Department
for Environment
Food & Rural Affairs

Risk Assessment on the spread of High Pathogenicity Avian Influenza (HPAI) H5N1 to wild birds from released, formerly captive gamebirds in Great Britain: Pheasants

Qualitative Risk Assessment

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Contents

Risk Assessment on the spread of High Pathogenicity Avian Influenza (HPAI) H5N1 to wild birds from released, formerly captive gamebirds in Great Britain: Pheasants 1

Qualitative Risk Assessment 1

Executive summary 5

Background 8

Hazard Identification 14

Definitions 14

Risk Questions 15

- Scope 15
- Assumptions 17

Risk Assessment 20

- Terminology related to the assessed level of risk and uncertainty 20
- Likelihood calculations 21

Entry assessment 22

- Likelihood, p_1, a captive pheasant is infected with HPAI H5N1 prior to release and is released while infectious 23
- Likelihood, p_2, that a pheasant in a released flock of pheasants is infected with HPAI H5N1 after release 24

Exposure assessment 25

- Estimated number of contacts resulting in an infection between wild bird groups and pheasants, assuming infected pheasants are present in high numbers in each habitat 25
- Estimated number of contacts resulting in an infection between wild bird groups and pheasants 29

Results: Aggregated likelihood of infection of one or more wild birds at a release site 32

Calculation of aggregated probabilities 32

Risk question 1 33

Risk question 2 36

Summary of results 38

Consequence Assessment....39

Uncertainty 40

Areas for further work.... 42

Conclusions....42

References....44

Appendix A: Calculation of aggregated probabilities 46

Risk question 1: Calculation of aggregated probability, that is the probability that one or more wild birds are infected from pheasants released at a release site during July and August in Great Britain. 47

Risk question 2: Calculation of aggregated probability, that is the probability that one or more wild birds are infected from pheasants amplifying H5N1 after release at a site during July and August in Great Britain.... 48

Executive summary

In Great Britain, pheasants are released from captivity during July and August in large numbers (tens of millions) for the purpose of shooting later in the year. This year (2022) is unprecedented in that sustained transmission of high pathogenicity avian influenza virus (HPAIV) H5N1 has been maintained in wild birds across Great Britain over the summer. The wild bird species mainly affected over the summer have been seabirds breeding at multiple coastal sites around Great Britain. Additionally, resident Canada geese, mute swans and mallard ducks have been infected at some inland sites and there are also several reports of raptor species being infected including buzzards, red kites and hen harriers. In previous years the national risk of HPAIV H5 in wild birds in Great Britain has been classified as low over the summer months with wild bird cases a very rare event over the summer. However, currently (August 2022), this risk is still at MEDIUM. In the face of this exceptional scenario, the qualitative risk assessment presented here addresses the additional risks posed to wild birds by the activity of releasing large numbers of pheasants from captivity in July and August in Great Britain.

The risk assessment considers transmission of HPAIV to wild birds from pheasants infected at a release site before release (risk question 1; RQ1) and from pheasants infected after release (risk question 2; RQ2). This risk assessment considers the release of large numbers of pheasants in excess of wild bird populations at an individual release site. It does not consider the total number of release sites across Great Britain, and it does not consider release sites where smaller numbers of pheasants are released.

The release of gamebirds within an avian influenza restriction zone is not allowed and so the assessment for RQ1 is restricted to the Free Area (FA). The likelihood for pheasant to wild bird transmission is, therefore, considered negligible in the Protection Zone (PZ) and Surveillance Zone (SZ). Pheasants may have already been released before the establishment of a PZ or SZ, so these areas are considered for RQ2.

Ten wild bird groups are considered, namely Anseriformes (ducks, geese and swans), pigeons, birds of prey, owls, passerines (finches and sparrows), corvids, seabirds (skuas, sea terns, auks, gannet), waders, gulls and wild pheasants (pheasants that were released in previous seasons). Eleven habitats are considered; namely woodlands, scrub, heathlands, grasslands, mountains, rocky habitats, wetlands, freshwaters and coastal habitats (as defined by the British Trust for Ornithology, BTO), and farmland and urban habitats.

The risk assessment concludes that, in the FA in July and August 2022, the overall likelihood of HPAIV transmission to wild birds from pheasants infected with HPAIV before release is high to very high for Anseriformes, birds of prey, corvids, waders, gulls and wild pheasants and medium for pigeons, owls and passerines but negligible for seabirds. The overall likelihood of infection of one or more wild birds ranges from medium to very high in all habitat types except coastal habitats, mountains, and rocky habitats.

