely. However, in tabulating the information in this way, one point that is striking is that a few of the species collectively account for a very large proportion of the individuals involved. In particular, over half of the birds arriving from such a direction as to introduce a risk of AI infection are Black-headed Gulls, and addition of just Wigeon, Lapwing and Teal brings the total up to 90% of the birds. Adding Pochard and Tufted Duck brings this total up to 97%, comprising just six species. Many of these individual birds summer in Russia, where cold winter weather may promote the persistence of AI viruses in the soil and where various AI strains have previously been recorded. However, this too is not quite so straightforward, because the real risk if such a species picking up an infection overseas will be related to the number of different localities that the birds frequent as well as the absolute number of birds involved. For example, a species that breeds in large colonies, with the whole colony then migrating together might present a lower risk than a less common, but more dispersed species that might come into contact with more potential sources of disease. It must also be considered that Russia is an enormous country, that many of the birds concerned will breed in remote areas well away from sources of AI in poultry and that the local populations of these species east of the Urals generally do not migrate to Europe.

Finally, whilst birds migrate at broadly the same time each year, there is always some variation between years due to weather conditions, such as the timing of when wetlands begin to freeze up further north and east (thus pushing waterbirds further south and west) and the wind direction and strength (which can aid or hinder bird migration). Furthermore, as well as influencing the timing of the main period of autumn migration, weather conditions later in the winter can also lead to further “cold-weather movements” of birds; a freeze in the near-continent can lead to an exodus of birds to the UK. All this variation could affect the

size of the risk of HPAI incursion into the UK through a wild bird vector, independent of other influences on the risks presented by the species of concern.

Table II.1. Summary of migratory patterns of UK waterbirds potentially relevant to HPAI transmission to the UK

Species	Main period of arrival	Approx number of birds arriving from east/northeast	Notes
Mute Swan	n/a	0	Most Mute Swans in the UK are resident - interchange with the continent is rare
White-fronted Goose	November to January	2,000	Also approx 15,000 Greenland White-fronted Geese arrive, but not from areas of concern from HPAI perspective
Greylag Goose	n/a	0	Most Greylag Geese in the UK are either resident, or migrate from Iceland (about 100,000), which is not of concern for HPAI
Red-breasted Goose	n/a	0	Rare vagrant only in the UK - most migrate from Siberia to the Black Sea
Eurasian Wigeon	September to November	400,000	
Gadwall	September to December	15,000	
Common Teal	August to October	200,000	
Mallard	September to December	50,000	Very difficult to assess how many birds arrive in the autumn, may not even be this high
Northern Pintail	September to November	30,000	
Garganey	August to September	200	
Northern Shoveler	July to September	10,000	
Red-crested Pochard	n/a	0	Small introduced population only in UK - genuine vagrants rare
Common Pochard	August; October to December	50,000	Smaller peak in August, then more sustained arrival later in the autumn
Tufted Duck	July to December	70,000	Arrival appears to be very protracted
Great Cormorant	August to September	1,000	Number of immigrants difficult to judge but small compared to resident numbers
Common Coot	August to October	100,000	
Lapwing	October to December	300,000	
Ruff	July to February	500	Arrival appears to be very protracted
Black-tailed Godwit	July to September	0	About 30,000 birds come from Iceland, of no concern for HPAI
Black-headed Gull	July to January	2,000,000	Protracted arrival
Black Tern	August to October	200	Variable but small numbers pass through in the autumn

MODULE III. FARM-SPECIFIC RISKS RELATING TO WILD BIRD SPECIES PRESENCE AT STUDY FARMS

3.1 Introduction

For this part of the project, the risks of AI infection from wild birds were assessed at the farm level for each farm visited for the surveys described under Module I, thus forming a demonstration of a general farm-specific risk assessment protocol. Farms are referred to by reference codes, for which a key has been supplied to the British Poultry Council and British Egg Industry Council outside this report. Codes beginning with "B" are broiler chicken farms, with "L" layer chicken farms and with "T" turkey farms.

3.2 Methods

All the wild bird species records made during the field surveys were collated at the site level and the risks of carrying or transmitting the H5N1 virus associated with these species are reported. The risk of a particular wild bird species transmitting the virus to poultry, may relate to a number of factors including habitat choice, gregariousness, the degree of interaction with other species and diet (e.g. scavenging species are more likely to become infected through contact with the virus from carcasses). The report 'Ornithological data relevant to the spread of Avian Influenza in Europe; Further identification and field assessments of Higher Risk Species' (Veen et al. 2007) categorises the species-specific risks, ranked as low or high, and outlines the possible routes of transmission. Species and their associated risk are summarised below (Table 1). We used the conclusions of this report to interpret the field results in terms of farm-specific risks of AI transmission. Veen et al. classified species as "Higher Risk Species" (HRS) for five reasons, described below. The nature of the risks posed by each group is also illustrated in Figure III.1

3.2.1 Group A – Risk of Introduction and Spread of H5N1 by Migratory Species (Migration and winter period).

Species posing a higher risk of introducing H5N1 from outside the EU to within the EU borders. This was based on migratory behaviour (migratory species being of higher risk) and habitat use (using freshwater and/or agricultural land); it also considers whether species are highly gregarious or generally exhibit a high level of close interaction with other species. Note that the populations of some of these species that might bring a virus into the EU are not the same populations that visit the UK, so species identity alone might over-estimate levels of risk.

3.2.2 Group B – Risk of spreading H5N1 by non-migratory or resident Species (non-breeding period / winter period).

Species posing higher risk of spreading H5N1 further once it has been introduced into the EU, including non-migratory species (or migrants within the EU), inhabit freshwater and/or agricultural habitats, are highly gregariousness and/or often interact with other species.

3.2.3 Group C – Risk of spreading H5N1 by colonial Breeding Birds (breeding period)

Once the virus has arrived in the EU, species posing a higher risk of spreading H5N1 during the breeding season. This included species that often occupy breeding territories near freshwater or agricultural habitats and form colonies.

3.2.4 Group D – Risk of spreading H5N1 by predators and scavengers (year-round)

Species posing a higher risk of spreading H5N1 once it has been introduced to the EU. This included those species that often prey or scavenge on waterbirds, which are a key risk group.

3.2.5 Group E – Bridge Species

High risk species that might also spread H5N1 to poultry. Bridge species were considered as those that bridge the gap between outbreaks of H5N1 among wild birds and the human environment (including farms), and included those that have either a relatively high chance of getting infected with and spreading H5N1, or are also likely to come into contact with humans and/or poultry. Pied wagtail is perhaps a good example of bridge species, as they spend a lot of time foraging around water bodies where there is the potential for them to pick up the virus, but are also are attracted to farm buildings where they could more readily spread disease to poultry.

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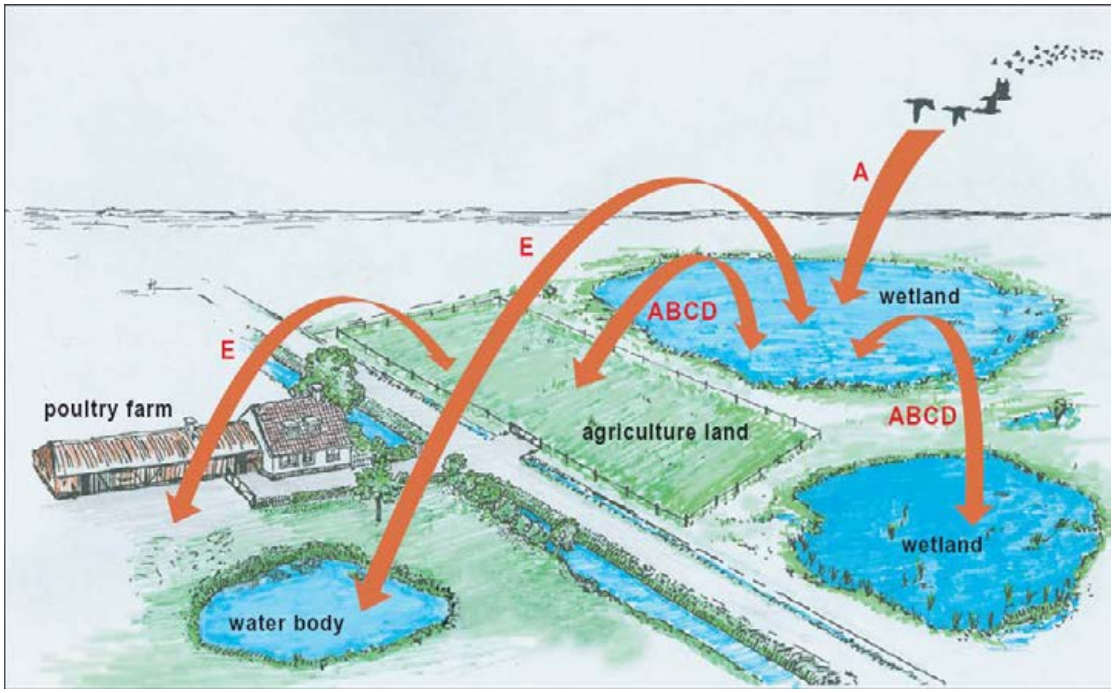

Figure III.1. Diagram outlining the potential routes of infection for the H5N1 virus (taken from Veen et al. 2007). Note that this is intended only to illustrate concepts diagrammatically, not to depict a real poultry farm at a realistic scale. In practice, a "water body" inducing risks in this way would have to be large (i.e. a lake or reservoir) and poultry farms would not be sited as close to such waterbodies as is depicted here.

Figure III.1 illustrates the potential routes of infection between wild birds and poultry. Outbreaks are assumed to be more likely to start in wetland habitats, being introduced by a migrant bird from a species with high susceptibility to infection by H5N1 (group A). The virus might then spread further, via migratory or non-migratory wildfowl, to other wetlands and agricultural habitats (group B). Once the virus has reached these locations, both waterbirds and terrestrial species (group E) may aid in the spread of H5N1 to poultry farms. The factors that may increase the likelihood of infection are related to the gregariousness of the infected species and how likely they are to come into close contact with other species. Predatory birds might be more at risk of contracting AI through their prey but are less likely to spread the disease, as they are solitary. Scavengers are more at risk of contracting and spreading viruses (Blount et al. 2003), as some species roost and nest in large groups, although the most common scavenging species in the UK are generally found as pairs or small groups (carrion crows, magpies and ravens). Table III.1 below highlights HRS-listed species and their associated risk group. The "risk of contact" is also included, based on the likelihood that the species is to be found around poultry farms.

Table III.1. Species recorded on, or around the studied poultry farms from survey work completed during November/December 2010. Species highlighted in bold are regarded as HRS (Veen et al. 2007) Details for their inclusion as a HRS are also listed below as group category A-E. Species not highlighted are not regarded as higher risk and therefore no further details have been given. The risk of contact with poultry is categorised as low (L) medium (M) or high (H) based on how common the species tends to be around poultry farms. H= high contact risk with poultry, M=medium contact risk, L=low contact risk, O=no contact risk. Those species marked in bold with * were not originally included as HRS by Veen et al. (2007), but were included as such based on expert opinion and knowledge regarding species ecology; but also apparent habitat preferences, behaviour, abundance and level of interactions with other HRS species during the surveys.

Species	GROUP						Risk of Contact with Poultry	Found dead in the wild with H5N1. E – Within Europe O – Outside Europe only
	A	B	C	D Predator	D Scavenger	E H – Human, P – Poultry		
Cormorant	**Y**		**Y**				**M (2)**	**O**
Little Egret	**Y**		**Y**				**L (1)**	**E**
Grey Heron			**Y**			**P**	**M (2)**	**E**
Mute Swan	**Y**					**H P**	**M (2)**	**E**
Pink-footed Goose	**Y**						**L (1)**	
Brent Goose	**Y**						**L (1)**	
Egyptian Goose							L (1)	
Shelduck							L (1)	
Mallard	**Y**					**H P**	**H (3)**	
Red-legged Partridge*							**M (2)**	
Grey Partridge							M (1.7)	
Pheasant*							**H (3)**	
Red Kite					**Y**		**L (0.3)**	
Marsh Harrier				**Y**			**O (0)**	
Sparrowhawk				**Y**			**L (0.3)**	
Common Buzzard					**Y**		**L (0.3)**	**E**
Kestrel							L (0.3)	
Peregrine Falcon				**Y**			**O (0)**	**E**
Moorhen*							M (2)	
Golden Plover	**Y**						**L**	
Northern Lapwing	**Y**					**P**	**M (2)**	
Snipe							L (1)	
Woodcock							O (0)	
Green Sandpiper							L (1)	
Black-headed Gull	**Y**		**Y**			**H P**	**H (3)**	**O**
Common Gull	**Y**						**L (1)**	**E**
Lesser Black-backed Gull					**Y**		**L (1)**	
Herring Gull					**Y**		**L (1)**	
Great Black-backed Gull					**Y**		**0 (0)**	
Feral Pigeon*							**M (2)**	
Stock Dove		**Y**				**P**	**H (2.7)**	
Woodpigeon		**Y**				**H P**	**H (3)**	
Collared Dove		**Y**				**H P**	**H (3)**	
Barn Owl								
Little Owl								

Table III.1, continued

Species	GROUP						Risk of Contact with Poultry	Found dead in the wild with H5N1. E – Within Europe O – Outside Europe only
	A	B	C	D Predator	D Scavenger	E H – Human, P – Poultry		
Green Woodpecker								
Great Spotted Woodpecker								
Skylark							M (2)	
Meadow Pipit							M (2)	
Grey Wagtail*							**L (0.5)**	
Pied Wagtail*							**H (2.7)**	
Wren								
Dunnock								
Robin								
Stonechat								
Blackbird							M (1.7)	
Fieldfare		**Y**				**P**	**M (2)**	
Song Thrush							M (1.7)	
Redwing		**Y**				**P**	**M (2.0)**	
Mistle Thrush							L (1)	
Goldcrest								
Long-tailed Tit								
Marsh Tit								
Coal Tit								
Blue Tit								
Great Tit								
Nuthatch								
Treecreeper								
Jay							L (0.3)	
Magpie					**Y**	**H P**	**H (3)**	
Jackdaw		**Y**			**Y**	**H P**	**H (3)**	**E**
Rook		**Y**	**Y**			**H P**	**M (2)**	
Carrion Crow					**Y**	**H P**	**M (2)**	
Raven					**Y**		**L (1)**	
Common Starling		**Y**				**H P**	**H (3)**	**O**
House Sparrow		**Y**				**H P**	**H (3)**	
Tree Sparrow							M (2)	
Chaffinch		**Y**				**H P**	**M (2.3)**	
Greenfinch							M (1.7)	
Goldfinch							L (1)	
Linnet							L (0.7)	
Bullfinch							O (0)	
Reed Bunting							L (0.3)	
Yellowhammer							M (1.7)	

3.2.6 Farm-specific risks according to geography and local bird abundance

Snow et al. (2007) estimated the relative risk of transmission of H5N1 from wild birds to poultry in all 10km squares in Britain by mapping relative abundance scores (derived from BTO data sets) in summer and winter of the 24 UK wild bird species most likely to transmit the virus and the density of poultry across the UK. For this project, the same 10km-square-specific bird abundance scores were used to describe the potential risk to free-range poultry from wild birds in the area local to each of the farms visited for Module I (see Snow et al. 2007, provided as Appendix 1, for details of bird abundance scoring methods). First, scores for the 10 km Ordnance Survey national grid square in which each farm was found were extracted. Then, because farms will, in some cases, have been close (i.e. within easy flying range of risk species) to the edge of these 10km squares and because more mobile species might easily move distances of greater than 5km in a short period of time, the 10km squares surrounding the one in which the farm lay (making a 30×30km, 900km^2, area) were also considered. Figure III.2 ranks the study farms, based on the smaller-scale risk score (10km area), and also displays the larger-scale (900km^2) scores. Scores at the two spatial scales are reasonably highly correlated (0.69 for absolute score values and 0.73 for the rank orders), but are clearly not identical, which indicates a level of uncertainty in what the "real" level of risk from proximity to high risk wild bird species might be.

It is important to note that these scores relate only to the *relative* abundance of potential risk species from area to area, not to any *absolute* risk of infection: **the absolute risk of infection actually being present in any of the species considered remains low, so the differences between farms should be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high.** Exactly how low the "low risk" is will be determined, mostly, by the overall risk that infection will be brought into Britain by wild birds. Another important point is the 24 species considered to be major risk species by Snow et al. were all rare (with the exception of black-headed gull) on the study farms for this project. Thus, while there may be relatively high risks of these species being in the areas surrounding some farms, these risks may well not translate into real increased risks of infection.

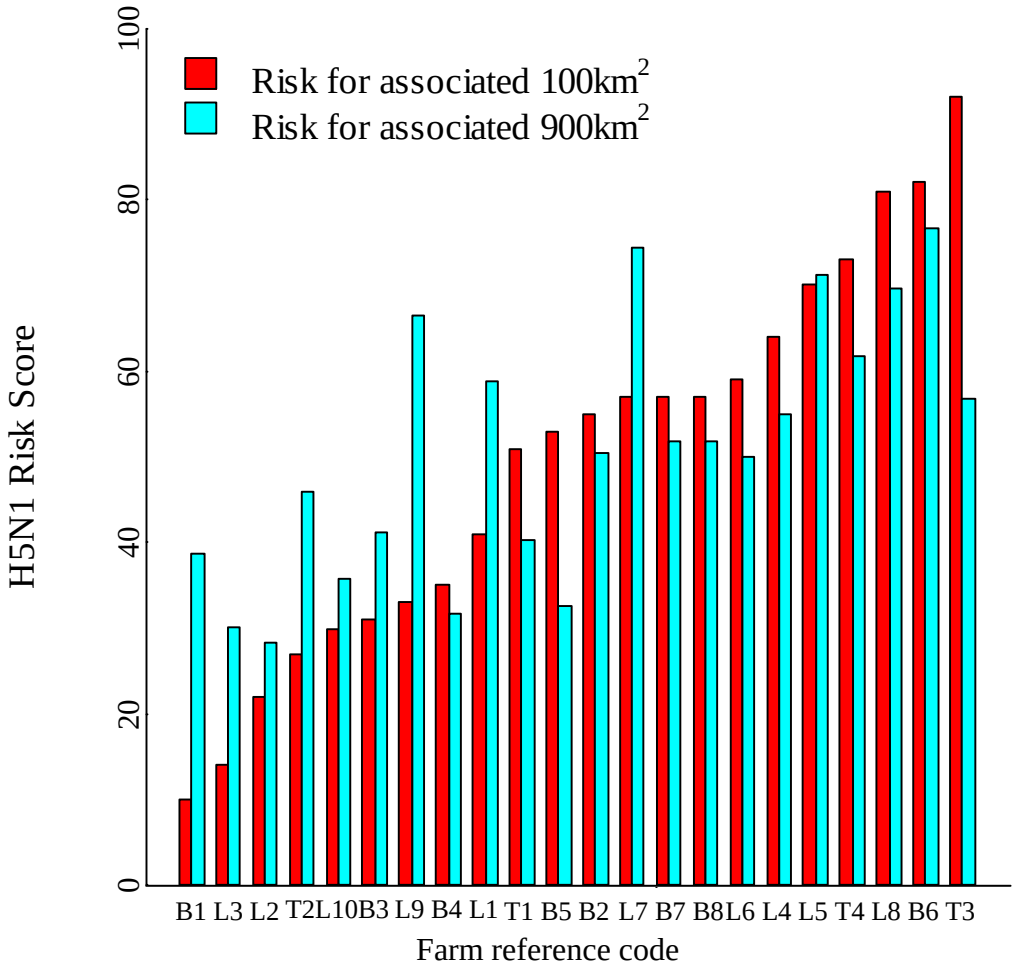

Figure III.2. Risk scores for each farm derived from relative abundances of birds in the farm survey sample. Farms are ranked from left to right in order of risk score at the smaller spatial scale.