The risk assessment also concludes that in the FA in July and August 2022, the overall likelihood of HPAIV transmission to wild birds from pheasants infected with HPAIV after release is very high for Anseriformes, birds of prey, corvids, waders, gulls, and wild pheasants, high for owls and passerines, medium for pigeons, and negligible for seabirds. The overall likelihood of infection of one or more wild birds ranges from high to very high in all habitat types except coastal habitats, mountains, and rocky habitats. These likelihoods are the same in PZ and SZ.

The aggregated likelihood of HPAI H5N1 infection of one or more wild birds by released pheasants at a release site during July and August is estimated by aggregating the likelihood that each captive pheasant is infected before release (RQ1) or after release (RQ2) with the estimated number of effective wild bird and pheasant contacts (meaning contacts that would result in an infection of the wild bird). This was done for each habitat and for each bird group. The estimates of effective contacts are based on the expected abundance of wild birds present in each group in those habitats in Great Britain in July and August, the behaviour of those birds that may expose them to infection from released pheasants (given pheasants are present in high numbers) and the likelihood that pheasants are present in the habitat. Central to the calculation of the aggregated risk of infection of one or more wild birds is the likelihood that a wild bird contact is with an infected pheasant (as opposed to an uninfected pheasant).

For captive pheasants infected prior to release (RQ1), the aggregated likelihoods of infection of other wild birds (per release site) over July and August are estimated to be very high for corvids and wild pheasants in farmland and woodland habitats. The likelihood of infection in gulls is estimated to be very high in farmlands, and high in wetlands. For birds of prey the exposure is high in these habitats, but the likelihood of transmission to birds of prey is increased to very high because they eat the carcases of pheasants and therefore are exposed to higher viral loads. Waders and resident Anseriformes (ducks, geese and swans) have a high aggregated likelihood of transmission from pheasants in wetlands. For seabirds, the aggregated likelihood of HPAIV infection from released pheasants is negligible. For both passerines (finches and sparrows) and pigeons the aggregated likelihood is very high, but the risk of spread to pigeons and passerines is reduced to medium because of their suspected greater resistance to HPAIV compared to other wild bird species. For RQ1, the habitats with very high aggregated likelihoods of one or more transmissions to wild birds per pheasant release site are farmland, wetland and woodland.

For captive pheasants infected with HPAIV after release (RQ2), with the exception of seabirds, pigeons and passerines the likelihood of one or more infections in wild birds (per release site) is very high for all other bird groups considered (Anseriformes, birds of prey, owls, corvids, waders, gulls and wild pheasants). The exposure to pigeons and passerines is also very high but the risk is reduced to medium for pigeons and reduced to high for passerines because of their suspected greater resistance to HPAIV H5. The likelihood of exposure to seabirds is negligible. All habitats other than coastal habitats, mountains, scrub and rocky habitats are of concern: farmland, freshwaters, wetlands, urban habitats, and woodland are considered to have very high likelihoods of transmission of HPAIV from released naïve pheasants to wild birds.

The uncertainty is addressed here. It is proposed that the uncertainty for the high to very high risks predicted here for various bird groups and habitats is high. This is due to the unprecedented nature of the 2021 to 2022 HPAI epizootic and the limited data available on pheasant numbers and release site locations, wild bird abundance at release sites, susceptibility of some wild bird families and, importantly, contact rates between released pheasants and wild birds.

This risk assessment concludes that, during an exceptional season such as the year 2022, when there is continual HPAI circulation in Great Britain wild bird populations (wild bird risk is still at MEDIUM in July and August) the release of several millions of captive pheasants during July and August 2022 has a very high likelihood of infecting one or more wild birds with HPAI H5N1 in the vicinity of release sites in many types of habitat. As well as the welfare impact of released pheasants becoming infected with HPAI, these susceptible pheasant populations could result in maintenance of HPAI H5N1 in the other wild bird populations and ultimately lead to increased infection pressure to resident wild birds over the late summer and early autumn, before migratory waterfowl species arrive in Great Britain in late autumn.

This risk assessment does not take into account the large number of pheasants released at multiple sites across Great Britain. The results presented here for RQ1 apply to a single release site where a small proportion of the pheasants are infected at point of release. Due to the incubation period and the two-day time it takes to develop signs in infected pheasants, there is a chance that infected birds may not be spotted and would be released. The aggregated probability for RQ1 is the probability that one or more wild birds of a given wild bird group within a given habitat release site are infected around the release site where a low proportion of the pheasants are infected at point of release. After release, more of those pheasants will become infected by wild birds and/or by those "released and now wild" pheasants due to the medium probability that wild birds are infected nationally. The aggregated probability for RQ2 relates to a release site where a medium proportion of the pheasants are infected after release.

This risk assessment does not consider the full picture across Great Britain in terms of the number of pheasant release sites. Clearly a release site where none of the released pheasants are infected only presents a risk to wild birds when these pheasants become infected through wild bird contact after release (RQ2). On the basis that the current risk (July and August 2022) to poultry is LOW, it may be assumed that a low proportion of the pheasant release sites across Great Britain have infected pheasants in the case of RQ1. This increases to a medium proportion of the pheasant release sites across Great Britain in the case of RQ2.

Further work could assess the number of infected pheasant release sites across Great Britain. There are limited data on pheasant numbers and the locations of release sites, which could be collected at premises registration. On the basis that the national risk to poultry with poor biosecurity is estimated to be low (July and August 2022), a small proportion of these sites across Great Britain may be infected at point of release. According to the results of the Rapid Risk Assessment here, each of these would present a very high risk of infecting certain groups of wild birds, particularly in woodland and farmland habitats.

Background

The first report this season (2021 to 2022) of HPAI H5N1 in the UK was in a wild bird rescue centre in Worcester on 26 October 2021. To 25 August 2022, HPAI H5N1 has been confirmed at 111 poultry and captive bird premises in England, 11 premises in Scotland (including one in the Shetland Islands) and 5 premises in Wales. Migratory wild waterfowl departed in large numbers from late March and are expected to start to return from September with a peak in December or January. To 25 August 2022, there have been 1,572 HPAI H5 detections in wild birds, in 371 locations involving 61 species in 82 counties. Of the wild birds sampled during passive surveillance, the species of wild birds affected by HPAI in mainland Great Britain have varied throughout the current 2021 to 2022 season, including a greater variety of wild bird species overall compared to previous seasons. An increasing proportion of birds of prey and raptor species and other resident species (Passeriformes, Columbiformes) have become infected as the outbreak has progressed. More recently, many seabirds (Charadriiformes) including gannets, gulls, terns, guillemots and great skua have become infected throughout the summer months in an unprecedented epizootic, and sedentary species of geese and ducks (Anseriformes) have become infected at inland sites. The risk of HPAI H5 infection in wild birds in Great Britain was reduced from high to **MEDIUM** on 23 May 2022 as a result of the decreasing infection pressure in wild bird species and the reduced environmental contamination/virus survivability due to warmer temperatures and extended periods of high intensity sunlight (Kurmi et al. 2013). The 2021 to 2022 HPAI season has had an uncharacteristically long tail to the epizootic in Great Britain with an order shift in the species of wild birds that have been detected, as described in previous reports, and an unprecedented third peak in wild birds across Europe, with seabirds heavily represented during June, July and August, when these birds form colonies to breed (EFSA et al., 2022).

The unprecedented spread of HPAI H5N1 through breeding seabirds in Great Britain (and north-western Europe) over the summer has resulted in an uncoupled risk to these particular wild birds from the poultry risk and the risk to other wild bird species. Given the uncoupling of this part of the wild bird infection pressure on poultry risk and the high environmental temperatures, the risk of HPAI exposure to poultry and captive birds across the whole of Great Britain in late July was reduced to **LOW** (with low uncertainty for stringent biosecurity measures, but high uncertainty where biosecurity is sub-optimal). The Avian Influenza Prevention Zone (AIPZ), in place since 15 October 2021, was lifted in Great Britain on 16 August 2022.

By mid-August each year, many of the seabird species (auks in particular) are starting to disperse out to sea, although gannets and some skuas may remain until well into September. However, there is evidence of HPAIV H5N1 infections in resident mallard ducks, Canada geese and mute swans that remain at inland sites in Great Britain and the wild bird risk is therefore maintained at **MEDIUM** (25 August 2022) and indeed for the first time may not fall to LOW before the arrival of the migratory ducks, geese and swans in the autumn.