3.3 Individual Farm Accounts

Descriptions of the birds found on each individual farm are provided below along with the farms' associated 900km^2 risk scores (Figure III.2). Tables summarize the species found on the surveys of each farm and the behaviours/locations recorded in each case. Species in bold are classed as high risk see above; P = present during surveys. Specific notes on the birds and behaviours observed on each farm and their relevance to AI risk are provided below each table, followed by a summary of the level of AI risk posed from contact with wild birds, as indicated by the survey results.

3.3.1 Farm B1 (Risk score 38.8)

Farm Type: Broiler Farm
Location: West Country
Date: 2nd December 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P			
Blackbird	P	P	P	P
Blue Tit		P	P	
Buzzard	P			
Carrion Crow	P	P	P	
Chaffinch	P	P	P	
Dunnock			P	
Feral Pigeon*		P		
Goldfinch	P	P		P
Green Woodpecker		P		
Greenfinch		P	P	
Grey Wagtail*	P			
Gull Sp.	P	P		
House Sparrow			P	
Jackdaw	P	P		
Meadow Pipit	P	P	P	P
Peregrine Falcon		P		
Pheasant*				P
Pied Wagtail*	P	P	P	P
Redwing		P	P	
Robin			P	P
Song Thrush		P		P
Starling	P	P		
Stock Dove	P	P		
Woodpigeon	P	P		
Wren			P	
Yellowhammer		P		

3.3.1.1 Description of site

The site held five modern barns in five small fields surrounded by arable farmland and hedgerows. Three of the fields contained long rough grass and 2-3m tall trees whilst the other two fields were more recently set up with short grass, along with a few newly planted trees. There was an area of mud/gravel outside each barn. Chickens were young and did not stray far from the sheds. There was some disturbance from a farm worker and the farm dogs during the survey.

3.3.1.2 Comments on species present on the site

The area of hedgerow along the track that leads past the barns and up to the farmyard attracted most of the wild birds including house sparrows, blackbirds and chaffinches. Of interest was a peregrine that flew high over the farm, although a HRS, the risk from peregrines seem low as they are unlikely to be attracted to the chicken farm.

3.3.1.3 Summary of AI risk

Low risk: Moderate numbers of wild birds using the site, with a high diversity of species including many high risk species. Located in an area of very low AI risk generally..

3.3.2 Farm B2 (Risk score 50.4)

Farm Type: Broiler Farm
Location: East Anglia
Dates: 7th, 10th & 18th December 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird		P	P	
Carrion Crow	P	P		P
Chaffinch	P	P	P	P
Common Gull		P		
Egyptian Goose		P		
Feral Pigeon*		P		
Fieldfare	P	P		P
Goldfinch		P	P	P
Green Woodpecker		P		
Greenfinch		P		P
Jackdaw	P	P		
Jay		P		
Lapwing	P			
Lesser Black-backed Gull	P	P		
Linnet		P		P
Magpie		P		
Meadow Pipit		P		P
Mistle Thrush		P		
Pheasant*				P
Pied Wagtail*	P	P	P	P
Red-legged Partridge*				P
Rook	P	P	P	
Skylark	P	P		P
Sparrowhawk		P		
Starling	P	P		P
Stock Dove	P	P		
Woodpigeon	P	P	P	P

3.3.2.1 Description of site

There were twenty-four modern sheds in one large field with an airbase to the west, a large stubble field and wooded area to the north, and arable land to the east and south. The southern part of the poultry field was a mixture of short grass, rough grass and mud. The most northerly part of the field was rough grass and stubble. On the first visit there were a number of muck piles left on the field, however these along with three of the sheds were no longer present on the final visit. Chickens did not venture far from the sheds. There was lots of disturbance by the workers as they walked and drove around the site on the first survey date, but no one was present on the final visit. The site was much cleaner on last visit than on the first.

3.3.2.2 Comments on species present on the site

The rough/stubble area at the northerly part of the field along with the stubble field to the north of the site attracted c.40 foraging skylarks and *c*. 100 linnets. These are low risk

species, however the stubble field also attracted HRS like wood pigeon, stock doves and corvids. A flock of c.100 corvids were feeding on the ploughed field to the east of the site, occasionally flying into the chicken area, feeding on the chicken field before returning to the ploughed land. The hedgerow to the east supported a flock of c.40 finches, mostly chaffinch and greenfinch. Buzzards were seen soaring over the woodland to the north of the farm, however they did not approach the farm, during the survey, remaining over the woodland. During the evening watch, gulls flew overhead on the way to their roost, and although some were fairly low, none landed within the chicken area. Pied wagtails and meadow pipits were recorded feeding on the muddy/fallow areas to the south of the chicken field.

3.3.2.3 Summary of AI risk

Low/moderate risk: A huge number of wild birds were recorded at this site, from all categories; this was probably due to the high quality of the surrounding habitat for birds. However, the farm is located in an area of low AI risk generally.

3.3.3 Farm B3 (Risk score 41.2)

Farm Type: Broiler Farm
Location: West Country
Date: 26th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird		P	P	
Blue Tit			P	
Buzzard	P	P		
Carrion Crow	P	P	P	
Chaffinch		P	P	
Dunnock			P	
Feral Pigeon*	P			
Goldfinch		P		
Great Spotted Woodpecker			P	
Great Tit			P	
Grey Wagtail*		P	P	
Herring Gull		P		
House Sparrow			P	
Jackdaw	P	P		
Jay		P	P	
Linnet	P	P		
Magpie		P	P	
Meadow Pipit	P	P		
Mistle Thrush		P	P	
Pheasant*			P	
Pied Wagtail*	P	P	P	
Redwing		P	P	
Robin			P	
Rook	P	P		
Song Thrush		P	P	
Sparrowhawk		P	P	
Starling	P	P	P	
Woodpigeon	P	P	P	
Wren			P	
Yellowhammer		P	P	

3.3.3.1 Description of site

This farm contained six very modern poultry barns situated in five fields on a steep valley. The fields were a mixture of short cut, and rough grass/ weeds and were divided by a number of hedgerows. The boundaries were a mixture of trees and hedgerows. The surrounding fields contained pasture, with the exception of one large stubble field. The chickens were inside the sheds on the day of our survey.

3.3.3.2 Comments on species present on the site

Few wild birds were seen at this site. Most of the smaller birds were present on the large stubble field adjacent to the farm, including flocks of linnets, pied wagtails and starlings, these species flew over the farm on the way to the stubble field. At dusk gulls and corvids

flew over very high on the way to their roosts, none were attracted by the presence of the farm.

3.3.3.3 Summary of AI risk

Negligible AI risk: few wild birds were seen around the farm and very few actually within the farm boundary. Located in an area of very low AI risk generally.

3.3.4 Farm B4 (Risk score 31.8)

Farm Type: Broiler Farm
Location: West Country
Date: 28th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird		P	P	P
Blue Tit	P	P	P	
Bullfinch			P	
Buzzard		P		
Carrion Crow	P	P	P	
Chaffinch		P	P	P
Feral Pigeon*	P	P		
Goldfinch		P		
Great Spotted Woodpecker			P	
Great Tit			P	
Gull sp.	P	P		
Jay	P			
Magpie		P	P	
Meadow Pipit	P	P	P	P
Nuthatch			P	
Pheasant*				P
Pied Wagtail*	P	P	P	P
Redwing	P	P	P	
Robin			P	P
Song Thrush		P	P	P
Starling	P	P		
Woodpigeon	P	P		
Wren			P	

3.3.4.1 Description of site

This site had very new and modern sheds, each surrounded by a small field. Each field contained short grass with newly planted trees and a small strip of mud/gravel outside each building. The chickens were very young and did not venture far from their housing. The surrounding land contained arable crops with tall, thick hedges with a wood to the west.

3.3.4.2 Comments on species present on the site

Very few birds were observed at this site. Pied wagtails, meadow pipits and chaffinch were seen feeding along the mud/gravel area outside the barns and the grass chicken fields. Other small birds were recorded in the tall hedge to the east of the site.

3.3.4.3 Summary of AI risk

Negligible AI risk: very few high risk species were recorded on the farm, which had the lowest densities of wild birds found at any site. Located in an area of very low AI risk generally.

3.3.5 Farm B5 (Risk score 32.7)

Farm Type: Broiler Farm
Location: West Country
Date: 30th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull		P		
Blackbird	P	P	P	P
Blue Tit			P	
Bullfinch		P	P	
Carrion Crow	P	P		
Chaffinch	P	P	P	
Dunnock			P	
Feral Pigeon*	P			
Fieldfare		P	P	
Goldfinch	P	P	P	
Greenfinch	P			
Grey Wagtail*				P
Gull	P	P		
Jackdaw	P	P		
Long-tailed Tit			P	
Magpie		P	P	
Meadow Pipit	P	P		
Pied Wagtail*	P	P	P	P
Raven		P		
Redwing	P	P	P	
Robin			P	P
Rook	P			
Song Thrush	P		P	
Starling	P	P	P	P
Woodpigeon	P	P	P	
Wren			P	
Yellowhammer	P			

3.3.5.1 Description of site

A small modern site split into two areas. The first area consisted of two barns with a narrow strip of sheep grazed grass and fruit trees outside. The second area consisted of four sheds, surrounded by sheep grazed grass and newly planted trees. The chicken farm was in a lowland valley surrounded by mainly arable and also pasture. The chickens were inside on the day of the survey.

3.3.5.2 Comments on species present on the site

At the first area some grain had been spilt by the silo attracting chaffinches, starlings and thrushes. There was a flock of c.100 winter thrushes, most of these were noted feeding in the adjacent cereal fields, although some were recorded in the hedgerows and also perched on the fruit trees within the chicken field. At the second site, most of the bird activity was centred around the large thick hedge with crossed between the four barns. Both pied and grey

wagtails and robins were seen feeding by the mud and puddle outside the entrance to the barns.

3.3.5.3 Summary of AI risk

Very low risk: a moderate number of high risk species was recorded inside and around the farm, with moderate densities of wild birds overall. Located in an area of very low AI risk generally.

3.3.6 Farm B6 (Risk score 76.7)

Farm Type: Broiler Farm
Location: West Country
Date: 1st December 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull		P		
Blackbird	P	P	P	P
Blue Tit	P	P	P	P
Bullfinch			P	
Carrion Crow	P	P		
Chaffinch	P	P	P	
Collared Dove		P	P	
Dunnock			P	P
Feral Pigeon*		P		
Goldfinch	P	P	P	
Great Spotted Woodpecker		P	P	
Green Woodpecker	P			
Greenfinch	P	P	P	
Grey Wagtail*			P	P
House Sparrow			P	
Jackdaw	P	P	P	
Lapwing		P		
Lesser Black-backed Gull	P			
Magpie	P	P	P	
Meadow Pipit	P			
Mistle Thrush	P		P	
Pied Wagtail*	P	P		P
Redwing	P			
Robin		P	P	P
Song Thrush		P		
Starling	P	P		
Woodpigeon	P	P		
Wren			P	

3.3.6.1 Description of site

A very small site, with one very modern shed set within a small old farmyard. Large and mature *Leylandii*/conifer trees surrounded the shed on both sides. The area that wasn't conifers was a mixture of very short grass, scrub and concrete track from the foundations of previously removed sheds. Adjoining the site was arable land, gardens, farmyard and housing. Although these were older birds they did not stray more than a few metres from the entrance due to the very cold outside temperature.

3.3.6.2 Comments on species present on the site

Very few birds recorded at this site; most of the activity came from the adjoining farmyard and garden. A grey wagtail was seen feeding on the concrete outside the barn entrance. Low risk species Robin and blackbirds were recorded in and at the base of the *Leylandii* trees c.5m from the barn entrance.

3.3.6.3 Summary of AI risk

Low risk: Although located in an area of low/moderate AI risk, rather few species were recorded on the farm, most of which were in the low risk category.

3.3.7 Farm B7 (Risk score 51.7)

Farm Type: Broiler Farm
Location: East Anglia
Date: 16th November 2010

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P	P	P
Blackbird	P		P	
Blue Tit			P	
Carrion Crow	P	P	P	P
Chaffinch		P	P	
Feral Pigeon*		P		
Goldcrest			P	
Goldfinch			P	
Great Tit			P	
Green Woodpecker				P
Greenfinch		P		
Grey Partridge		P		
Greylag Goose		P		
Herring Gull		P		
Jackdaw	P	P	P	P
Kestrel		P		
Lesser Black-backed Gull	P	P	P	P
Linnet		P		
Long-tailed Tit			P	
Magpie		P		
Mallard		P		
Meadow Pipit		P		P
Pheasant*			P	P
Pied Wagtail*	P	P	P	P
Red-legged Partridge*			P	P
Robin			P	
Rook	P	P	P	P
Skylark		P		P
Song Thrush	P		P	
Sparrowhawk	P	P		
Starling	P	P	P	P
Woodpigeon	P	P	P	P
Wren			P	
Yellowhammer		P	P	

3.3.7.1 Description of site

One field containing eighteen metal modern sheds, with a mixture of short grass, a few weeds and muddy patches. The field was surrounded by further chicken fields, arable land, residential housing and tall trees and scrub. Each shed had a silo at the end which was filled up at the top by a machine and feed was spilt onto the ground and on top of the silos. The chickens did not stray far from the sheds, and did not use the whole area available to them. Some of the sheds were being cleaned out and the chicken shed mess had been left outside

the sheds, also there was a large pile of muck in the corner of the field. There was constant disturbance during the survey from workers on the site, who were cleaning the sheds and filling the silos.

3.3.7.2 Comments on species present on the site

This was part of the same site as Farm B8 and many of the comments above are also relevant here. There were a large number of wild birds present around this site and the surrounding chicken fields, mainly corvids, starlings and gulls. There were attracted to the muddy areas around the barns and around the feeders.

There was a flock of c.200 starlings, which were attracted to the chicken fields and were feeding on and around the silos, especially after the silos had been filled up suggesting food had been split by the machine in the process. Attracting in a HRS like starlings via food spillage is something that needs to be addressed at this site.

Gulls were also seen on the fields attracted to what seem to be mud and muck left from the cleaning out of the barns. The pair of Egyptian geese were still present, this time wandering around the adjacent cereal field. Although not listed as a HRS, Egyptian geese could present a risk as an effective bridge species given its habitat preferences of both water areas and agricultural land. Corvids were also attracted into the field. Rooks and jackdaws were common around the whole area and a large number passed over the site at dusk whilst going to roost in the distance, some way from the chicken area

3.3.7.3 Summary of AI risk

Low/moderate risk: a high number of wild birds were recorded at this site, from all categories, particularly gulls (high risk), which appear to be attracted to the poultry area. Located in an area of low/moderate AI risk.

3.3.8 Farm B8 (Risk score 51.7)

Farm Type: Broiler Farm
Location: East Anglia
Date: 12th November 2010

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P	P	P
Blackbird			P	
Blue Tit			P	
Buzzard		P		
Carrion Crow	P	P	P	P
Chaffinch	P		P	
Collared Dove	P	P		
Common Gull		P		P
Dunnock			P	
Egyptian Goose	P			
Feral Pigeon*	P	P	P	P
Goldfinch		P		
Great Tit			P	
Green Sandpiper	P	P		
Grey Heron		P		
Herring Gull		P		
Jackdaw	P	P	P	
Lapwing		P		
Lesser Black-backed Gull	P	P		
Long-tailed Tit			P	
Magpie		P		
Mallard		P		
Meadow Pipit		P		
Pheasant*				P
Pied Wagtail*		P	P	P
Red-legged Partridge*				P
Redwing	P	P		
Reed Bunting			P	
Robin			P	
Rook	P	P	P	P
Snipe		P		
Sparrowhawk	P			
Starling	P	P	P	P
Woodpigeon	P	P	P	
Wren			P	

3.3.8.1 Description of site

One field containing 18 metal modern sheds, with a mixture of short grass, a few weeds and muddy patches. The field was surrounded by further chicken fields, arable and rough land, a reservoir and tall trees. Each shed had a silo at the end, which was filled up from the top by a machine, feed was spilt onto the ground and on top of the silos. The chickens did not stray far from the sheds, and did not use the whole area available to them. There was constant

disturbance during the survey from workers on the site, cleaning the sheds and filling the silos.

3.3.8.2 Comments on species present on the site

There were a large number of wild birds present around this site and the surrounding chicken fields, mainly corvids, starlings and gulls. There were attracted to the muddy areas around the barns and around the feeders.

There was a flock of c.400 starlings, which were attracted to the chicken fields and were feeding on and around the silos, especially after the silos had been filled suggesting food had been split by the machine in the process. Attracting in a HRS like starlings via food spillage is something that needs to be addressed at this site.

Gulls were also seen on the fields attracted to what seem to be mud and muck left from the cleaning out of the barns. The gulls were also noted bathing the reservoir to the south of the chicken area. There were muddy, rough areas outside the chicken field that had attracted a green sandpiper and a pair of Egyptian geese. Although not listed as a HRS, Egyptian geese could present a risk as an effective bridge species given its habitat preferences of both water areas and agricultural land. The pair was later observed walking around the adjacent chicken field.

Corvids were also attracted into the field. Rooks and jackdaws were common around the whole area and a large number passed over the site at dusk whilst going to roost in the distance, some way from the chicken area.

3.3.8.3 Summary of AI risk

Low/moderate risk: similar to nearby Farm B7, a high number of wild birds were recorded here, especially inside the poultry area. In particular, a high number of higher risk species were recorded. Located in an area of low/moderate AI risk.

3.3.9 Farm L1 (Risk score 58.8)

Farm Type: Layer Farm
Location: East Anglia
Date: 10th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird	P		P	P
Blue Tit			P	
Carrion Crow	P	P		
Chaffinch	P		P	
Collared Dove	P	P	P	
Dunnock			P	
Feral Pigeon*	P		P	
Fieldfare			P	
Great Spotted Woodpecker			P	
Great Tit			P	
Green Woodpecker		P		P
Greenfinch		P	P	
House Sparrow			P	
Jackdaw	P	P	P	P
Jay		P		
Lesser Black-backed Gull		P		
Magpie	P	P	P	P
Mallard	P	P		P
Mistle Thrush		P	P	
Moorhen*				P
Mute Swan				P
Pheasant*	P			
Pied Wagtail*	P	P	P	
Redwing			P	
Reed Bunting			P	
Robin	P		P	
Rook		P	P	
Skylark	P	P		
Song Thrush			P	
Starling	P	P	P	P
Stock Dove	P			
Woodpigeon	P	P	P	
Wren			P	
Yellowhammer			P	

3.3.9.1 Description of site

A single modern shed surrounded by one large grass field separated into several compartments. The boundary and surrounding area included a small woodland, farmyard, residential housing and arable farmland. The compartment surrounding the shed consisted of was long rough grass with newly planted trees, outside this area the grass was shorter and grazed by sheep. A large, deep drain bordered the eastern edge of the field. Chickens roamed

over the whole area including the woodland by the side of the shed. There was a water trough for the sheep in one of the compartments and lines of pylons crossed the field

3.3.9.2 Comments on species present on the site

There were large numbers of corvids, pigeons and starlings in the area and a number of rooks were seen perching on the electric pylons bisecting the site, as well as feeding on one of the sheep/chicken fields. The water trough placed in one of the sheep fields provided a water source and attracted starlings and corvids into the field. A large flock of starlings of c.50 were seen in a number of areas around the farm, perched on the wires, feeding in the newly planted grass area and sheep/chicken field and also perched on the tall trees surrounding the site. Although there were a number of pigeons and doves in the area, none were seen on the chicken fields remaining in the boundaries and adjacent farmland.