Estimates of the number of pheasants in the UK vary. Madden (2021) estimated that 31.5 million pheasants are released in the UK every year whereas Aebischer (2019) estimated the same number at 47 million (95% Confidence Interval (CI): 39 to 57 million). The Great Britain poultry register showed 50.6 million pheasants and partridges in Great Britain (Aebischer 2019). Of these, 50% are usually imported, mostly as eggs from France ([The Game Farmer's Association](#)).

Before the start of the shooting season, gamebirds are not expected to range far from their release sites. Roughly 60% to 80% of pheasants are expected to survive to the start of the shooting season (1 October) in the absence of HPAI (Figure 1), with 37.5% of released pheasants shot by hunters and, by the end of shooting season, approximately 16% are expected to survive (Turner and Sage, 2003). On average around 60% of pheasants released for shooting at seven sites in the UK did not end up being shot (Figure 2; Madden et al. 2018) and most of these were predated or scavenged. The 4 main explanations for avoiding being shot were predation, disease, starvation and dispersal.

Figure 1 The survival of 325 radio-tagged pheasants after release into open-topped pens (Turner and Sage, 2003).

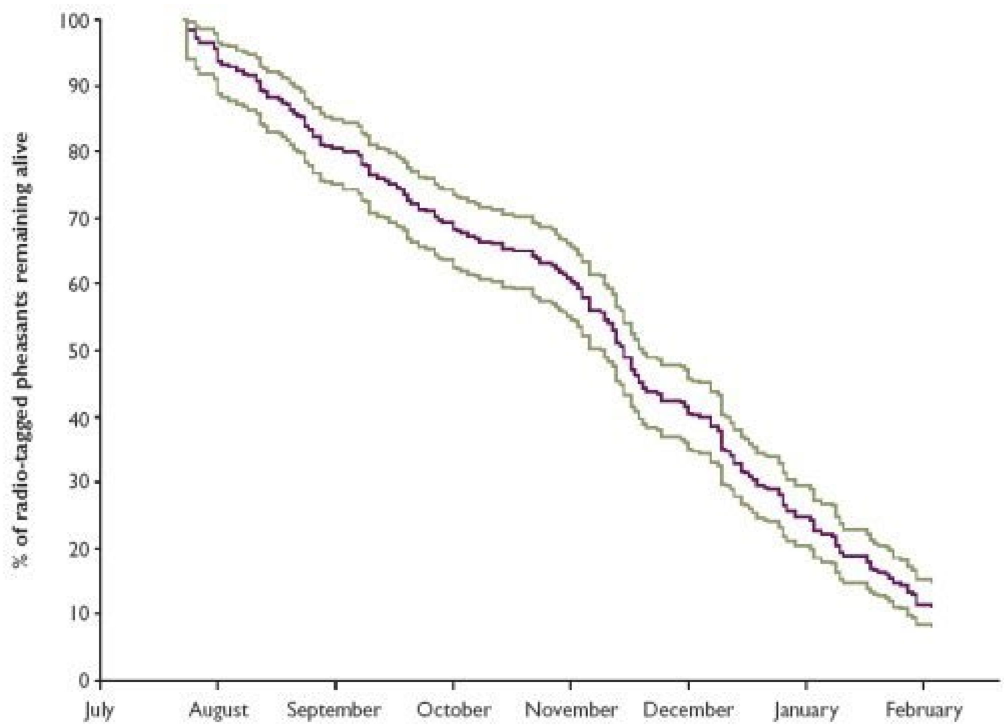
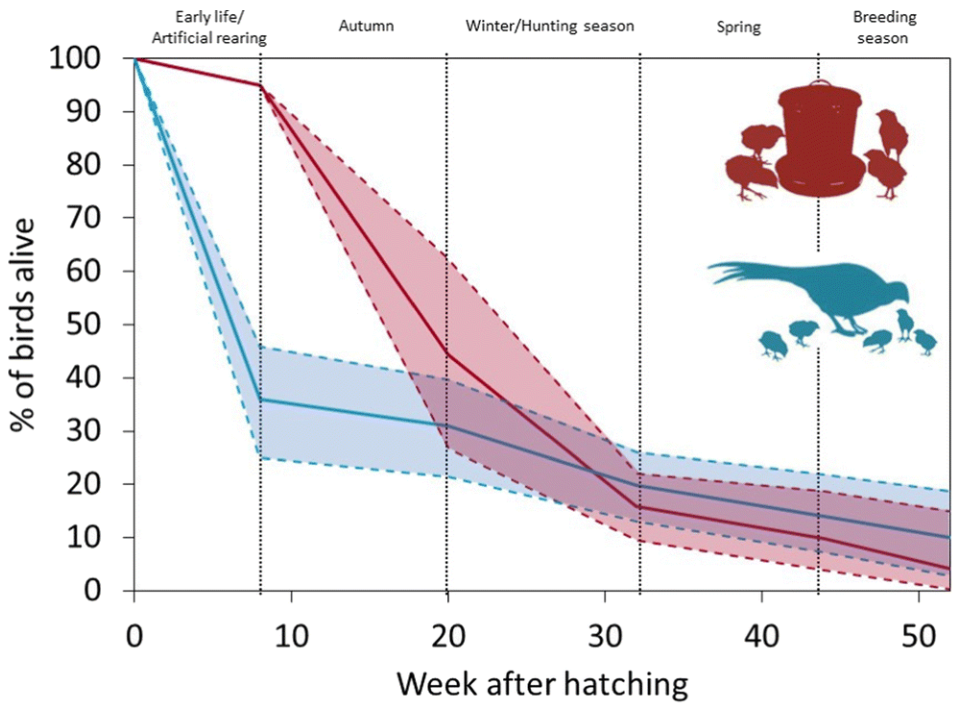