The drain provided habitat for the moorhens, mallard and mute swans, and black-headed gulls flew up and down the edges, which therefore provides a infection risk. Whilst the swans and mallard are unlikely to venture into the chicken area, moorhen could act as a bridge species and wander into the field. Although the moorhens remained in the drain during the survey.

Fieldfares and redwings remained in the surrounding boundaries, and did not enter the field although fieldfares were noted perched on the wires.

3.3.9.3 Summary of AI risk

Low risk: A fair number of wild birds were recorded at this site, a high proportion of which were lower risk passerines. High risk species were recorded but in low densities. Located in an area of very low AI risk generally

3.3.10 Farm L2 (Risk score 28.4)

Farm Type: Layer Farm
Location: West Country
Date: 25th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird	P	P	P	P
Blue Tit	P		P	
Buzzard	P	P		
Carrion Crow	P	P		
Chaffinch	P	P	P	P
Fieldfare		P		
Great Tit			P	P
Greenfinch		P	P	
Gull sp.	P	P		
House Sparrow		P	P	
Jackdaw		P		
Lesser Black-backed Gull	P	P		
Magpie	P	P		
Meadow Pipit		P		
Pied Wagtail*		P	P	P
Raven	P			
Redwing	P	P	P	P
Robin	P		P	
Song Thrush			P	
Sparrowhawk		P		
Starling		P	P	P
Thrush	P			
Woodcock				P
Woodpigeon	P	P		
Wren			P	

3.3.10.1 Description of site

The site had one large shed surrounded by a short cut grass field. The adjacent land was predominantly made up by pasture, residential housing and gardens. A line of poplars encircled the barn; the ground between the shed and trees being a mixture of mud and gravel. The rest of the field was short grass with some rushes in the wetter areas. The chickens remained close to the barn, very few ventured further than the line of poplar trees. To the east of this field was another chicken shed with another large grass field beyond.

3.3.10.2 Comments on species present on the site

Most of the wild birds recorded were seen in or around the fields nearby the adjacent house. House sparrows and chaffinch were both present and there were also a number of birds attracted to the poplars surrounding the barn. A flock of c.40 starling were observed feeding in the mud under the poplars and in the mud next to the barn it self. Redwings, blackbirds, pied wagtails and robins were also noted feeding under these trees. The owners informed us that they had problems with buzzards and ravens preying on the chickens, although there was no evidence of this on the day of the survey.

3.3.10.3 Summary of AI risk

Negligible AI risk: few high risk species recorded on the farm and very low densities of wild birds in general. Located in an area of very low AI risk generally.

3.3.11 Farm L3 (Risk score 30.1)

Farm Type: Broiler Farm
Location: West Country
Date: 27th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird		P	P	P
Blue Tit		P	P	
Bullfinch			P	
Buzzard	P			
Carrion Crow	P	P		P
Chaffinch	P	P	P	
Dunnock			P	
Fieldfare	P		P	
Goldcrest			P	
Goldfinch			P	
Great Tit	P		P	
House Sparrow			P	
Lesser Black-backed Gull	P	P		
Magpie			P	
Meadow Pipit		P	P	P
Mistle Thrush			P	P
Pied Wagtail*	P	P	P	P
Raven	P			
Redwing		P	P	
Robin		P	P	
Rook	P			
Song Thrush		P	P	
Sparrowhawk		P	P	
Starling	P	P		
Woodpigeon	P	P	P	
Wren			P	
Yellowhammer		P		

3.3.11.1 Description of site

The farm contained two modern large sheds surrounded by fields. Very few chickens were seen using this field the grass field with newly planted trees, although this may have been due to the weather conditions. The most southerly field had a mixture of short and rough grass and newly planted trees and the area around the poultry building had a high proportion of mud and gravel. The most northerly field was predominantly mud and gravel; the mud most likely was a result of high recent rainfall. The site had tow areas fenced off with newly planted trees.

3.3.11.2Comments on species present on the site

Many high risk passerine species were recorded in the adjacent farmyard, including a number of house sparrows and chaffinch. Thrushes were flushed from the hedgerows around the farm.

3.3.11.3 Summary of AI risk

Negligible AI risk: very few high risk species recorded on the farm; moderate densities of passerines, but few of the higher risk gulls and corvids. Located in an area of very low AI risk generally.

3.3.12 Farm L4 (Risk score 55)

Farm Type: Layer Farm
Location: East Anglia
Dates: 5th&6th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird			P	
Blue Tit	P	P	P	
Carrion Crow		P	P	P
Chaffinch	P	P	P	
Goldcrest			P	
Goldfinch		P		
Great Tit			P	
Green Woodpecker			P	
Greenfinch		P	P	
Gull sp.	P	P		
Herring Gull		P		
Jay	P		P	
Kestrel	P		P	
Lesser Black-backed Gull		P		
Linnet		P		
Long-tailed Tit		P		
Magpie	P	P		
Marsh Tit			P	
Meadow Pipit	P	P		
Mistle Thrush			P	
Pheasant*			P	P
Pied Wagtail*		P	P	P
Red-legged Partridge*				P
Robin			P	
Rook		P	P	
Shelduck	P			
Skylark		P		P
Song Thrush		P		
Starling	P	P		
Treecreeper			P	
Woodpigeon	P	P	P	P
Wren			P	
Yellowhammer			P	

3.3.12.1 Description of site

A single modern barn in a large grass field surrounded by coniferous woodland strips. The field was mostly short grass which patches of newly planted trees surrounded by an electric fence and grass margin. The chickens foraged a good distance from the barn using most of the available area.

3.3.12.2 Comments on species present on the site

There were large numbers of gulls and corvids passing over the site, possibly heading for the nearby pig fields situated only a couple of fields away. A high percentage of the gulls passed

at height and did not seem to be attracted to the chicken area. However a few of the corvids, mainly the carrion crows were seen foraging in the field mostly in the rougher grass next to the newly planted trees. The surrounding wooded habitat contained a number of low risk species, but also good numbers of roosting woodpigeons. The partridges and pheasants were noted along the field boundaries.

3.3.12.3 Summary of AI risk

Low risk: high densities of birds were seen in and around the farm, especially pigeons (but generally not particularly high risk species). Located in an area of low/moderate AI risk.

3.3.13 Farm L5 (Risk score 71.2)

Farm Type: Layer Farm
Location: East Anglia
Date: 8th& 9th December 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird			P	
Blue Tit	P	P	P	
Carrion Crow	P	P	P	P
Chaffinch	P	P	P	P
Collared Dove			P	
Common Gull	P	P		
Dunnock			P	
Feral Pigeon*	P	P	P	
Feral/hybrid Goose			P	
Fieldfare	P	P	P	
Goldfinch	P	P	P	
Great Spotted Woodpecker		P	P	
Great Tit			P	
Green Woodpecker		P		
Greenfinch		P	P	
Grey Wagtail*		P		
Herring Gull		P	P	
Jackdaw	P	P	P	
Jay		P	P	P
Kestrel		P		
Lesser Black-backed Gull	P	P		
Long-tailed Tit			P	
Magpie		P	P	P
Mallard			P	
Meadow Pipit		P		
Moorhen			P	
Pheasant*		P	P	P
Pied Wagtail*		P	P	
Red-legged Partridge*			P	P
Robin			P	
Skylark		P		
Snipe	P	P		
Song Thrush			P	
Sparrowhawk		P		
Starling	P	P	P	
Stock Dove			P	
Woodcock			P	
Woodpigeon	P	P	P	P
Wren			P	

3.3.13.1 Description of site

This was a very large site, with one big modern barn in the centre of four large grass fields. There were a number of hedgerows and ditches around the perimeter of the farm and also dividing up the fields within the chicken area with a large number of tall standard trees both along the hedgerows and within the field area. The fields were a mixture of newly planted trees and rough grass and short grass grazed by horses. There were a couple of small ponds on the boundary of the site, including a large pond in an adjacent garden to the west. Residential housing, gardens and rough common land was situated to the west, and old factory to the north, arable stubble land to the east and a landfill site and arable land to the south. The chickens wandered over the whole area available to them

3.3.13.2 Comments on species present on the site

The most noticeable activity on this farm and the highest infection risks came from the constant passage of gulls moving from the surrounding farmland to the landfill site adjacent to the farm. Although most of the passage and circling by the gulls occurred over the landfill site and surrounding land, still 1000+ of these HRS were recorded passing over the chicken field. Several herring gulls were roosting on the factory to the north of the farm flying over the fields to reach the landfill site. Two herring gulls were observed sitting on the barn roof during the survey. Carrion crows, magpies and jays were all observed foraging within the chicken area. The pond to the north west of the site held mallard, feral geese and moorhen. The pond looks unlikely to attract migrant wildfowl so the risks are low, however the mallard could bring in the infection from elsewhere which is then spread to the chicken field via the moorhens which were feeding along the field edge.

3.3.13.3 Summary of AI risk

Low/moderate risk: very high densities of birds were seen in and around the farm, with by far the highest density of gulls seen anywhere (all gulls are classed as high risk). Located in an area of low/moderate AI risk.

3.3.14 Farm L6 (Risk score 50.1)

Farm Type: Layer Farm
Location: West Country
Date: 24th November 2009

Species Present	Outisde Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird			P	P
Blue Tit			P	
Carrion Crow	P	P	P	P
Chaffinch	P	P	P	
Common Gull	P			
Dunnock			P	P
Feral Pigeon*	P			
Fieldfare		P		
Goldfinch		P		
Great Tit			P	
Grey Wagtail*		P	P	
Herring Gull		P		
House Sparrow			P	
Jackdaw	P	P		
Kestrel		P		
Lesser Black-backed Gull		P		
Linnet	P			
Little Egret	P			
Long-tailed Tit		P		
Magpie	P	P	P	P
Meadow Pipit	P	P		
Pied Wagtail*		P	P	
Redwing		P	P	
Robin			P	
Rook	P	P		
Song Thrush		P	P	
Sparrowhawk		P		
Starling		P		
Woodpigeon		P		
Wren			P	

3.3.14.1 Description of site

Two sheds in three fields. Two fields were covered in 4-5m trees, the third field contained short grass. The chickens could roam in the three fields but none were seen in the top grass field they all remained under the trees. At the bottom of one of the fields there was a fast running stream running along a ditch but this might only have been present due to recent weather conditions.

Sheds were not as modern as the East Anglian layer farms but no evidence of holes for wild birds to enter. The silos were filled whilst we were present, the food was pumped in at the base of the silo and there no evidence of food being spilt. The survey was halted whilst the

silos were being filled. The farm was positioned on top of a hillside with views across to a river estuary. To the west and north of the farm the hill sloped steeply down to estuary inlets.

3.3.14.2 Comments on species present on the site

Its location at the top of the hill surrounded by the estuary was probably responsible for the number of fly-over gulls seen during the survey. From the top of the hill there was a view over the estuary, from here it was noted it was supporting a number of estuary birds including shelduck, wigeon, teal, curlew, redshank, and a large number of gulls. No waterbirds were seen close to the chicken area, staying below in the valley on the estuary mudflats. There is potential that the gulls could act as a bridge species between the waterfowl in the estuary and the chicken farm. However the gulls did not appear to be attracted to the chicken field, mainly flying over the site and none were seen to land, reducing this probability.

A thick hedgerow to the east side of the field contained most of the smaller bird species including the winter thrushes, and chaffinches. The adjacent farmyard also contained a number of small birds including chaffinch, house sparrows and grey and pied wagtails, which stayed in the field boundaries and were not seen venturing into the chicken fields.

3.3.14.3 Summary of AI risk

Very low risk: rather low densities of birds were recorded and few birds were attracted inside the boundary of the farm. Located in an area of low/moderate AI risk.

3.3.15 Farm L7 (Risk score 74.4)

Farm Type: Layer Farm
Location: East Anglia
Date: 9th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird			P	
Blue Tit			P	
Buzzard		P		
Carrion Crow	P	P	P	
Chaffinch		P	P	
Collared Dove		P		
Common Gull		P		
Dunnock			P	
Fieldfare		P	P	
Goldfinch		P	P	
Great Spotted Woodpecker			P	
Green Woodpecker	P	P		
Greenfinch			P	
Jackdaw		P	P	
Kestrel	P			
Lesser Black-backed Gull	P	P		
Linnet		P		
Long-tailed Tit			P	
Magpie		P	P	
Mallard	P			
Meadow Pipit	P	P		
Moorhen			P	
Mute Swan		P		
Pheasant*				P
Pied Wagtail*	P	P		
Red-legged Partridge*				P
Redwing			P	
Robin			P	
Rook	P	P	P	
Skylark		P		
Sparrowhawk		P		
Starling	P	P	P	
Stock Dove		P		
Woodpigeon	P	P	P	P
Wren			P	
Yellowhammer		P	P	

3.3.15.1 Description of site

One large modern shed in a large grass field, chickens also had access to three further fields, surrounded by arable and pastoral farmland. The main central field contained the shed, patches of newly planted trees and short grass with a few patches of weeds. Deep ditches separated fields. The field north of the 'shed' field had grazing cattle on occasions (not on th

day of the survey). The first field to the south of the 'shed field' was also short grass but with about 20% weeds and cattle also had access to this field. The forth and most southerly field contained cattle, very few chickens were seen in this field mostly roaming in the 'shed field' and northerly field. The whole site was surrounded by an electric fence and grass track.

3.3.15.2 Comments on species present on the site

Two species of waterfowl were recorded during the survey, but both were in flight and, although the pair of mute swans did pass directly over the shed, the risk presented from such "contact" with these species has to be considered minimal. The hedgerows contained a number of berries attracting a number of winter thrushes although none were seen in the chicken field, remaining along the boundaries. A large number of corvids were present in the area around the farm but none were seen inside the chicken area.

3.3.15.3 Summary of AI risk

Very low risk: a moderate number of wild birds were recorded at this site, which was located in an area of low AI risk generally.

3.3.16 Farm L8 (Risk score 69.7)

Farm Type: Layer Farm
Location: West Country
Date: 3rd December 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird	P	P	P	P
Blue Tit		P	P	
Buzzard	P	P		
Carrion Crow	P	P	P	P
Chaffinch	P	P	P	P
Coal Tit			P	
Collared Dove			P	
Cormorant		P		
Dunnock			P	P
Feral Pigeon*		P		
Fieldfare		P		
Goldfinch	P	P		
Great Spotted Woodpecker	P		P	
Great Tit	P		P	
Green Woodpecker			P	
Greenfinch		P		
Herring Gull		P		
House Sparrow			P	
Jackdaw	P	P		
Kestrel		P		
Lapwing	P			
Lesser Black-backed Gull		P		
Long-tailed Tit			P	
Magpie		P	P	P
Nuthatch			P	
Pied Wagtail*	P	P		P
Raven		P		
Redwing		P	P	
Robin		P	P	P
Skylark		P		
Song Thrush	P		P	P
Sparrowhawk		P		
Starling		P		P
Woodpigeon	P	P	P	P
Wren			P	

3.3.16.1 Description of site

This was the largest site covered by the survey. There were two large modern barns. The chickens from one barn had access to four fields whilst the second barn was in one large horse grazed grass field. The farm was adjacent to arable farmland surrounded by hedgerows and woodland strips, the poultry fields were grazed by horses except close to the shed entrances that were again a mixture of mud and gravel. There were a number of tall

‘standard’ trees in both the hedgerow and in the field itself. . There was quite a lot of human disturbance during the survey as workers moved between the stables and the chicken field ‘paddocks’. The owners informed us there had been many problems with ravens killing the chickens, taking up to 500 birds a year and that they now have a license to shoot ravens.

3.3.16.2 Comments on species present on the site

This was a very busy site, with a high number of wild birds, lots of human activity and chickens roaming over a wide area. High risk corvid species included carrion crows that were perched on the tall trees around the edges and foraging on the chicken fields. Corvids and gulls passed over the site at roost, possibly heading towards a nearby lake..

3.3.16.3 Summary of AI risk

Low/moderate risk: high densities of passerines were recorded around the site and most high risk species recorded on other sites were seen here. Located in an area of low/moderate AI risk.

3.3.17 Farm L9 (Risk score 66.4)

Farm Type: Layer Farm
Location: East Anglia
Date: 17th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird	P	P	P	
Blue Tit			P	
Bullfinch			P	
Buzzard		P		
Carrion Crow	P			
Chaffinch	P	P	P	
Common Gull	P			
Dunnock			P	
Goldcrest			P	
Goldfinch	P	P	P	
Greenfinch	P	P	P	
Jackdaw		P		
Jay			P	
Lesser Black-backed Gull	P	P	P	
Linnet	P	P		
Magpie			P	
Meadow Pipit	P	P		P
Pheasant*	P		P	P
Pied Wagtail*		P	P	P
Red Kite	P	P		
Redwing	P			
Robin			P	
Skylark	P	P	P	
Snipe	P			P
Sparrowhawk		P		
Starling		P		
Stock Dove	P			
Woodpigeon	P	P	P	
Yellowhammer		P	P	

3.3.17.1 Description of site

One large modern barn surrounded by one large grass field split into sections. Arable land, a small copse, a small amount of scrub and tall thick hedgerows surrounded the farm. Outside the barn was a large area of mud and gravel and a few wooden structures for the chickens. All but two sections were grazed by sheep, the section nearest the barn and a very over grown set-aside rough grass/weedy area which was left ungrazed. Chickens could roam into any section, but most stayed close to the shed.

3.3.17.2 Comments on species present on the site

The area seemed to be low in bird numbers, except for the 500+ Woodpigeons present in the boundary and feeding on the adjacent oil seed rape field.

The surprising record for this site was two red kites circling with a buzzard over the wood to the north of the field. Although both these species are considered HRS, the risk from these birds seems fairly low. Neither species showed interest in the chicken field area, instead using the thermals at the top of the hill, on the very clear and sunny day. Wild game cover was present on the adjoining land attracting 30+ finches, mostly linnet, greenfinch and chaffinch.

Very few gulls were present mainly flying over the set aside field to the south of the site. However one lesser black-backed gull was noted perched on one of the wooded structures in the chicken fields, which had been put out for the chickens to climb.

3.3.17.3 Summary of AI risk

Very Low AI risk: few wild birds were recorded at this site, with the exception of a moderate number of pigeons. A fair number of high risk species were seen inside the farm but in low densities. Located in an area of very low AI risk generally.

3.3.18 Farm L10 (Risk score 35.8)

Farm Type: Layer Farm
Location: West Country
Date: 28 & 29th November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird			P	P
Blue Tit	P	P	P	
Bullfinch			P	
Buzzard	P	P		
Carrion Crow	P	P	P	
Chaffinch	P	P	P	P
Dunnock			P	
Feral Pigeon*	P	P		
Great Spotted Woodpecker			P	
Great Tit		P		
Greenfinch			P	
Grey Wagtail*		P		
Gull sp.	P	P		
House Sparrow		P	P	
Jackdaw	P	P		
Long-tailed Tit		P	P	
Magpie		P		
Meadow Pipit	P	P	P	
Pheasant*	P	P	P	P
Pied Wagtail*	P	P	P	P
Raven	P	P		
Redwing	P	P	P	
Robin			P	
Rook	P			
Skylark		P		
Song Thrush	P	P	P	P
Starling	P	P	P	
Stock Dove	P			
Woodpigeon	P	P	P	
Wren			P	

3.3.18.1 Description of site

This was a large site, so only three barns and fields were covered during the survey. The first field contained mature 5-6m trees with very little grass and the chickens were seen foraging throughout much of this area. The second field was mostly short grass with a large mud/gravel area. The third was short grass, a mud/gravel patch outside the barn and an area of woodland along the edge. Although an older site, the sheds were modern and clean with few or no access points for wild birds. The site was surrounded by pasture and arable land with a few wild game strips in the neighbouring fields.

3.3.18.2 Comments on species present on the site

There were a large number of corvids in the pasture to the west of the site, however they were not recorded within the chicken field. A pied wagtail was seen feeding in the mud/gravel area outside one of the chicken barns. There were 3 wild game covers in the field adjacent to the chicken farms attracting a number of winter thrushes, and pheasants. A flock of c.100 starlings were also seen flying around the site, but were not observed landing in the chicken field. House sparrows were present in the hedgerows to the south of the barn entrance as well as the residential area to the south of the site.

3.3.18.3 Summary of AI risk

Low risk: a relatively high number of high risk species recorded in flight near the farm and the high densities of wild birds overall around the farm, probably as a result of the proximity of suitable wild bird habitat. Located in an area of very low AI risk generally.

3.3.19 Farm T1 (Risk score 40.3)

Farm Type: Free Range Turkey Farm
Location: North Yorkshire
Dates: 27th & 30th October 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull	P	P		
Blackbird				P
Blue Tit	P			
Carrion Crow	P	P	P	
Common Gull	P	P		
Dunnock			P	
Golden Plover	P	P		
Goldfinch	P	P		P
Greenfinch				P
Jackdaw		P		
Kestrel	P			
Lapwing	P	P		
Lesser Black-backed Gull		P		
Linnet		P		
Magpie			P	
Meadow Pipit	P	P		P
Pied Wagtail*	P	P	P	P
Redwing		P		
Robin			P	
Skylark	P	P	P	P
Starling	P	P	P	
Stonechat				P
Tree Sparrow			P	
Woodpigeon	P	P		
Wren				P

3.3.19.1 Description of site

The site consisted of a large grass field, surrounded by arable land and sheep fields. Poultry area contained mostly short cut grass, with a few trees and rough grass closer to the turkey sheds. Turkeys were young and did not venture far from their housing. The site was surrounded by an electric fence with track around the outside and some wild bird cover/rank vegetation. The buildings appeared to be old in comparison to some other sites, but were still in good condition with little evidence of holes and access points for birds inside the housing.

3.3.19.2 Comments on species present on the site

There was little evidence of wild birds using the grass area within the turkey farm except for some lower risk species, i.e. skylarks. Most of the bird activity was focussed on the surrounding fields especially the sheep field adjacent to the study area. Starlings (a high risk species) were recorded using the electric wires over the turkey area and the adjacent sheep field,, but not the turkey field itself. Starlings should be discouraged from perching on these wires, so as to reduce the risk of contact through droppings. Although many gulls were present around the area they did not seem to be attracted to the poultry field itself and were mostly recorded on the adjacent fields. The adjacent large flat cereal field supported 100+

golden plover and lapwings (both HRS) on the afternoon visit, although they seemed not to be using the poultry area itself.

3.3.19.3 Summary of AI risk

Very low risk: moderate numbers of wild birds were recorded at this site; more high risk species were seen here than at any other site, but outside the farm. Located in an area of low AI risk generally.

3.3.20 Farm T2 (Risk score 46)

Farm Type: Turkey Farm
Location: North Yorkshire
Date: 29th October 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Black-headed Gull		P		
Blackbird	P		P	
Blue Tit		P	P	
Carrion Crow	P	P	P	P
Chaffinch	P	P	P	
Common Gull		P		
Dunnock		P	P	
Feral Pigeon*	P	P	P	
Goldfinch	P	P		
Great Spotted Woodpecker			P	
Great Tit			P	
Grey Wagtail*		P	P	
Gull sp.	P	P		
House Sparrow			P	
Jackdaw	P	P		P
Kestrel		P		
Magpie		P	P	P
Moorhen			P	
Pheasant*			P	P
Pied Wagtail*		P	P	
Robin		P	P	
Rook		P		
Skylark	P	P		
Song Thrush			P	
Starling		P	P	
Tree Sparrow	P	P		
Woodpigeon	P	P	P	
Wren		P	P	
Yellowhammer	P	P	P	P

3.3.20.1 Description of site

Farm T2 was a large short cut grass field surrounded by arable farmland and a farmyard. There were no areas of trees within the turkey area just hay bales and wooded structures for the turkeys to climb on. There were no solid barn structures on this site rather the turkeys were kept in large 'poly tunnel' like buildings with many exit and entrance areas. Even when the turkeys are 'put away' at night there are many gaps and easy entrance points for small birds. Turkeys were bronze and older birds so roamed further from the 'sheds'. There was disturbance by workers during the surveys.

3.3.20.2 Comments on species present on the site

The highest concentration of birds found on the site was around the farmyard area next to the field and included a number of small birds, including chaffinch and house and tree sparrows. Although the 'sheds' had many entrances and exits no small birds were seen using the sheds,

despite the location next to the farmyard, and farm workers reported they had never seen small birds inside the sheds. Given the concentration of large aggressive birds inside these buildings it is probably an unattractive place for small wild birds. Three high-risk species, carrion crow, magpie and pheasant, were seen on the ground within the poultry area. Gulls were recorded flying over the fields but did not attempt to land. Large numbers of corvids were present on the adjoining arable fields.

3.3.20.3 Summary of AI risk

Negligible AI risk: few high risk species recorded on the farm, but a moderate number of passerines and high densities of gulls were found around the edges. Located in an area of very low AI risk generally.

3.3.21 Farm T3 (Risk score 56.8)

Farm Type: Turkey Farm
Location: North Yorkshire
Date: 28th October 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Blackbird		P	P	
Blue Tit			P	
Carrion Crow	P	P	P	P
Chaffinch		P	P	
Common Gull		P		
Cormorant		P		
Feral Pigeon*		P		
Fieldfare				P
Golden Plover		P		
Goldfinch		P		
Greenfinch		P		
Gull sp.	P	P		
Herring Gull		P		
Jackdaw		P		
Kestrel	P			
Lapwing		P		
Lesser Black-backed Gull		P		
Magpie	P		P	
Meadow Pipit		P	P	P
Mistle Thrush		P	P	P
Pheasant*				P
Pied Wagtail*		P	P	P
Redwing	P	P		
Robin			P	
Rook		P		
Skylark		P		
Song Thrush			P	
Sparrowhawk		P		
Starling		P		
Woodpigeon	P	P	P	
Wren			P	

3.3.21.1 Description of site

This site was a large grass field surrounded by cereal fields and an industrial area. The turkey field was mainly short cut grass, with a few sparse trees with rougher grass closer to the turkey sheds. There were a few areas of mud, mostly situated outside the sheds, with a tall hawthorn hedge plus a deep ditch on the boundary. Both non-free ranged and free-ranged birds/sheds were present, sheds seemed to be in good condition with little evidence of entrance and exit holes for wild birds to enter. Unfortunately during the survey the turkeys where kept inside the sheds.

3.3.21.2 Comments on species present on the site

The hawthorn hedge along the boundary contained a large number of berries attracting a number of thrushes, fieldfares, song and mistle thrushes and blackbirds as well as robins and dunnocks. Also the scrubby area by the concrete buildings within the turkey area was also attracting the thrushes and robins. Meadow pipits, thrushes and pheasants were seen using the grass field.

There was more activity on the afternoon visit to the site with thrushes, wagtails, pipits and corvids all using the field and resting on the electric pylon and shed roofs. Some were seen very close to the shed entrances, but they might not have approached as closely if the turkeys had been outside.

3.3.21.3 Summary of AI risk

Low risk: high densities of passerines were recorded around the site but most high risk species were not common. Located in an area of low/moderate AI risk.

3.3.22 Farm T4 (Risk score 61.8)

Farm Type: Turkey Farm
Location: East Anglia
Date: 3rd November 2009

Species Present	Outside Poultry Area	Flying Inside Poultry Area	Perched Inside Poultry Area	On the Ground Inside Poultry Area
Barn Owl		P		
Black-headed Gull		P		
Blackbird				P
Blue Tit		P	P	
Bullfinch	P			
Carrion Crow		P	P	P
Chaffinch		P	P	P
Common Gull		P		
Feral Pigeon*		P	P	P
Goldfinch		P	P	P
Green Woodpecker		P		
Greenfinch				P
Grey Partridge		P		
Jackdaw		P	P	P
Kestrel		P	P	
Lesser Black-backed Gull		P		
Linnet		P		
Long-tailed Tit	P			
Magpie		P	P	P
Meadow Pipit		P	P	P
Mistle Thrush		P		
Pheasant*				P
Pied Wagtail*		P	P	P
Red-legged Partridge*			P	
Redwing		P		
Robin			P	
Rook	P	P	P	P
Skylark		P		P
Starling	P	P	P	P
Woodpigeon	P	P	P	P
Wren			P	
Yellowhammer			P	

3.3.22.1 Description of site

This site was very large and only a portion of the whole site could be covered. The site was surrounded by trees and woodland, and surrounded by arable farmland. Vegetation in the turkey area consisted of areas of a mixture of rough grass and weeds, separated by concrete tracks. What appeared to be 'old pen' areas where filled with rough vegetation of seed-bearing thistles and weeds.

The sheds were much older than at previous sites and many looked in disrepair, such that there appeared to be many potential nest holes for birds.

Turkeys appeared to be of mixed breeds and older than those at other sites, so venturing further from the shed doors. Each field was surrounded by an electric fence/plastic wire fence, but this too was in some disrepair. There was some activity from workers during the surveys but disturbance was low as they were mainly travelling around the site in vehicles.

3.3.22.2 Comments on species present on the site

There were many birds at this site being attracted directly into the turkey fields these included HRS such as carrion crows, rooks, jackdaw, magpies, starlings, pied wagtails, game birds and chaffinches. Other lower risk species such as skylark, goldfinches and meadow pipits were present in high numbers. The increase in the number of birds at this site was probably due to the field habitat. The was rough land which contained a number of weeds, rather than the short cut grass found at the previous sites was providing a winter food source for many of the seed eating species. There must have also been a good number of insects on the fields given the number of corvids and starlings feeding in the fields. The surrounding wooded habitats provided the corvids with roosting and perching habitat, and nesting during the breeding season.

A number of gulls were seen flying over the site, but none were seen landing within the area. The old fallow 'pen' areas that were full of thistles and other tall weeds were attracting flocks of finches.

The roofs on some of the sheds were not in a good condition and feral pigeons were seen coming out of the roof space on one shed. Also a blue tit came out of a hole from underneath the roof eaves of a second shed. The area in the roof where the feral pigeons were noted would make a suitable nesting space in the breeding season and roosting space during the rest of the year, therefore attracting a HRS directly over the turkey area.

3.3.22.3 Summary of AI risk

Low/moderate risk: high densities of birds were found around the farm, with many corvids recorded inside the farm boundary (all corvids are classed as high risk). The farm almost certainly attracted wild birds due to the high cover of fallow/rough land. Located in an area of low/moderate AI risk.

MODULE IV. FIELD ASSESSMENTS OF THE RISK OF AVIAN INFLUENZA INFECTION OF HOUSED TURKEYS FROM WILD BIRD SOURCES

4.1 Introduction

Although this project was always focused on free-range poultry, the majority of poultry kept in the UK are housed throughout their lives and H5N1 avian influenza (AI) infections have occurred in such housed flocks. While direct anthropogenic routes must often be the likely route for infection in such cases, transmission via wild birds, at least for part of a chain from a source area overseas to direct contact with housed poultry, remains possible and has been suggested as a playing a role in previous outbreaks.

As a late addition to this project, the BTO was asked to comment on the risks of AI infection from wild birds through contact with housed poultry as well as with free-range birds. To do this, a field protocol was designed by which BTO ornithologists could assess the likely attractiveness of housed poultry sites to wild bird species and the apparent effectiveness of existing biosecurity measures in terms of limiting wild bird access to the interior of poultry sheds. Field visits were made to four housed turkey farms in East Anglia, which differed considerably in size, age and landscape context. Visits were conducted over one day only and consisted of a combination of visual inspection of the sites and the exterior of the turkey sheds and interviews with site managers.

4.2 Methods

Four housed, non-free-range turkey farms in East Anglia were visited by two experienced ornithologists during February 2010. The farms are referred to here by codes HT1 – HT4; a key to this code has been supplied to the British Poultry Council independently of this report. Visits were conducted in the morning (starting at around 1100) and lasted between one and two hours, depending on the size of the site. On arrival at each site, full biosecurity measures were followed, under the supervision of the site manager with showers being taken and clothes and footwear being changed.

The farm manager was then asked a series of questions regarding the biosecurity of the site and the general running of the turkey farm, with particular reference to the food, bedding and waste removal. These questions were intended to provide standardized collection of information about farm management practices, in the absence of lengthy periods of observation of actual farm activities, which were not feasible under this contract. Clearly, this means that the assessments of risk in this report are contingent upon the information being representative of actual practices.

A walk around the site then followed, studying carefully each shed in turn and mapping the surrounding habitats to assess the potential of the whole site for attracting different wild bird species. On each site, every shed was examined. The surveyors walked around each shed, noting whether air vents were secure, whether there were holes in the shed sides, any open roof spaces or doors or other visible bird access, whether the buildings appeared to provide potential nesting sites for wild birds and the general state of repair of the shed. The sites were surveyed on foot, except for Farm HT3, which was much larger in size, and a combination of walking and a vehicle was used.

The surrounding land and the sheds were assessed for the potential as nesting or roosting habitat, and as a source food and water throughout the year. Although no formal bird survey was carried out, the species present were noted and any species found sitting or flushed from the barns were mapped for future reference.

Several assumptions had to be made when interpreting the information collected on the site visits. Every shed on each site was assumed to be in active use, either containing birds or empty, awaiting the next rotation. It was also assumed that any holes or access points that were noted led into the barn itself and to a space in which there could be direct contact with the turkeys. During site visits, the surveyors did not enter the barns and the internal structure of the barn remained unknown. Therefore, some of the risks mentioned below, especially relating to some of the roof spaces may be overestimated, if apparent openings did not actually lead into the barn.

On leaving each site, biosecurity procedures were once again followed, with another shower and removal of the clothing and footwear used for the visit.

The results of the site visits and interpretation of what was found are summarized site-by-site below. Higher Risk Species (HRS) for spreading avian influenza (AI) were defined from the existing literature, as described in the main report on free-range birds. General conclusions across sites are then presented at the end of the report.

4.2.1 Farm HT1

Farm Type: Housed Turkey Farm
Location: Southwest Norfolk, East Anglia
Date: 4th February 2010

Species seen during visit	NOTES
Woodpigeon	
Pheasant	
Moorhen	
Carrion Crow	
Collared Dove	
Blackbird	Inc. one trapped under pond netting
Black-headed Gull	Flying over
Coal Tit	
Redwing	Mostly flying over but also in the tall trees along the boundary.
Robin	
Blue Tit	
Great Tit	
Chaffinch	Mostly seen and heard in the surrounding woodland, one seen perching on a silo
Pied Wagtail	
Grey Wagtail	
Grey Heron	
Siskin	30+ feeding in alder trees along river

Table IV.1. Species recorded 4.2.10. Species in bold are considered Higher Risk Species (HRS)

4.2.1.1 Description of site

An enclosed site surrounding by trees and woodland. Water sources included a small wooded stream running along the northern edge, three small ponds on site and a number of large puddles next to a few of the barns. There was a source of natural food and plenty of nesting places in the surrounding woodland/scrub, as well as tall trees for perching/roosting.

4.2.1.2 Comments on species present on the site

Very few species were seen using the area around the poultry barns; most species noted were in the surrounding woodland and scrub. The HRSs were all noted along the boundary or flying over the site, except for chaffinch as one bird was seen perching on top of one of the silos. Lower risk species pied and grey wagtails were seen feeding along the edge of the puddles and the areas under the air vents.

4.2.1.3 Suitability of the poultry site for wild birds

a Food

There appeared to be a food spillage under silo No.2, although this shed was no longer being used. However our attention was drawn to an area outside shed 5 where a number of thrushes and moorhens were pecking at the ground. On investigation there was some feed present on

the grass just off the concrete area. As there were no turkeys present in shed 5, it may be this was left after the shed was cleaned, but it was attracting birds to the area.

b Water

Although the main water tanks may act as a perch for wild bird species, all water tanks were covered and sealed and are highly unlikely to attract any wild bird searching for a water source.

There were three ponds and a stream present on site. The stream was well wooded with little access to the water. Although this might attract moorhens, it is very unlikely to attract other species of wildfowl, especially migrant species. A heron was seen flying along the tree line above the stream but is unlikely it could access the stream itself. The largest pond on the site is possibly big enough to hold a pair of mallard, but it had been covered with netting and was unlikely to attract any waterfowl. The second and third ponds were smaller and overgrown, and unlikely to attract waterfowl except for moorhens. There had also been some attempt to net the second pond, however much of it remained open and may provide a suitable nesting habitat for moorhen in the spring. It is considered that none of these ponds would attract any migrant wildfowl but would act as drinking pools for local species. During the survey a blackbird was found trapped underneath the netting placed over the largest pond, and improved netting may be suggested for this site

c Bedding

Bedding was secured in an old turkey barn with no access, there seemed little risk of transmission through the bedding here compared with the other sites visited.

d Sheds

In general the sheds were in good condition with very few access points for wild birds; air vents were blocked with mesh.

The air vents at the side of each sheds pointed downwards, allowing a pile of extracted mess to accumulate on the ground below the vents. This could potentially be an area for insects in warmer weather, attracting insect-feeding wild birds (probably not HRSs). During the site visit, some of the sheds were empty and had recently been cleaned out. Although most of the waste had been removed from the site, some residue remained on the concrete outside the barns. Again, this has the potential of attracting insects and therefore insect-eating wild birds.

Shed sides

In general, the sides of the sheds were in good condition with no access for wild birds accept for a small hole where a pipe used to be situated at the end of sheds 6, 8-11 and 14. AI risks from the presence of these holes are low. The holes are small and will only allow entry by small, low risk species, which may not be attracted anyway. In addition, from the outside, we could not be certain whether the holes led directly into the shed itself. However, the sheds are surrounded by suitable habitat for tits and both blue and great tits were present during the survey, so it is possible that the holes could be investigated by tits and therefore allow some contact between wild birds and turkeys.