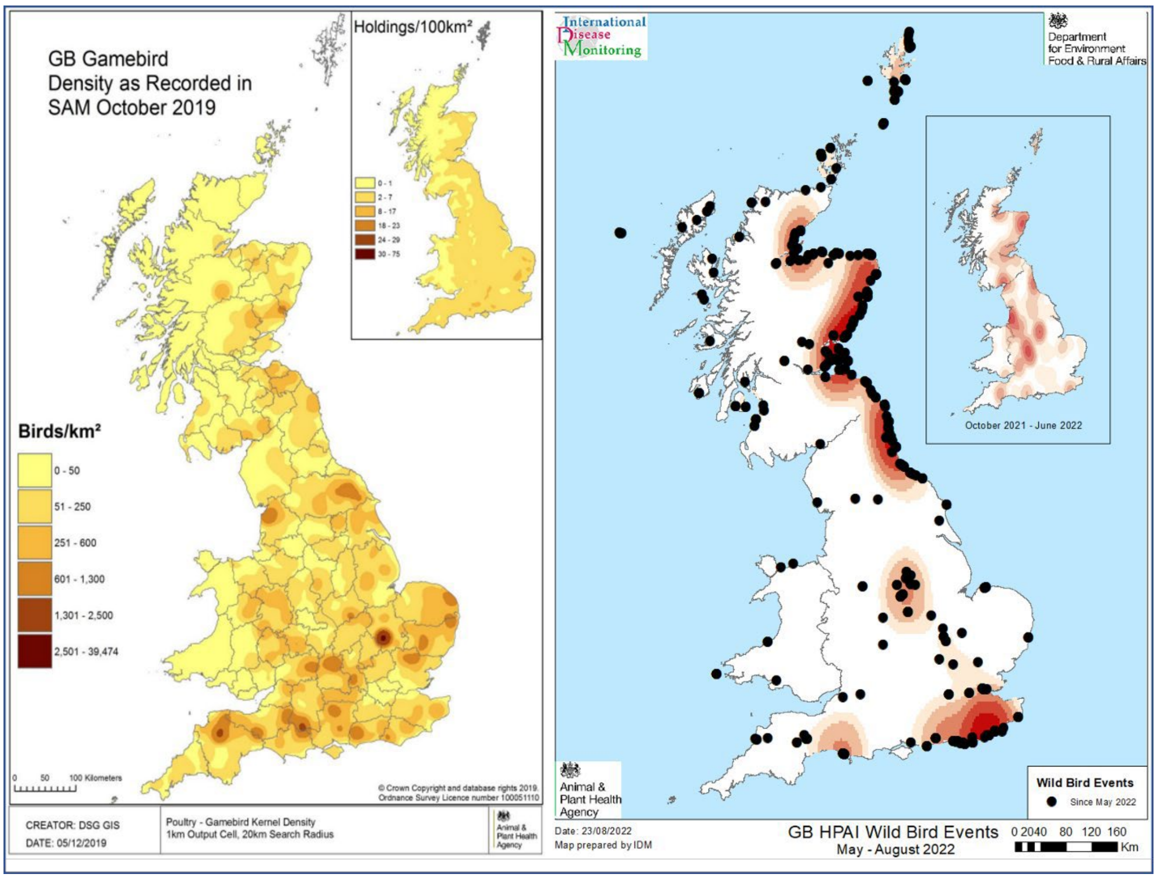
Figure 2 Mean survival of reared (red) and wild (blue) pheasants from hatching for one year. Taken from Madden et al. (2018).