Shed roofs: Lower Roof

There were no obvious gaps in the roofs and there was little potential to attract nesting birds, although the corrugations along the roof edge of some sheds would provide sufficiently large entry points for small birds, such as house sparrow and starling, into the roof space to nest,

both of these species are considered to be HRSs. From ground level, it was not possible to assess if these corrugations and therefore the access to the roof space/shed were blocked. If they are, then there is no potential for nesting birds as the gap would be too small and exposed. If these corrugations are open, the risk at this site would still be low as no sparrows or starlings were noted during the visit. It is also probable that, outside of the breeding season, birds would have no reason to investigate these dark holes and spaces.

Shed roofs: Roof Tops
There were three different roof designs at Farm HT1 and two of these designs were considered potentially to be attractive to wild birds

1. Domed Cover Design with some sides.
This design is present on sheds 6-11 and a very similar design to the domed covered roofs at Farm HT3; the risks posed by this design are described/discussed in 1.3.4. No birds were seen using the roof space at Farm HT1 during our visit and perhaps the gap between the shed roof and the dome cover is smaller here, reducing the potential as a roost/nesting site. Further research would be necessary to prove whether this is the case. No feral pigeons or stock doves were seen at the site during the survey but, given the surrounding habitat, it is possible that both species could be recorded here.

2. Domed cover design without sides.
This design, present on sheds 4, 12 and 14, was similar to the other domed design except that there were no sides, just an open area. This might increase the likelihood of birds roosting under the dome cover, but it is too open to be suitable as a nesting site. Again if there is only a grate in the roof under the dome cover, then there could be contact between wild bird faeces and turkeys

The roof design on shed 5 looked fully secure with no possible entry for wild birds.

4.2.2. Farm HT2

Farm Type: Non- Free Range Turkey Farm
Location: Central Norfolk, East Anglia
Date: 1st February 2010

Species seen during visit	NOTES
Woodpigeon	
Starling	
Blackbird	
Great Tit	
Chaffinch	
Bullfinch	
Blue Tit	
Robin	
Moorhen	
Meadow Pipit	
Mistle Thrush	
Red-legged Partridge	Adjoining farmland only
Fieldfare	Adjoining farmland only
Carrion Crow	

Table IV.2. Species recorded 1/2/10. Species in bold are considered Higher Risk Species (HRS)

4.2.2.1 Description of site

Farm HT2 is a small site surrounding by arable land and residential housing/farmyard. The surrounding hedgerows provide sources of natural food and nesting habitat for many species, as well as tall trees for perching/roosting. Water sources included a small pond in the neighbour's back garden, at the boundary of the farm.

4.2.2.2 Comments on species present on the site

Very few birds were seen during the survey and the species recorded were mostly found along the hedgerow at the northern boundary and on the adjacent farmland. A chaffinch and a blackbird were seen on one of the silos. Moorhens were recorded along the northern boundary ditch and by the small pond in the neighbour's garden.

4.2.2.3 Suitability of the poultry site for wild birds

a Food

There was no evidence of food sources for wild birds relating to the poultry site.

b Water

There were no water tanks on site as the water supply came from the mains. The only water source was a small pond in a garden adjoining the poultry farm. The pond was large enough to attract mallard and moorhen but unlikely to attract any other migrant wildfowl. No ducks were seen during the survey, although moorhen were present and would probably nest close to the pond in the breeding season.

c Bedding
Bedding was stored in an open barn. As at previous sites the bedding was double-wrapped with external black polythene and then clear polythene inside and therefore direct contact with wild birds is unlikely. The barn provided a suitable nesting habitat for swallows, pied wagtails, feral pigeons and house sparrows and, if rodents are present on site, bird-to-mammal transmission is possible (see section 1.3.3).

d Sheds
In general, the sheds were in good condition with very few access point for wild birds; air vents were blocked with mesh. However, some of the mesh holes particularly along the vents along the rooftops, looked too big to prevent access by small birds. The AI risk is low as species such as tits that could possibly enter the sheds via the mesh are considered low risk species, and are also unlikely to be attracted to enter the shed.

There were no obvious gaps in the roofs and there was little potential to attract nesting birds, although, as at Farm HT1 and Farm HT4, the corrugations along the roof edge of shed 3 could provide nests sites for starlings and house sparrows (see comments in 2.3.4). However, species such as house sparrows that may be attracted to holes of this size were not recorded on the farm during the survey.

4.2.3 Farm HT3

Farm Type: Housed Turkey Farm
Location: North Norfolk, East Anglia
Date: 10th February 2010

Species seen during visit	NOTES
Blackbird	
Black-headed Gull	Including a dead one on the rough grassland.
Blue Tit	
Carrion Crow	
Common Gull	Resting on surrounding cereal fields
Curlew	Flying over only
Fieldfare	Feeding on the rough grass and hedgerows
Goldfinch	
Greenfinch	
Herring Gull	Resting on surrounding cereal fields
Jackdaw	
Kestrel	
Lapwing	Feeding on the rough grass and arable fields
Lesser Black-backed Gull	Resting on surrounding cereal fields
Little Owl	Seen in roof area
Magpie	
Marsh Harrier	Flying over surrounding arable area
Meadow Pipit	
Pheasant	
Pied Wagtail	
Pink-footed geese	Flying over only
Red-legged Partridge	Seen in roof area
Redwing	Feeding on the rough grass and hedgerows
Rook	
Song Thrush	
Starling	
Woodpigeon	
Wren	Seen in roof area
Yellowhammer	
Stock Dove	

Table IV.3. Species recorded 10.2.10. Species in bold are considered Higher Risk Species (HRS) for avian influenza

4.2.3.1 Description of site

Farm HT3 was a large site with a variety of habitats including rough grassland, arable crops, mature woodland and newly planted trees, rough/set-aside areas, hedgerows and a small amount of scrub. This diversity of habitat was probably responsible for the high diversity and density of birds seen on the site. There are plenty of natural nesting areas around the site in hedgerows and wooded areas, while berry bushes, rough grass, stubble fields and set-aside land provided natural food sources for different bird species. There were no obvious water sources within the boundary of the farm.

4.2.3.2 Comments on species present on the site

HRS seen on site included a flock of gulls an adjacent cereal field and flying over the site. There was also large rookery on the adjoining farmland, with a mixed flock of rooks and jackdaws on the set-aside field below the rookery. A marsh harrier was seen flying across the adjacent cereal fields and starlings were present, but only in very small numbers. There were good numbers of skylarks, stock doves and lapwings on the cereal fields and winter thrushes on the rough grassland and berry bushes. One of the employees was a bird watcher and reported seeing 170-180 species on the site over the last 15 years.

Apart from a couple of ditches, there were no obvious water sources on site, and none suitable for wildfowl. However given the number of geese (mostly migrants from northern Russia and Iceland) that are present on the North Norfolk coast in winter, it is not surprising they have been seen around the site. Depending on the surrounding winter crop rotation it is possible that geese might be attracted to the adjacent farmland. One of the workers reported seeing brent geese on the cereal fields and a large flock of pink-footed geese were recorded flying over distant arable land during the survey.

The same employee informed us of a number nest boxes that had been put up in the woodland for tits, owls, spotted flycatcher and woodpeckers; there was also an owl box in the old tractor shed, none of the boxes were observed during the survey. Although the presence of nest boxes could attract birds into the area, they may not necessarily be increasing the risk of AI infection. The nest boxes are away from the sheds and are targeting species that are not considered high risk. The presence of owls on site could help with rodent control and placing nest boxes away from the sheds may deter species from investigating the barns as potential nesting sites.

4.2.3.3 Suitability of the poultry site for wild birds

a Food

There was no evidence of spilled food at the base of the silos or around the site. There were only two sheds containing birds on our visit; the other sheds had been cleaned. There was a large pile of feeders left outside the sheds: if these had not been cleaned before they were left outside they could act as a source of food and be attractive to wild birds. We noticed that the doors to some of the silos had been left open. Although these silos were dark and probably, therefore, unattractive to wild birds, if some food remained inside, wild birds could have been induced to enter. If they leave faeces whilst inside the silo this may lead to another possible line of infection. Even if birds are not attracted inside the silos because of the darkness it is possible that the opening to the silo might act as a perch for wild birds and whilst resting at the entrance faeces could enter the silo. The wooden doors at the base of silo 3 were broken, allowing us to view under the silo. This area had evidence of faeces, but it was impossible to say whether these were mammalian or avian as it was also very wet. This shows, however, that wild animals had been attracted to this area. The area under this silo would also be likely to attract insects in warmer weather, and therefore insect eating birds. However, none of the bird species likely to be attracted in these ways are those presenting the highest risk of AI transmission.

b Water

Although the main water tanks may act as a perch for wild bird species, all water tanks were covered and sealed and highly unlikely to attract any wild bird searching for a water source.

However, some of the water tanks next to the sheds were raised up on a wooden frame. Under this structure, there were a number of wooden beams suitable for birds to roost and a stock dove was flushed from underneath one of towers. From the amount of faeces present underneath this beam it suggests that this beam is used frequently as a roost/resting place, although by no means necessarily by any species presenting an AI risk.

c Bedding

The bedding was stored on pallets outside the shed. We had been informed that the shavings were stored wrapped in black polythene, and then inside this, the shavings are also covered in clear polythene. Before entering the barn, the shaving packs were taken from the black wrapping, then into the barn in the clear plastic before being opened in the barn. However around the site it was noticed that the black plastic was open and therefore the clear plastic wrapping was open to the elements and to possible contact by wild birds. In some cases, the clear plastic wrapping was also ripped leaving the bedding completely open to the elements and contact with wild birds. The stacks of bedding could be an attractive place for birds to sit and rest, although there are probably more attractive potential perching areas elsewhere on the site. Even if the shavings were fully covered, there is also still a risk of infection being passed on by rodents. Rodents could easily gnaw through the polythene and the shavings could be attractive warm, safe place to nest/rest. If the rodents had been in contact with infected wild bird faeces, there is a possible route for infection.

We understand from the farm manager that the floors of the sheds are lined with a layer of straw before the start of a new rotation of birds. Once the shed is lined with the straw it is fumigated before the birds arrive in the barn. The bales of straw are kept/stored outside the barns before they are used. Whilst left outside the barns it is possible that these bales will attract birds as they act as a perch and in some cases a source of food if there are seeds left in the bales or they attract insects. These bales could therefore contain faeces from wild birds, and we are not in a position to comment on whether the fumigation of this straw before use eradicates all risk for AI being transmitted in these straw bales. However, bales are unlikely ever to attract large numbers of individual birds or higher risk species.

There was a large pile of bales to the north of the site, along one of the tracks. These looked like old bales that probably will not be used in the sheds, but this area is likely to attract insects in warmer weather and, therefore, attract wild birds, although again not AI risk species. This area also has the potential to act as a nesting place/food source for rodents and therefore an area where bird/mammal interactions might occur.

d Sheds

There were 24 sheds present on this site. The air vents to all of the sheds were covered by chicken wire, so there was no bird access at these points. There were at least two sheds (13 & 24) with a flap covered by a grate. If this is flap is opened at anytime and there is no further mesh, then the holes in this grate would be too big to prevent access by small wild bird species such as tits and finches, although there is no reason to expect that there is any particular incentive for such species to go through them and these species do not present high risks.

Shed sides

All but one shed we considered to be in a good condition with no obvious bird access or holes in the side of the sheds. However, shed number 5 was in a poor condition with an open hole in the side big enough to allow bird access to the barn.

Lower Roof
Some of the roofs were made of corrugated iron and in most cases the roofs were secure with no entrance holes or possible nesting areas. The eves of the sheds look unattractive for roof-nesting species, such as sparrows and swifts. However, shed 5 had a very large hole in the roof with easy access for any wild bird, shed 3 & 4 also had a couple of areas where wild birds could potentially enter the shed through the roof (although we could not be certain). The roof design on sheds 6 & 7 was more secure, as although the corrugations were larger, all holes were obviously blocked with no possible access points to the sheds. This was the best design we saw on any of the sites we visited

Roof Tops
There were five different rooftop designs at Farm HT3, three of which could be attractive to wild birds.

1. Chimney Design
This design was present on sheds 6, 7, 12, 23 and 24: a chimney-like structure with an opening near the top and a roof covering. We felt there is a possibility that this design could be provide a nesting place for species such as jackdaws, feral pigeons and stock doves. Feral pigeons were not seen during the survey but could potentially be present in the area, whilst stock dove and jackdaw were recorded on our visit. The chimneys may be too deep as a possible nesting place; only a return visit during the breeding season would properly assess whether these areas are actually used as nesting sites. From outside the building, we were unable to ascertain the internal chimney design, but if there is a grate that drops straight down into the turkey barn, not only does that provide a base for these birds to nest on but also potential contact via droppings from two HRS, if they use these areas for nesting, straight into the barn. However, no birds were noted around the chimneys during the survey and only a breeding season visit could ascertain whether these locations are used for nesting in practice.

2. Slat Design
This design was present on sheds 8, 9 and 10. On sections of the roof where the slats are intact, there is only a small gap, so smaller species may not be attracted to this dark area, but entry is certainly possible. However, many of these slats were broken, with a wide, open entrance into the loft space. This has the potential to be highly attractive nesting site for feral pigeon and stock dove (a HRS). Out of the breeding season, this roof area may be an attractive roost site, with warmth from the barns and the cover from the roof above the slats. As with the chimney design, once inside the roof area, if there is only a grate between the wild birds and the inside of the barn, transmission would be possible via faeces dropping through the grate. During our visit a stock dove was present on roof 8, along with two red-legged partridges.

3. Domed Cover Design with some side panels
This design was present on sheds 11, 13-20 and 22. At the top of the roof there is a domed cover about 30-50cm above the roof joints. From ground level it was difficult to ascertain the suitability of this roof design for nesting and roosting birds. Although the warmth from the shed and the protection from the cover would certainly make this area suitable, the gap was possibly too small for pigeons and jackdaws. At the end of each shed, under the dome cover, there is a large enough space for a nesting dove and, on reaching shed 22, a sighting of two little owls demonstrated that there was also easy access to the roof space along the entire length of the roof. As the survey continued along the row of sheds, we found four red-legged partridges and a wren in the roof space of shed 15. Neither of these species is considered high

risk, but if partridges and little owls can fit into this space, it suggests that some HRSs could use this roof area. As mentioned previously, if there is only a grate under this dome and an open air space going straight into the barn, there is a possible AI transmission route via faeces from birds in the roof area.

4.2.4. Farm HT4

Farm Type: Housed Turkey Farm
Location: West Cambridgeshire, East Anglia
Date: 3rd February 2010

Species seen during visit	NOTES
Woodpigeon	Mostly perched on surrounding trees
Blue Tit	
Great Tit	
Blackbird	
Pheasant	
Moorhen	5+ around pond area
Carrion Crow	
Stock Dove	
Reed Bunting	In scrub by pond
Linnet	
Pied Wagtail	
Goldfinch	
Black-headed Gull	Flying over
Chaffinch	
Grey Wagtail	

Table IV.4. Species recorded 3/2/10. Species in bold are considered Higher Risk Species (HRS)

4.2.4.1 Description of site

The farm is surrounded surrounding by trees, situated in open arable farmland. Water sources included a large pond on site and drainage ditch to the north, as well as a few small, ephemeral puddles next to the barns. The surrounding woodland/scrub will provide a source of natural food for many species, as well as tall trees for perching/roosting. The surrounding trees and hedgerow provided plenty of potential nesting habitat.

4.2.4.2 Comments on species present on the site

Very few species were seen using the area around the poultry barns; most species noted were in the trees and scrub. The HRSs were all noted along the boundary or flying over the site. Lower risk species (blackbird) and possible higher risk "bridge species" (pied and grey wagtails) were seen feeding along the edge of the puddles and the areas under the air vents, but may have been less likely to use these areas in drier conditions.

4.2.4.3 Suitability of the poultry site for wild birds

a Food

There was no evidence of food sources for wild birds relating to the poultry site.

b Water

Although the main water tanks may act as a perch for wild bird species, all water tanks were covered and sealed and are highly unlikely to attract any wild birds searching for a water source.

There was one large pond on site, which was large enough to be suitable for migrant waterbirds such as teal and wigeon, but probably more likely to attract mallard. Some attempt had been made to put a net across the pond and this would certainly reduce the attractiveness of the pond to wild migrant waterfowl. However, this netting had since sunk to just beneath the surface, although it had probably been pushed down further by the layer of thick ice present on the day of the survey. It would certainly be advisable to re-net this pond to improve the deterrence of waterfowl. There were a number of moorhens present around this pond and, although this is a low risk species, they could potentially act as a bridge species moving a virus from the pond to the shed area, if they came into contact with infected migrant wildfowl. The nearby ditch/drain was not observed during the survey: its presence was only known due to a description by an employee at the site, but locally resident moorhen and mallard are again the main species likely to be attracted to such a habitat.

c Bedding

Bedding was secured in the barns, but there is limited storage inside and shavings are left on pallets outside in a similar set up to Farm HT3. Unlike the Farm HT3 site, the shavings were well covered by the black plastic. A route of transmission via rodents still seems possible as previously discussed in section 1.3.3. With the high density of farmland ditches in the surrounding area, experience suggests that rodent numbers could be quite high in this area.

d Sheds

The sheds were very similar to those at Farm HT3 and in good condition, with very few access points for wild birds. Air vents were blocked with mesh. The vents pumped out warmth and sawdust into the air attracting wagtails and blackbirds, however there was no accumulation of muck under the vents as seen at Farm HT1.

The same flaps as seen on two of the sheds at Farm HT3 were present on all the sheds at Farm HT4. If the flaps are opened at anytime and there is no further mesh, the holes in the grate would be too big to prevent access by small wild bird species such as tits and finches but, as before, there is no particular reason to suspect that they would be enticed to enter.

There were no obvious gaps in the roofs and there was little potential to attract nesting birds, although, as at Farm HT1, the corrugations along the roof edge could potentially provide nesting holes for starlings and house sparrows. See comments in section 4.2.2.3d.

4.3 General Conclusions and Recommendations

AI contamination of poultry sheds from infected wild birds could occur via several routes. If biosecurity procedures are sound and sheds are sealed, however, the risk should be zero even if infected wild birds are immediately outside, or even sitting on, a shed. The BTO does not have the expertise to comment on the details of biosecurity procedures, so we do not do so here. However, we can address the likely attractiveness of the sheds and their surroundings to wild birds with different potential risks of AI transmission, such that the potential implications of failures in biosecurity are clarified.

Wild birds could play a part in transmitting infection by carrying the disease themselves and taking it into poultry sheds, either by entering the sheds or by defecating through openings into the sheds. This is likely only ever to involve a small range of species that seem to be more susceptible to infection, such as waterfowl (see main report), which are not among the species most likely to be attracted to any part of a housed poultry site. Regardless of the effectiveness of biosecurity, therefore, the risk of infection by this route is low. A second route, however, involves physical transmission in which an uninfected wild bird transports infected material (most probably faeces) into a shed on their beaks or feet. This brings a much wider range of species into consideration as potential "bridge species" (see main report). Any wild bird species could potentially transmit disease in this way, but birds that feed on the ground in habitats where susceptible/carrier species are also common are more likely to present a problem in this way. However, the absolute level of risk involved must again be low because it must be unlikely, in most circumstances, that a wild bird that encounters potential carriers like migratory waterfowl also then enters a poultry shed without any infected material having first been wiped or washed off its body. Thus, overall, all discussion of risk here should be taken as relative to the context of a low absolute risk in general.

During the site visits the sheds were studied carefully looking for potential roosting or nesting holes in the shed roofs or sides that could potentially provide access for wild birds or their faeces. The findings are listed for each site above and the potential for each shed to attract wild bird species is assessed. The sheds at Farm HT4 and Farm HT2 appeared to be more secure than the sheds at Farm HT3 and Farm HT1.

The design of the vents on the sheds at Farm HT4 may require further investigation to assess the potential for entry by wild birds. On the days of the surveys at both Farm HT4 and Farm HT2, it appeared that only small, low risk species could potentially enter the sheds. The risk of AI transmission is further decreased because these species are also unlikely to be attracted inside. Small, hole-nesting species might also be able to use the roof corrugations at some sites and only further investigations into the structure of the roof from the inside would determine the actual potential access at these points. These corrugations could possibly be an attractive nesting hole for house sparrows or starlings, among HRSs, but this would still only present any potential risk of AI transmission if there were also open access for birds or faeces from the nesting cavity into the barn itself. Sparrows were not recorded at any of the sites visited, but only a visit in the breeding season would properly investigate the potential of these barns for small nesting birds.

The shed roofs at Farm HT3 and Farm HT1 presented more queries. Poultry sheds are warm, potentially providing a good resting place for some species on a cold day and, at both sites, there is a further risk as the roof designs on a number of the sheds provided potential roosting and nesting areas for wild birds. The holes could potentially attract HRSs such as pigeons,

stock doves and jackdaws. During our visit to Farm HT3 we noted red-legged partridge (HRS), wren, stock dove (HRS) and little owl using the roof area. The actual potential risks from these roof designs depends on the internal structure if the shed itself and whether there is direct access for faecal material into the barn. This seems unlikely, as it would be apparent as a leak in wet weather and would, therefore, presumably rapidly be repaired, but if not, it could be wise to change the design or alter the roofs to make them less attractive to wild bird species.

As well as shed structures, another potential area for failures in biosecurity to interact with wild bird use is where material that is taken into sheds from outside has become contaminated before being taken inside. The biggest area of risk for this sort of transmission seems to be with the bedding used for the housed birds. Apart from the site at Farm HT2, where bedding was stored in a sealed barn, the other sites gave some cause for concern in this respect, particularly at Farm HT3. Here, bedding was exposed to the elements and direct avian to bedding contact was possible, although few species are likely to be attracted to it. Where the bedding is stored in an open area, even undercover in a barn, infection is possible from bird to mammal contamination. Rodents that have been in contact with avian faeces could potentially gnaw through the bedding's packaging and transfer the virus into the poultry's bedding. There was no evidence of holes in the packaging caused by rodents but it was unknown how long the bedding had been stored in the open. Clearly, the actual risk from this route of infection depends on infected birds being present in the general area, from which rodents might carry infected material on their bodies to the bedding. This is possible but, as with the other wild-bird-related infection scenarios, requires a chain of events that are, individually, rather unlikely to occur and even less likely to occur together. Thus, the overall, absolute risk must be small.

In terms of AI contamination via bridge species, the nature of the habitat immediately surrounding poultry shed sites will have a major impact on the potential for such species to come into contact both with carrier species and the interior of poultry sheds. It is hypothesized that an outbreak of AI in wild bird populations in the UK is most likely to arise in wetland habitats. The farm sites that contained a water source could therefore be more at risk from the wild bird population, although it should be noted that the largest potential risks are presented by migratory waterbirds that tend to be found in large flocks and large habitat areas. Of the sites visited, Farm HT4 contained a pond of a suitable size to attract some migrant wildfowl, although the netting covering the pond makes this seem highly unlikely. The garden pond next to the site at Farm HT2 has the potential to attract mallard, although the pond is small and unlikely to attract more than a couple of pairs. Most mallards are not migratory and birds on a pond like this are likely never to move far or to interact with many other mallards so as to pick up or to spread an IA infection. The spread of AI onto the poultry sites is therefore more likely via a bridge species that are at high risk of contracting the disease once it has arrived in the area and are also attracted into poultry farms. The risk of infection is then related to the distance to the nearest water body suitable for migratory wildfowl, relative to the movements generally made by the bridge species.

Although the ponds are unattractive to migrant waterfowl they will still act as a drinking pool for a number of species and also an attractive place for moorhens to forage and breed. Moorhens are fairly sedentary birds unlikely to travel more than 20km, but they could act as an effective bridge species, bringing in the virus to the ponds, and spreading it to other species that are using to pool to drink.

The geese seen at Farm HT3 present a slightly different possibility, as it is the food source rather than water that presents more of a risk factor. Although the geese still require wetland, during the day whilst searching for a food they are more likely to use an arable field with good feeding opportunities. However, although the arable land at Farm HT3 is situated close to the turkey sheds, the geese are unlikely to get too close to the barns and again the risk is higher from bridge species.

The rough grassland at Farm HT3 attracted a large number of winter thrushes and lapwings, both HRSs and medium risk, bridge species. Lapwings would not be attracted to sitting or roosting on the sheds, so only present a risk of carrying the virus into the area and spreading it to another bridge species. Such passive, physical contamination between species must be very unlikely. Although seen close to the barns, neither fieldfares nor redwings were observed perching or roosting on the sheds, being more attracted to the surrounding hedgerows when flushed, again suggesting they only pose a remote threat as a bridge species. Stock doves and gulls were seen on the fields where the lapwings and winter thrushes were also feeding. Stock doves were noted on the shed roofs and although gulls were not recorded on any of the roofs during this survey they were seen perching on shed roofs during the free-range site visits and are known to roost on buildings.

Every site visited had adjacent areas of woodland and/or hedgerow habitat, which were mostly attracting lower risk species, e.g. blue tits. The exceptions were woodpigeon, winter thrushes, chaffinch and corvids; of these HRSs, woodpigeons and corvids remained in the boundaries and only the winter thrushes and chaffinch were found in close proximity to the sheds. These are not species likely to be attracted to enter sheds, with the possible exception of chaffinch, if grain were available to them inside and through a large, open entry point. This seems unlikely, as it would represent a major breach of basic biosecurity.

Pied wagtails and gulls are attracted to both wetland habitats and agricultural lands. In the case of pied wagtails many were seen on or around the poultry sheds, attracted by the warm sheds that attract their insect food source. Pied wagtails were seen on numerous occasions perched on shed roofs, but none were seen near to the holes and gaps and are unlikely to be attracted to these areas, staying mainly on the open roof area. In practice, any risk of contamination via pied wagtails is likely to involve infected faecal material from a waterbird, say, being carried on a wagtail's feet; this material would then have to travel from the outside of a shed to the inside by another route because the wagtail would be very unlikely to go inside itself.

To conclude, the species of most concern are those likely to be attracted to the sheds: gulls, corvids, stock doves, feral pigeons, pied and grey wagtails, house sparrows and starlings. These all present a relatively high risk of bringing AI into the area as well as of contact with poultry if sheds are not biosecure. Of these species the gulls, and pied wagtails may present the biggest risk of bringing AI from a nearby water source, but are unlikely to enter shed roof spaces. Contamination is therefore likely to be via another bridge species such as feral pigeons that are far more likely to enter the shed. There is potential for the sheds to attract house sparrows and starlings during the breeding season with possible nesting holes present. Further research into the shed design and studies within the breeding season are required better to assess this threat, but absolute risk levels from this route for infection are probably very low.

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Risk-based surveillance for H5N1 avian influenza virus in wild birds in Great Britain

L. C. SNOW, S. E. NEWSON, A. J. MUSGROVE, P. A. CRANSWICK, H. Q. P. CRICK, J. W. WILESMITH

Recent outbreaks of the H5N1 strain of avian influenza in Europe have highlighted the need for continuous surveillance and early detection to reduce the likelihood of a major outbreak in the commercial poultry industry. In Great Britain (GB), one possible route by which H5N1 could be introduced into domestic poultry is through migratory wild birds from Europe and Asia. Extensive monitoring data on the 24 wild bird species considered most likely to introduce the virus into GB, and analyses of local poultry populations, were used to develop a risk profile to identify the areas where H5N1 is most likely to enter and spread to commercial poultry. The results indicate that surveillance would be best focused on areas of Norfolk, Suffolk, Lancashire, Lincolnshire, south-west England and the Welsh borders, with areas of lower priority in Anglesey, south-west Wales, north-east Aberdeenshire and the Firth of Forth area of Scotland. These areas have significant poultry populations including a large number of free-range flocks, and a high abundance of the 24 wild bird species.

IN 1996/97, a new, highly pathogenic form of avian influenza (HPAI) emerged in poultry markets in Hong Kong (Shortridge and others 1998). Identified as belonging to the H5N1 subtype, the virus has since spread throughout south-east Asia, through eastern Russia and into Africa and eastern Europe. The first cases in western Europe appeared in 2006, and in March 2006 a dead whooper swan (*Cygnus cygnus*) was washed up on the shores of Cellardyke in Scotland, the first case in Great Britain (GB). It is now widely accepted that wild birds, in particular migratory wildfowl, provide a reservoir for a variety of avian influenza subtypes.

Low pathogenic forms of avian influenza (LPAI) viruses have been isolated from at least 105 species of wild bird belonging to 26 different families (Olsen and others 2006), and appear to be most prevalent in Anseriformes (ducks, geese and swans) and Charadriformes (gulls, terns and waders). The occurrence of influenza viruses among these species, particularly wildfowl, is important because the annual migrations of many of them can bring them into contact with large numbers of domestic and wild birds that could become infected (Webster and others 1995). There is some evidence that the virus is also maintained at low levels in some populations of waders and gulls, but the subtypes involved tend to be different from those isolated from ducks (Kawaoka and others 1988). The role of wild birds in the spread of HPAI is less clear. So far, the H5N1 strain that originated in south-east Asia has caused the death of wild birds belonging to over 60 species (Olsen and others 2006). In May to June 2005, wild birds were partially implicated in an outbreak that killed more than 6000 birds at Lake Qinghai in China, affecting large numbers of geese, ducks and gulls, with a particularly devastating impact on the globally threatened bar-headed goose (*Anser indicus*). In January 2006 a period of cold weather in the Black Sea region of eastern Europe resulted in the westerly movement of large numbers of wildfowl, possibly bringing H5N1 with them, followed by several outbreaks that year in Europe in both poultry and wild birds. Recent reports suggest that wild birds may have been the source of the spread of H5N1 over long distances throughout Europe in 2006 (Kilpatrick and others 2006), although local spread within Europe is more likely to have been due to movements within the poultry industry (Normile 2006a).

Before the current global epidemic of H5N1, the isolation of HPAI viruses from wild birds was rare, and when they were isolated it was usually in the vicinity of outbreaks in poultry. However, during the recent spread of H5N1, larger numbers of wild birds and poultry have been infected with the same Asian strain, suggesting that wild birds may play at least some role in the dispersal of the virus (Normile 2006b).

Given the persistence of the disease in south-east Asia, another westward incursion of H5N1, or a progeny strain, is highly likely. At the time of writing, there have been a number of outbreaks in Europe in 2007, and a third outbreak of H5N1 has been confirmed in GB. In response to the increased threat of further outbreaks in Europe, the EU has intensified its programme for the surveillance and early detection of avian influenza in wild birds and poultry. In GB, the surveillance is carried out by sampling shot birds, live-caught birds and birds found dead and reported by members of the public. The work described here was carried out in 2006 in response to increased concern about the presence of H5N1 in Europe and the potential risks to the GB poultry industry. Its aim was to identify the geographical areas where surveillance, notably for the collection of dead birds for screening, should be targeted.

MATERIALS AND METHODS

The work was designed to identify three types of areas: first, areas where commercial poultry are at greatest risk of an incursion of H5N1 from wild birds; secondly, areas in which the wild bird species that are most likely to carry the virus are most abundant; and thirdly, the areas in which the above two factors coincide or overlap.

Commercial poultry

Information on the GB poultry population is held in the GB Poultry Register, a mandatory register of all commercial poultry holdings with 50 or more birds. Using holding-level information contained in this database on May 12, 2006, all commercial poultry holdings with chickens, turkeys, geese or ducks (including ducks reared for breeding or shooting) were ranked according to the estimated likelihood of an incursion from a wild bird source; limitations in the data quality precluded the inclusion of gamebirds in the analysis.

There are considerable gaps in the knowledge of the epidemiology of avian influenza, and a lack of published studies on the risk factors for the transmission of H5N1 from wild birds into poultry flocks in Europe. A semiquantitative approach was therefore used to determine the risk to poultry holdings: scores were assigned to each holding on the basis of a number of holding-level factors that were considered to

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L. C. Snow, BSc, MSc, PhD, Centre for Epidemiology and Risk Analysis, Veterinary Laboratories Agency, New Haw, Addlestone, Surrey KT15 3NB
S. E. Newson, BSc, PhD, **A. J. Musgrove,** BSc, PhD, **H. Q. P. Crick,** BA, PhD, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU
P. A. Cranswick, BSc, Wildfowl and Wetlands Trust, Slimbridge, Gloucestershire GL2 7BT
J. W. Wilesmith, BVSc, HonMFPHM, DipECVPH, MRCVS, Department for Environment, Food and Rural Affairs, Page Street, London SW1P 4PQ

TABLE 1: Assumptions made with respect to the risk to poultry holdings in Great Britain, the degree of uncertainty surrounding them and the effect of removing or changing these assumptions on the ranking of 10 km squares

Assumptions	Uncertainty	Rank 1 squares that change (%)	Total squares (rank 1 to 5) that change (%)
Risk of incursion is dependent on holding size	High: no published evidence, assumption made on basis of discussion with experts	32·22	28·47
Dependence on holding size is non-linear and best described by the natural log of the number of birds*	High: no published evidence, assumption made on basis of discussion with experts	48·71	55·85
Free-range holdings are at higher risk than indoor holdings	Medium: no empirical evidence; however, assumption is frequently cited and there is agreement between experts	18·81	16·54
Ducks and geese are at higher risk if outdoors than chickens and turkeys	High: some evidence of differences in management that may affect likelihood of contact with wild birds, but assumption is based on expert opinion	10·56	17·72
Breeders and hatcheries are at lower risk	Medium: biosecurity is known to be high on the majority or breeding premises and hatcheries owing to the value of the stock	NA	NA

* Alternative scenario tested was that the holding size risk was proportional to the number of birds
NA Not applicable

be important in determining a holding's risk of introduction of infection. These included the numbers and species of birds on the holding, and whether they were housed indoors or kept outdoors. While numerical values were attached to each factor, there is little empirical information to support the values and much uncertainty surrounding them. In most cases the scores were based on unpublished reports or communications with experts.

The size of holding was considered to be an important factor in determining the risk of incursion, because the more birds there are on a holding, the greater the chance that one of them may come into contact with wild birds or infected faeces, particularly if they are kept outdoors. Although it is not known how the risk might increase with the size of holding or whether it should be best described as a linear or other function, expert opinion supports the idea that an addition of 10,000 birds is likely to increase the risk to a holding of 1000 birds more than it would to a holding of 100,000 birds. For this reason, the score assigned to each holding was the natural log of the number of birds on the holding, and analyses were carried out to determine the effect that assuming a linear relationship would have on the final map of the risk to poultry holdings.

A second factor considered important in determining the risk to poultry was the environment in which they were kept. For birds kept indoors there is likely to be minimal risk of direct contact with wild birds, regardless of the species being kept. However, if the birds are kept outdoors, the risk increases and the species becomes a more important factor. Free-range birds are frequently cited as having a high risk of contact with wild birds (Pfeiffer 2006, European Food Safety Authority [EFSA] 2006), although the evidence is largely circumstantial. In most enterprises, outdoor ducks and geese will have access to a pond or pool, and they are more likely to be fed outdoors than chickens and turkeys – two factors that

TABLE 2: Species of birds that are considered to be at most risk of being exposed to H5N1 outside the EU and that migrate to Great Britain

Common name	Scientific name
Mute swan	*Cygnus olor*
Whooper swan	*Cygnus cygnus*
Bewick's swan	*Cygnus columbianus*
Greater white-fronted goose (European subspecies)	*Anser albifrons albifrons*
Brent goose (dark-bellied subspecies)	*Branta bernicla bernicla*
Shelduck	*Tadorna tadorna*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Eurasian wigeon	*Anas penelope*
Common teal	*Anas crecca*
Common pochard	*Aythya ferina*
Tufted duck	*Aythya fuligula*
Moorhen	*Gallinula chloropos*
Coot	*Fulica atra*
Northern lapwing	*Vanellus vanellus*
Eurasian golden plover	*Pluvialis apricaria*
Snipe	*Gallinago gallinago*
Ruff	*Philomachus pugnax*
Black-headed gull	*Larus ridibundus*
Common gull	*Larus canus*
Herring gull (Baltic subspecies)	*Larus argentatus argentatus*
Lesser black-backed gull (south-west Scandinavian subspecies)	*Larus fuscus intermedius*

TABLE 3: Monitoring schemes contributing data on wild bird populations, showing the periods for which data were available and used in this study

Survey	Months	Years	Reference
Wetland Bird Survey core counts	Jan-Dec	2000-2005	Banks and others (2006)
Goose/Swan Monitoring Programme roost counts	Sep-Mar	2000-2005	Banks and others (2006)
Waterways Breeding Bird Survey	Apr-Jun	1998-2004	Marchant and others (2006)
Breeding Bird Survey	Apr-Jun	2000-2005	Raven and Noble (2006)
Winter Farmland Bird Survey	Nov-Feb	1999-2003	Gillings and others (In press)
Winter Gull Roost Survey	Dec-Feb	2003-2004	Banks and others (2007)
National Rook Survey	Apr-Jun	1996	Marchant and Gregory (1999)
National Heron Survey	Mar-Jun	2003	Marchant and others (2004)
Seabird 2000 (for breeding gulls)	Apr-Aug	2000-2002	Mitchell and others (2004)
Breeding Atlas	Apr-Aug	1988-1991	Gibbons and others (1993)
Winter Atlas	Sep-Mar	1981-1984	Lack (1986)

TABLE 4: Order in which data from the wild bird surveys were used to assign abundance scores for to 10 km squares

Order	Breeding populations (April-August)	Wintering populations (September-March)
1	Rook, Heron and Seabird 2000 (breeding gull) surveys	Winter Gull Roost Survey
2	Wetland Bird Survey core counts	Goose/Swan Monitoring Programme roost counts
3	Waterways Breeding Bird Survey	Wetland Bird Survey core counts
4	Breeding Bird Survey	Winter Farmland Bird Survey
5	Breeding Atlas	Winter Atlas

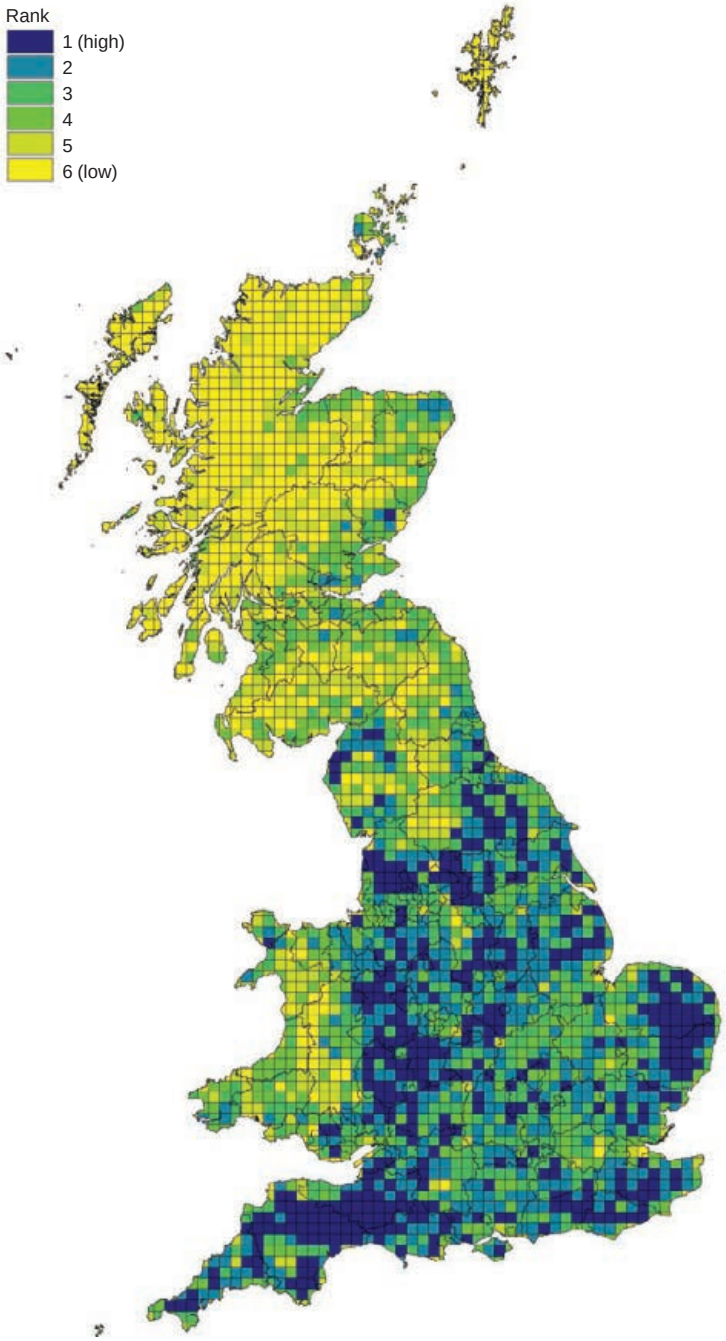

FIG 1: Map showing the risk of incursion of avian influenza H5N1 in domestic poultry in areas ranked 1 to 6 in order of high to low risk

will potentially attract wild birds and increase the likelihood of contact. To account for these differences, a score of 3 was assigned to outdoor ducks and geese, a score of 2 to outdoor chickens and turkeys, and a score of 1 to indoor birds, regardless of their species; analyses were undertaken to assess the effect of these assumed scores.