Data on dispersal by reared pheasants in the UK is limited. However, before the start of the shooting season, gamebirds are not expected to range far from their release sites and estates will continue to provide supplementary feed to ensure a steady supply of released birds during the season. Turner (2007) tracked the movements of 334 radio-tagged pheasants at 6 large shooting estates in southern England. The maximum distances moved from the release pen (prior to the start of the shooting season) ranged from just 32m up to 4,685m across individuals. On average the furthest distance individuals had moved away from the release pen was 913m. Overall, 90% of pheasants' home ranges of around 280 hectares (a circle with a radius of 940m).

The numbers of birds released varies around the UK, with some areas of higher gamebird densities than others (Figure 3). However, imports of gamebirds from France have not been possible in 2022 due to HPAI and trade restrictions, although imports from other countries have gone ahead. As such there is anecdotal evidence that there have been substantially fewer captive gamebirds released this year than previous years (Ornithological Expert Panel, August 2022). While this reduces the numbers of pheasants in Great Britain overall, there is anecdotal evidence to suggest that some release sites are still at full capacity, while some shoots will not take place at all this year (Ornithological Expert Panel, August 2022). There is some overlap of areas with high game bird densities from 2019 (Figure 3 left) and areas of high HPAIV H5N1 in wild birds from October 2021 to June 2022 (Figure 3 right inset) although there are also areas with high game bird densities and low wild bird cases such as across East Anglia and the home counties.

Figure 3 *Left*: Captive gamebird densities across Great Britain as recorded in SAM in 2019. Gamebirds are made up of multiple species, including pheasants, partridge and ducks reared for shooting or for consumption or breeding birds for such purposes. *Right*: Map of Great Britain showing the relative density of positive HPAI H5 findings in wild birds as shading from May to August 2022, and the most recent findings reported in July as black dots. Inset map shows the relative densities of positive HPAI H5 findings in wild birds from October 2021 to June 2022.



The release of large numbers of gamebirds such as pheasants prior to shooting season given the presence of HPAI H5N1 in wild birds is relevant for several reasons:

1. The UK is in the unprecedented situation in 2022 of having HPAI H5N1 present at **MEDIUM** risk levels in wild birds over the summer at the same time that huge numbers of pheasants are to be released.

This poses a potential risk of infection of pheasants – either before or after release. Wild birds coming from coastal areas, particularly where mass mortality events have been observed and HPAI has been detected, could present higher risks.

2. It is well known that pheasants are susceptible to infection with HPAI H5N1, this has been determined through experimental infection studies. investigation of report cases concerning pheasants and the testing of wild pheasants submitted via the APHA wild bird surveillance scheme, via which several large die off events in pheasants have been reported in 2022 (National Reference Laboratory, Weybridge; data in press).

3. The potential for wild birds to come into contact with infected released pheasants leading to HPAI transmission from infected pheasants. Examples of wild birds which could contact pheasants include gulls (black-headed, Mediterranean, herring, lesser-black-backed), corvids (carrion crows, hooded crows, magpies, ravens) and raptors. Pheasant feeding sites are known to attract wild birds (Madden et al. 2018) promoting interaction and virus transmission, and infected pheasant carcasses could transmit infection to raptor species including buzzards and owls.