It is recognised that bird species vary in their clinical response to avian influenza, but there is little information available on the probability of different species becoming infected as a result of contact with HPAI; for this reason the probability was assumed to be the same for all species of poultry.

Other factors, such as the proximity to bodies of water, and biosecurity, are undoubtedly important, but there were limited data for holdings on these factors. Commercial breeders and hatcheries were considered to be at negligible risk, because of the high level of biosecurity practised against avian influenza and other infectious diseases by this sector of the industry.

The risk for each species present on each holding was calculated as the product of the scores described above, and the total score for each holding was calculated as the sum of the scores for each species present. This meant that a holding with two different species was equivalent to two smaller holdings, each with a single species, because each species would have a different risk. Using National Grid 10 km squares, total risk scores were then calculated for each square as the sum of the risk scores for the holdings within that square.

Table 1 summarises the assumptions made and the degree of uncertainty surrounding them. Further analyses were carried out to assess the sensitivity of the final maps showing the risk to poultry holdings to the assumptions made about how the risk was determined: these included the removal of the assumptions that outdoor ducks and geese are at higher risk than outdoor chickens and turkeys; that outdoor birds are at higher risk; and that the risk increases with the size of holding; and assuming that the risk is proportional to the number of birds, rather than to the natural log of the number of birds. Because the main aim was to predict the areas at higher risk, the effect of these changes was assessed by counting the proportion of rank 1 squares that were affected by removal or changing of the assumptions.

Distribution and abundance of wild birds

On the basis of discussions with ornithological and epidemiological experts, 24 migratory wild bird species that winter in GB were considered to have a high probability of exposure to H5N1 outside the EU (Table 2). The movements of these species have been described by Wernham and others (2002). In addition to these 24 species, a much wider group of species may be important in the secondary spread of the virus, for example, other larids and corvids. To obtain information on the distribution and abundance of any wild bird species, distribution and abundance data from 11 ornithological monitoring schemes (Table 3) were collated for all the wild bird species that are regularly recorded in GB, comprising some 200 million records. It was necessary to use data from several schemes, because no one scheme provided the best information for all the species and all months of the year.

Abundance scores (0 to 5) were assigned to each 10 km square for each species for each month for each survey, where 0 is the absence of a species and abundance increases from 1 to 5. For multispecies surveys, the abundance scores were determined by ordering the raw counts within a survey from smallest to largest across all species and dividing the data into five bands, each containing an equal or approximately equal number of counts. This scaling within surveys, across species and months, produces relative scores that are comparable within and to a large extent between surveys, so that a species occurring in low numbers in a particular month will only ever receive a low abundance score. When there was more than one abundance score for a 10 km square for one species in one month, it was necessary to use the most appropriate data source. To achieve this, scores were assigned by using the data from the surveys in a particular order. Table 4 shows the hierarchy used for the entire dataset covering all wild bird species regularly recorded in GB. Using this hierarchy, an abundance score for a 10 km square for one species for one month was used from the count from the first survey if the abundance score was more than 0. If the abundance score was 0, the next survey was checked for a score greater than 0, and so forth. If all the surveys recorded an abundance score of 0, then the resulting abundance score for that 10 km square for that species for that month was 0. At the lowest level in the hierarchy, the wintering and breeding atlases provided complete geographical coverage at the 10 km square resolution.

TABLE 5: Numbers of commercial poultry and poultry holdings by type and housing in Great Britain used in the analysis, including voluntary registrations of holdings with fewer than 50 birds

Poultry type	Number of birds	Number of holdings
Chickens (indoor and outdoor)	191,143,000	14,422
Outdoor chickens	19,915,000	10,906
(% birds/holdings outdoors)	(10·4)	(75·6)
Turkeys (indoor and outdoor)	10,970,000	2291
Outdoor turkeys	797,000	1132
(% birds/holdings outdoors)	(7·3)	(49·4)
Ducks (indoor and outdoor)	5,722,000	5500
Outdoor ducks	1,564,000	4969
(% birds/holdings outdoors)	(27·3)	(90·3)
Geese (indoor and outdoor)	215,000	3667
Outdoor geese	187,000	3475
(% birds/holdings outdoors)	(87·0)	(94·8)
Chickens, ducks, geese and turkeys (indoor and outdoor)	208,050,000	16,089
Outdoor chickens, ducks, geese and turkeys	22,462,000	12,272
(% chickens, ducks, geese and turkeys outdoors)	(10·8)	(76·3)
Total other poultry*	54,417,000	7009
Total	262,467,000	23,098

* Includes ratites, pigeons, quail, pheasants, partridges and guinea fowl

It was considered that the risk of H5N1 would be likely to be greatest after the main arrival of migratory waterbirds between October and December. To consider this period, the maximum score recorded for each 10 km square for each species for each month over the three-month period was taken to produce a map for each of the 24 species, and the scores for each of the maps were summed to produce a combined map for all 24 wild bird species.

Combining wild bird abundance with risk to poultry

A single map showing priority areas for surveillance was constructed by calculating the product of the score of wild bird abundance and the score for poultry risk in each 10 km square. The scores were then categorised to give ranks from 1 to 6, with a rank of 6 indicating that there were either no poultry or no wild birds present in the 10 km square, and the ranks from 5 to 1 indicating risks in increasing order of priority for surveillance.

RESULTS

There are over 262 million registered domestic poultry in GB, distributed throughout the country but with a significant spatial clustering of poultry holdings and birds. Table 5 shows the breakdown of types of poultry based on the dataset used in the current analysis (including a small number of voluntary registrations of holdings with fewer than 50 birds). Approximately 79 per cent of these birds are chickens (73 per cent), turkeys (4 per cent), ducks (2 per cent) or geese (0·1 per cent), with other poultry, predominantly gamebirds, not included in the present analysis but making up the remaining 21 per cent of birds. Variable proportions of birds are kept outdoors, depending on the species, but the difference in the proportion of birds and holdings registered as outdoor suggests that the majority of chickens, ducks and turkeys are kept in large indoor flocks.

The ranking of the 10 km squares in terms of the risk to poultry is shown in Fig 1. The raw scores have been grouped into 6 quantiles, 1 indicating the squares considered at highest risk and 6 indicating the squares with a negligible risk because they contain no registered poultry. In all cases the ranks are ordinal. Large areas of the Scottish Highlands, the north of England and inland Wales appear to contain no registered commercial poultry. The lower-lying areas of England, the north and south coasts of Wales and the east coast of Scotland should be considered at higher risk, and the location of the highest-ranking squares indicate that Norfolk, Suffolk, Devon, Lancashire and the Welsh borders (Hereford, Shropshire and Cheshire) should be considered at greatest risk because they have large poultry populations and a high proportion of outdoor holdings. North and West Yorkshire, Lincolnshire, Nottinghamshire and Derbyshire also contain a large number of high-ranking squares. Smaller areas of high risk to poultry occur in Anglesey, north-east Scotland, the

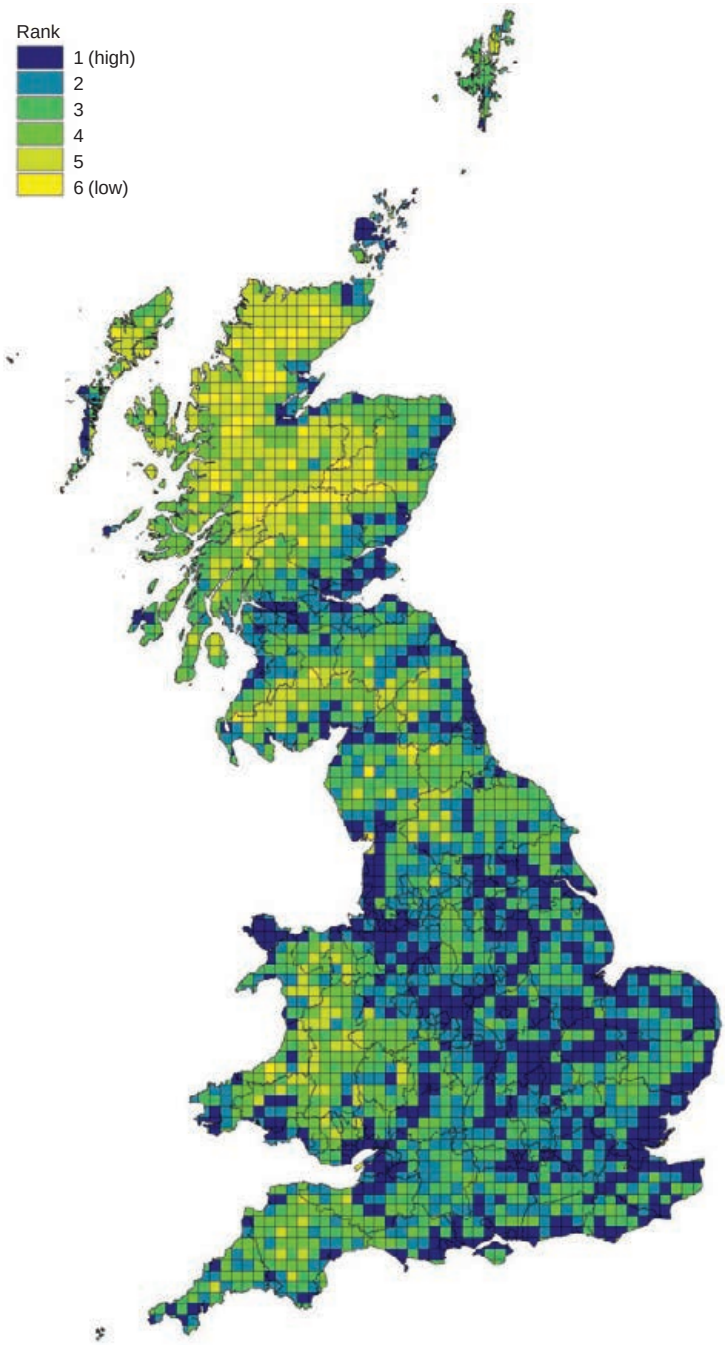

FIG 2: Map showing wild bird abundance scores (ranked 1 to 6 in order of high to low abundance), based on the combined scores for the 24 wild bird species considered to be at most risk of being exposed to H5N1 outside the EU and that migrate to Great Britain

TABLE 6: Number (%) of 10 km squares occupied by each wild bird species, mean abundance scores on occupied squares, and the relative contribution that each species makes to a combined wild bird species map

Species	Occupied squares (% of total)	Mean abundance score on occupied squares	Contribution to combined species map (%)
Mute swan	1677 (57)	2·53	3·7
Whooper swan	941 (32)	2·54	2·1
Bewick's swan	448 (15)	2·54	1·0
Greater white-fronted goose (*albifrons*)	256 (9)	2·53	0·6
Brent goose (*bernicla*)	256 (9)	3·02	0·7
Shelduck	1008 (34)	2·52	2·2
Mallard	2508 (86)	4·00	8·7
Gadwall	800 (27)	2·67	1·8
Northern pintail	712 (24)	2·31	1·4
Northern shoveler	886 (30)	2·64	2·0
Eurasian wigeon	1556 (53)	3·65	4·9
Common teal	1916 (66)	3·58	5·9
Common pochard	1469 (50)	3·09	3·9
Tufted duck	1614 (55)	3·26	4·7
Moorhen	1960 (67)	2·74	4·6
Coot	1652 (56)	3·25	4·6
Northern lapwing	2247 (77)	4·51	8·8
Eurasian golden plover	1550 (53)	4·11	5·5
Snipe	2122 (73)	2·63	4·8
Ruff	305 (10)	1·91	0·5
Black-headed gull	2272 (78)	4·49	8·8
Common gull	2237 (77)	3·92	7·6
Herring gull	2298 (79)	3·80	7·5
Lesser black-backed gull	1541 (53)	2·69	3·6

Fife region and some parts of Cumbria, East Sussex, West Sussex and Kent.

In addition to listing the main assumptions made, Table 1 shows the results of the analyses to examine how sensitive the poultry risk maps are to changes in these assumptions by showing the proportion of the total and top-ranked 10 km squares that were altered as a result of the changes. Removing the assumption about species resulted in changes in 11 per cent of the top-ranked squares, and removing the assumption about housing resulted in changes in 19 per cent of them. Removing the assumption about holding size and assuming that the number of birds had no influence on the risk of incursion resulted in changes in 32 per cent of the top-ranked squares. The largest change occurred when the number of birds on the holding rather than the natural log of the number was used to assign the risk. Under this assumption, 49 per cent of the top-ranked squares changed. Clearly, the assumptions made about how the risk varies with the size of the holding have a large effect on the analysis, and a similar effect on the final maps of the surveillance priority areas. As knowledge of the epidemiology of avian influenza improves, these analyses will need to be revised, but current expert opinion supports the assumption that the effect of the size of holding is non-linear.

A map based on the combined abundance scores for the 24 wild bird species is shown in Fig 2; the abundances are grouped into six quantiles, with squares with a rank of 1 indicating the highest abundance and 6 the lowest abundance. The contribution that any species makes to the combined map depends on its abundance and distribution, with the most abundant and widespread species, such as mallard, northern lapwing and black-headed gull, contributing most (approximately 9 per cent of the combined species total), and the least abundant and most localised species, such as ruff, white-fronted goose and Brent goose, contributing least (less than 1 per cent of the combined total) (Table 6). The map shows that areas with a high abundance of the 24 species most likely to harbour H5N1 include East Anglia (Norfolk, Suffolk, Essex and Cambridgeshire), Staffordshire, Shropshire, Northamptonshire, Nottinghamshire, Bedfordshire, Leicestershire, Lincolnshire, East Sussex, Kent, Cheshire, Merseyside and Fife. Testing dead wild birds reported by the public in these areas would maximise the chance of detecting a wild bird with H5N1, irrespective of the likelihood that the bird might come into contact with poultry.

The wild bird abundance and poultry risk scores were combined to produce Fig 3, with squares ranked from 1 to 6 indicating the order of decreasing priority for wild bird surveillance. Squares with a rank of 6 had scores of 0, indicating an absence of either wild birds or poultry and thus assumed negligible risk. All the 10 km squares in the top rank, that is, approximately the top 20 per cent of the scored squares, are defined as priority squares for surveillance. Such squares combine a high abundance score for the 24 wild bird species of interest and high densities of higher-risk poultry holdings.

The broad patterns of the geographical distribution of high-risk squares with rank 1 and 2 suggest that, combined with local knowledge about wild bird and poultry populations, surveillance would be best focused on areas of Norfolk, Suffolk, Lancashire, Lincolnshire, south-west England and the Welsh borders. These areas have significant poultry populations, including a large number of free-range flocks, and high abundances of the 24 wild bird species. Smaller priority areas were identified in Anglesey, north-east Aberdeenshire and the Firth of Forth area of Scotland, which have significant numbers of the wild birds and dense but localised poultry populations. Surveillance in these areas would maximise the probability of detecting H5N1 in a wild bird that might potentially be introduced into a poultry flock.

DISCUSSION

The early identification of H5N1 and rapid implementation of control measures is crucial to controlling the spread of the disease. Preventive measures to minimise the risk of contact between wild birds and poultry, such as keeping free-range birds indoors, are not feasible in the long term, and it is therefore essential to identify H5N1 in wild birds before it has the chance to be introduced into poultry. However, when the potential source of virus is large and dispersed, and the prevalence of the disease is likely to be low, identifying where and how surveillance should be carried out poses significant problems. Targeting surveillance can help to make the best use of limited resources and maximise the chances of detecting the disease. This paper describes work to develop maps to direct surveillance to areas where infected wild birds are most likely to come into contact with domestic poultry. The maps have already been used to focus the national wild bird surveillance effort on areas with high densities of potentially at-risk migratory wild birds and large poultry populations. This is the first time that extensive wild bird and poultry data have been combined in such a way, and it provides a model for the development of a similar approach in other countries where data on wild birds and poultry are available.

With few H5N1 outbreaks in GB, it is difficult to validate the maps. Previous outbreaks of H5N1, for example, the 1963, 1979 and 1991 outbreaks in turkeys, have been in Norfolk, with a few cases in Suffolk and Herefordshire (Alexander 1982, 1995); these are all counties with over one quarter of their 10 km squares classed as high priority in the maps. In April 2006 there was an outbreak of the H7N3 strain of LPAI in three premises close to Dereham, Norfolk (DEFRA 2006). These premises were situated in a high-priority 10 km square, but the exact route of primary introduction remains unknown. In January 2007, a large commercial turkey premises in Suffolk was confirmed as having H5N1 of a similar strain to that found in Asia; however, the primary

source of incursion for this outbreak appeared to have been transfer within the poultry industry. A lack of any cases of H5N1 in the local wild bird populations, despite intensive surveillance of dead wild birds and wild bird droppings on the infected premises for virological examination, together with the ornithological and molecular genetic studies of the virus isolates from the outbreaks in Hungary and GB in 2007, supports this conclusion (DEFRA 2007). In November 2007, H5N1 was confirmed in a free-range turkey flock on the Norfolk/Suffolk border that also contained free-range ducks and geese on the same holding. This premises is located within a rank 1 square; however, the route of introduction is currently under investigation. No cases of H5N1 have been found in wild birds in GB since the whooper swan at Cellardyke in April 2006 (World Organisation for Animal Health [OIE] 2007); however, given the huge and dynamic wild bird populations in GB, there would be little chance of detecting the disease if it were present at low levels. Until now, the majority of wild birds that have been found to be infected with H5N1 in the world have died or been sick, and there have been few isolations of H5N1 from free-living, outwardly healthy birds; there is little evidence that they can carry the virus without showing clinical signs (Feare and Yasue 2006, Normile 2006b, Feare 2007). Current GB surveillance relies on reports of dead birds and mass die-offs. Coupled with targeted surveillance for these events, it is believed that there is a good chance of detecting H5N1 early, if it were present.

The maps should be regarded as adaptive, in that the thresholds at which the squares are ranked as high priority may be reviewed, depending on the number of birds reported and the resources available for collecting and analysing them. They can also be updated to incorporate new wild bird or poultry data or additional species if the international situation changes or new information becomes available. As more is learned about the epidemiology of avian influenza, the assumptions made in Table 1 may be adapted and refined. By using 10 km squares, the maps provide a rapid and standardised means of identifying priority areas. However, wild birds and poultry are not distributed uniformly within the 10 km squares, and particular sections of the squares may be more important. Furthermore, whereas poultry are essentially static for much of the time, wild birds of some species may move large distances. Gulls, for example, may feed at one or more sites during the day and roost at another site up to 50 km away (Horton and others 1983). Counts of birds from different surveys should indicate the varying use of sites, so no allowance has been made for such effects by including neighbouring squares or a wider buffer zone around priority squares. In addition, by focusing on the likelihood of incursion, the role that wild birds may play in subsequent spread of the disease has not been considered. Additional carrier species may play a role in spreading the virus from wild birds to poultry, but it is thought that infected poultry would have little opportunity to spread the disease to wild birds owing to the rapid speed at which HPAI causes poultry to die (Alexander 1995).

The GB Poultry Register provides the best source of population data for GB poultry, but there is the possibility of low-level site duplication, double counting of birds and non-registration of holdings, which may influence the 10 km squares identified as high priority. Furthermore, there is significant underrepresentation of smaller premises with fewer than 50 birds, most of which are likely to be kept outdoors. Registration for this sector is not compulsory, so it is not possible to estimate the number or distribution of these holdings. If registration is extended to small holdings the maps may be adapted to include them, and the additional data may have a significant effect on the surveillance priority areas owing to the large numbers involved. The analyses of the effects of changes in the assumptions showed that the estimates of risk were particularly sensitive to assumptions about the size of the holdings. Many interrelated factors may affect the risk of incursion, and size may act as a proxy for several of these; furthermore, the uncertainties surrounding the assumptions are large. These uncertainties should be borne in mind when using the maps to define priority surveillance areas, and local knowledge, coupled with ornithological and epidemiological expertise, should also be used.

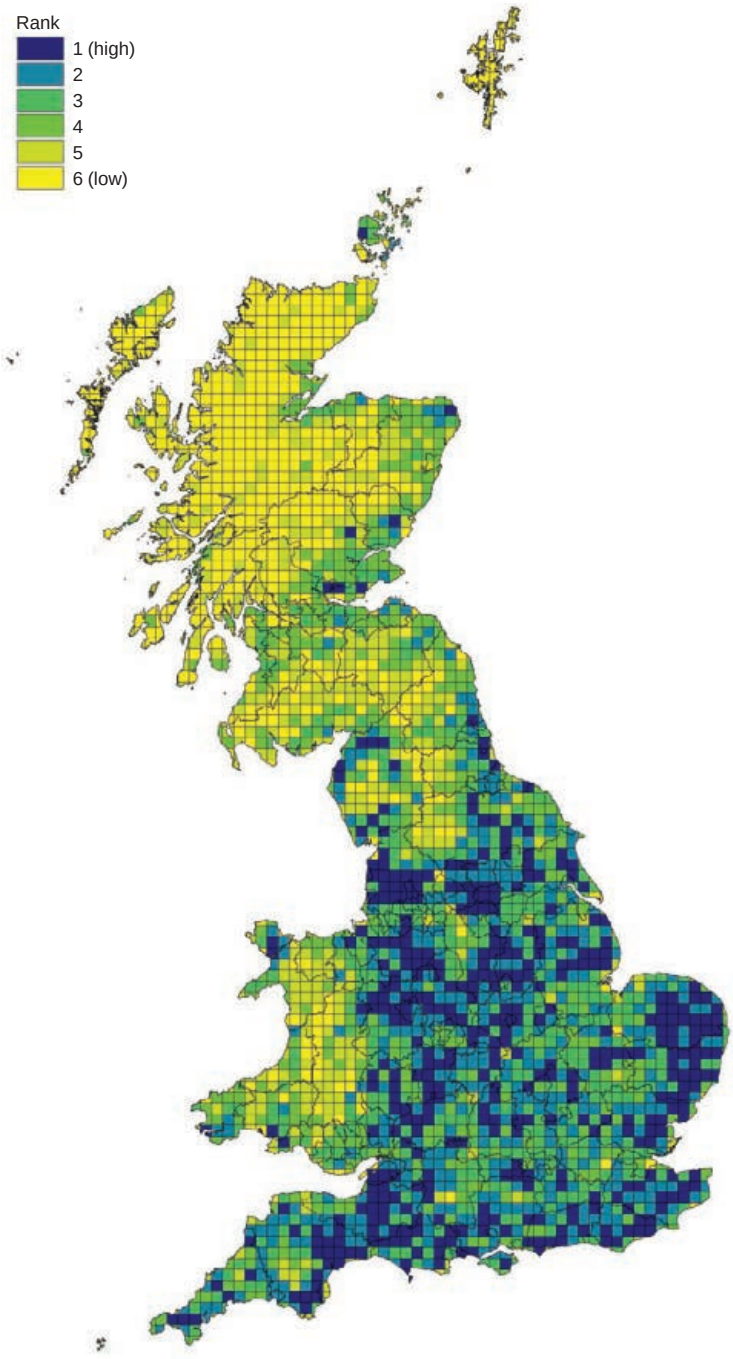

FIG 3: Map showing the areas of Great Britain where the probability of incursion of H5N1 is likely to be highest (ranked 1 to 6 in order of high to low risk), prepared by combining the data shown in Figs 1 and 2

For the wild bird data, the use of several data sources should have reduced the biases associated with particular surveys, although the residual level of bias remains uncertain. Gamebirds have not been included in the maps owing to uncertainties about the data, but they may pose significant risks because they are kept outdoors for much of their

lives and are frequently moved between premises for shoots. Preliminary work to assess the effect of including pheasants and partridges among the outdoor poultry suggested that there would be little change in the overall risk profile.

Because of the qualitative nature of this work and the considerable uncertainties that affect the risks of incursion, particularly in the poultry sector, the maps cannot be used to predict where the next outbreak might occur or where the next infected wild bird might be found. Poultry producers, regardless of whether they are located in a high- or low-risk area, must maintain good biosecurity and good management practices to minimise contact between their poultry and wild birds and thus reduce the risk of an outbreak of avian influenza.

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EXECUTIVE SUMMARY: BROILER CHICKENS

1. H5N1 (Highly Pathogenic) Avian influenza (HPAI) has the potential to cause significant impacts on human health and the economics of the poultry industry. The disease has been identified in both wild bird populations and domestic flocks, so the infection of free-range broiler chickens from wild bird sources is a real possibility.

2. The overall risk of HPAI transmission to broiler chickens from wild birds is very low. Infection rates in wild populations are low, few species migrate to the UK from regions where the disease is more common, these "high risk" species are rare on poultry farms and infected wild birds probably have impaired migration and movement abilities. Advice about "relatively high" risks needs to be taken in this context. Differences between farms or habitats should, therefore, be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high.

3. Few species representing higher risks of AI transmission were associated with poultry farms, with the exception of gulls. This group was the one most commonly seen flying over farms, but gulls rarely observed on the ground and there was no evidence that they were attracted to poultry fields in practice. The absolute level of risk of AI transmission from wild birds, even if the virus were present in the local populations of the higher risk species, therefore appears to be low.

4. Among the wild bird species that appeared to be attracted to farms, the features that attracted them most were perches (trees and man-made structures), spilt grain and fallow/rough land. Perched birds could potentially present an AI risk via defecation onto the ground, while fallow/rough land can provide both seed and invertebrate food resources for wild birds that could attract them to feed alongside poultry. Minimizing the occurrence of these features in chicken areas would reduce chicken contact with wild birds, but the benefits might be small in practice because the wild birds involved do not represent high AI risks. It is also noted that the planting of trees/shrubs is becoming standard practice to encourage chickens better to utilise the range area. Given the lower susceptibility of chickens than other poultry types to AI and the welfare benefits, it seems unlikely that the marginal extra risk of infection from tree and shrub planting would justify changing this practice.

5. In general, the landscape around farms was more important than features within the farm as an influence on use by wild birds. Gulls were most common at farms near to rubbish tips. Waterbirds, migratory species of which present the highest risk of carrying AI, were not found on chicken farms, but are found on or around large waterbodies (lakes, reservoirs, washlands and open estuaries, the latter especially where they have peripheral salt or grazing marshes). Infection via both of these species groups is most likely to occur via hypothetical, so-called "bridge species" (animals that carry infected material physically from habitats where carriers are found to poultry farms) or other means (e.g. via human agents). This means that farms closer to rubbish tips and large waterbodies are likely to be at greater risk of AI transmission and that it would be preferable to site farms at least several kilometres from these habitats. Note, however, that this applies within the context of the overall low risk of AI infection from wild birds and that the lower susceptibility of chickens than other poultry types means that this may be less of an issue.

6. Patterns of migration of AI risk species into and out of the UK are diverse, so there is no obvious, clearly delimited "risk period". However, movements from areas of relatively high AI incidence all occur in the autumn. Collation of autumn migration patterns across species suggests that risks may be greatest in September to November, with October probably seeing

the largest numbers of higher risk birds arriving overall. Not enough is known about the relative likelihood of any of the species concerned actually carrying HPAI to be more specific on the precise period of highest risk. The timing of movements also varies annually with weather conditions.

EXECUTIVE SUMMARY: LAYER CHICKENS

1. H5N1 (Highly Pathogenic) Avian influenza (HPAI) has the potential to cause significant impacts on human health and the economics of the poultry industry. The disease has been identified in both wild bird populations and domestic flocks, so the infection of free-range layer chickens from wild bird sources is a real possibility.

2. The overall risk of HPAI transmission to layer chickens from wild birds is very low. Infection rates in wild populations are low, few species migrate to the UK from regions where the disease is more common, these "high risk" species are rare on poultry farms and infected wild birds probably have impaired migration and movement abilities. Advice about "relatively high" risks needs to be taken in this context. Differences between farms or habitats should, therefore, be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high.

3. Few species representing higher risks of AI transmission were associated with poultry farms, with the exception of gulls. This group was the one most commonly seen flying over farms, but gulls rarely observed on the ground and there was no evidence that they were attracted to poultry fields in practice. The absolute level of risk of AI transmission from wild birds, even if the virus were present in the local populations of the higher risk species, therefore appears to be low.

4. Among the wild bird species that appeared to be attracted to farms, the features that attracted them most were perches (trees and man-made structures), spilt grain and fallow/rough land. Perched birds could potentially present an AI risk via defecation onto the ground, while fallow/rough land can provide both seed and invertebrate food resources for wild birds that could attract them to feed alongside poultry. Minimizing the occurrence of these features in chicken areas would reduce chicken contact with wild birds, but the benefits might be small in practice because the wild birds involved do not represent high AI risks. It is also noted that the planting of trees/shrubs is becoming standard practice to encourage chickens better to utilise the range area. Given the lower susceptibility of chickens than other poultry types to AI and the welfare benefits, it seems unlikely that the marginal extra risk of infection from tree and shrub planting would justify changing this practice.

5. In general, the landscape around farms was more important than features within the farm as an influence on use by wild birds. Gulls were most common at farms near to rubbish tips. Waterbirds, migratory species of which present the highest risk of carrying AI, were not found on chicken farms, but are found on or around large waterbodies (lakes, reservoirs, washlands and open estuaries, the latter especially where they have peripheral salt or grazing marshes). Infection via both of these species groups is most likely to occur via hypothetical, so-called "bridge species" (animals that carry infected material physically from habitats where carriers are found to poultry farms) or other means (e.g. via human agents). This means that farms closer to rubbish tips and large waterbodies (lakes or reservoirs) are likely to be at greater risk of AI transmission and that it would be preferable to site farms at least several kilometres from these habitats. Note, however, that this applies within the context of the overall low risk of AI infection from wild birds and that the lower susceptibility of chickens than other poultry types means that this may be less of an issue.

6. **Patterns of migration of AI risk species into and out of the UK are diverse, so there is no obvious, clearly delimited "risk period". However, movements from areas of**

relatively high AI incidence all occur in the autumn. The presence of layer chickens outside all year round does not, therefore, present any appreciably greater risk than is associated with broilers that have seasonal peaks in numbers. Collation of autumn migration patterns across species suggests that risks may be greatest in September to November, with October probably seeing the largest numbers of higher risk birds arriving overall. Not enough is known about the relative likelihood of any of the species concerned actually carrying HPAI to be more specific on the precise period of highest risk. The timing of movements also varies annually with weather conditions.

EXECUTIVE SUMMARY: TURKEYS

1. H5N1 (Highly Pathogenic) Avian influenza (HPAI) has the potential to cause significant impacts on human health and the economics of the poultry industry. The disease has been identified in both wild bird populations and domestic flocks, so the infection of free-range turkeys from wild bird sources is a real possibility.

2. The overall risk of HPAI transmission to turkeys from wild birds is very low. Infection rates in wild populations are low, few species migrate to the UK from regions where the disease is more common, these "high risk" species are rare on poultry farms and infected wild birds probably have impaired migration and movement abilities. Advice about "relatively high" risks needs to be taken in this context. Differences between farms or habitats should, therefore, be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high.

3. Few species representing higher risks of AI transmission were associated with poultry farms, with the exception of gulls. This group was the one most commonly seen flying over farms, but gulls rarely observed on the ground and there was no evidence that they were attracted to poultry fields in practice. The absolute level of risk of AI transmission from wild birds, even if the virus were present in the local populations of the higher risk species, therefore appears to be low.

4. Among the wild bird species that appeared to be attracted to farms, the features that attracted them most were perches (trees and man-made structures), spilt grain and fallow/rough land. Perched birds could potentially present an AI risk via defecation onto the ground, while fallow/rough land can provide both seed and invertebrate food resources for wild birds that could attract them to feed alongside poultry. Minimizing the occurrence of these features in turkey areas would reduce turkey contact with wild birds, but the benefits might be small in practice because the wild birds involved do not represent high AI risks. It is also noted that the planting of trees/shrubs is becoming standard practice to encourage turkeys better to utilise the range area. Given the higher susceptibility of turkeys to AI than other poultry types, it would be precautionary to pay more attention to these issues on turkey farms. In particular, a solution to the tree problem that maintains turkey welfare benefits would be only to plant shrubs, which do not provide perches for crows, rooks and jackdaws, the most important risk species here.

5. In general, the landscape around farms was more important than features within the farm as an influence on use by wild birds. Gulls were most common at farms near to rubbish tips. Waterbirds, migratory species of which present the highest risk of carrying AI, were not found on turkey farms, but are found on or around large waterbodies (lakes, reservoirs, washlands and open estuaries, the latter especially where they have peripheral salt or grazing marshes). Infection via both of these species groups is most likely to occur via hypothetical, so-called "bridge species" (animals that carry infected material physically from habitats where carriers are found to poultry farms) or other means (e.g. via human agents). This means that farms closer to rubbish tips and large waterbodies are likely to be at greater risk of AI transmission and that it would be preferable to site farms at least several kilometres from these habitats. Note, however, that this applies within the context of the overall low risk of AI infection from wild birds. Nevertheless, the greater susceptibility of turkeys than other poultry types means that this may be a particular concern for turkey farms.

6. Patterns of migration of AI risk species into and out of the UK are diverse, so there is no obvious, clearly delimited "risk period". However, movements from areas of relatively high

AI incidence all occur in the autumn. Collation of autumn migration patterns across species suggests that risks may be greatest in September to November, with October probably seeing the largest numbers of higher risk birds arriving overall. Not enough is known about the relative likelihood of any of the species concerned actually carrying HPAI to be more specific on the precise period of highest risk. The timing of movements also varies annually with weather conditions.

EXECUTIVE SUMMARY: HOUSED TURKEYS

1. H5N1 Avian influenza has the potential to cause significant impacts on human health and the economics of the poultry industry. The disease has been identified in both wild bird populations and domestic flocks, so the infection of poultry kept for meat and eggs from wild bird sources is a real possibility. For housed birds, however, this possibility can be removed by effective biosecurity.

2. The overall risk of HPAI transmission to turkeys from wild birds is very low. Infection rates in wild populations are low, few species migrate to the UK from regions where the disease is more common, these "high risk" species are rare on poultry farms and infected wild birds probably have impaired migration and movement abilities. Advice about "relatively high" risks needs to be taken in this context. Differences between farms or habitats should, therefore, be interpreted as being between "a low risk" and "a not quite so low risk", rather than between low and high.

3. The landscape around farms affects potential use of farms by wild birds. Nearby rubbish tips and large waterbodies (lakes, reservoirs, washlands and open estuaries, the latter especially where they have peripheral salt or grazing marshes) mean that relatively high risk species (gulls and migratory waterbirds, respectively) can be close enough that hypothetical, so-called "bridge species" (animals that carry infected material physically from habitats where carriers are found to poultry farms) or other means (e.g. human agents) could bring AI onto a farm site. It would, therefore, be preferable to site farms at least several kilometres from these habitats. Note, however, that this applies within the context of the overall low risk of AI infection from wild birds and that proper biosecurity measures would negate this potential threat.

4. Patterns of migration of AI risk species into and out of the UK are diverse, so there is no obvious, clearly delimited "risk period". However, movements from areas of relatively high AI incidence all occur in the autumn. Collation of autumn migration patterns across species suggests that risks may be greatest in September to November, with October probably seeing the largest numbers of higher risk birds arriving overall. Not enough is known about the relative likelihood of any of the species concerned actually carrying HPAI to be more specific on the precise period of highest risk. The timing of movements also varies annually with weather conditions.
5. The species of most concern found in surveys of four housed turkey farms in East Anglia were gulls, corvids, stock doves, feral pigeons, pied and grey wagtails, house sparrows and starlings. These all present a relatively high risk of bringing AI into the area as well as of contact with poultry if sheds are not biosecure. Of these species, gulls and pied wagtails may present the biggest risk of bringing AI from a nearby water source, but are unlikely to enter shed roof spaces. Contamination is therefore likely to be via another bridge species such as feral pigeons that are far more likely to enter sheds. In theory, nesting holes could allow infected or bridge species birds into sheds in the breeding season, but the species likely to use such holes are low in AI risk, the spring is not a period when AI incursion is likely and no turkeys are housed in sheds at this time, so absolute risk levels from this route for infection are probably very low. Moreover, again, effective biosecurity would mean that all bird activity outside sheds is irrelevant to AI infection risk.