4. The number of gamebirds released. It is estimated that over 40 million pheasants and partridges are released each year in Great Britain (Aebischer 2019, Madden 2021). This is a substantial number when compared, for example, to the number of wild naturally occurring ducks, geese and swans which overwinter in the UK (74,000 mute swans, 210,000 teal, 440,000 wigeon and 710,000 mallards winter in the UK (RSPB)). The concern is that the release of these gamebirds could provide an additional source of susceptible birds which could serve as a reservoir of H5N1 and present a mechanism to maintain the virus in Great Britain over the late summer/early autumn in the months leading up to the arrival of large numbers of migratory wild birds. This could be similar to the maintenance of HPAI observed in seabirds breeding over the summer months around the coast of Great Britain where there has been evidence of spill over into resident wild bird species such as mallards, mute swans and Canada geese at inland sites during July and August.

5. Studies show that around 70% of those released pheasants are still alive in October when migratory waterbirds arrive to overwinter in the UK (Figure 1; Turner and Sage, 2003) and, if harbouring circulating virus, they could present a population where viral re-assortment could occur when exposed to potential new virus strains introduced to Great Britain by migratory waterbirds.

Hazard identification

The hazard identified is the high pathogenicity avian influenza virus (HPAI) H5N1 as this is the predominant subtype isolated from the UK during the current season to date (H5N8 was detected in one mute swan in November 2021, but not since). Continued circulation of this virus in resident birds in Great Britain at this time of year, when pheasants are being released, is unprecedented.

Definitions

For this risk assessment the following definitions apply:

Gamebird: this term is used to refer specifically to pheasants in this assessment, unless explicitly stated otherwise.

Captive gamebirds: gamebirds that are enclosed in pens that have not been allowed outside of the pens via gates. The pens may have open or closed tops and birds will still be considered captive.

Released gamebirds: gamebirds that have been released from pens this season via the opening of gates. These birds are considered released regardless of any management practices for example, feeding or health checks. Birds may be allowed to re-enter the pens via funnels or pop holes and will still be considered released.

Wild gamebirds: gamebirds that were released from pens in previous seasons or those born outside of captivity. This does not include gamebirds that were released this season, although they are considered to be wild under law.

Note that, in this assessment, the term ‘pheasant’ refers to released pheasants unless otherwise stated.

Risk questions

The specific risk questions addressed are:

RQ1: In July and August 2022, what is the probability (risk) that a flock of captive pheasants are infected with HPAI H5N1 prior to release, are infectious at the point of, or shortly after, release and go on to infect one or more wild birds after release?

RQ2: In July and August 2022, what is the probability (risk) that a flock of released, naïve pheasants are infected with HPAI H5N1 after release and go on to infect one or more wild birds?

For RQ1 and RQ2:

Is the probability (risk) different in a PZ/SZ and in the free area?

Are there any wild bird species or habitats for which there is increased risk?

Scope

This assessment is only applicable to the current HPAI 2021 to 22 season, when HPAIV H5N1 was sustained in breeding wild birds within Great Britain over the summer. Previous or subsequent HPAI seasons are outside the scope of this assessment.

This assessment considers only HPAI H5N1 during the 2022 epizootic in Great Britain.

This assessment considers the release of large numbers of pheasants in excess of wild bird populations at an individual release site. As such, the results may not apply to release sites where pheasant numbers do not exceed wild bird numbers in the area, and it does not consider the full number of release sites across Great Britain. If the pheasants are not in excess of the number of wild birds, then the number of contacts increase with both wild bird numbers and pheasant numbers and is more difficult to estimate.

This assessment only considers the risk of HPAI H5N1 transmission to wild birds from released pheasants that were previously captive in the current season (2022). The release of gamebird species other than pheasants is outside the scope of this assessment.

The assessment considers the risk to ten different wild bird groups chosen to represent a range of species with high abundance and/or high pheasant contacts (Table 1). Wild pheasants are included due to their greater numbers compared with other gamebirds such as partridges and quail, known susceptibility to HPAI H5N1 and presumed similar behaviour and habitat choice to released pheasants. Other wild gamebird species are excluded from this assessment. A total of 11 wild bird habitats as defined by BTO are considered, namely: coastal habitats, freshwaters, grasslands, heathlands, mountains, rocky habitats, scrub, wetlands and woodlands. Farmland habitats and urban habitats are also considered.

Table 1: The ten bird groups included with examples of species that are considered in the assessment.

Group	Examples
Anseriformes	Ducks, geese and swans
Pigeons	Woodpigeons, collared doves (does not include feral doves in towns)
Birds of prey	Hawks, buzzards, eagles, harriers and falcons
Owls	Tawny owl, Barn Owl, Short-eared Owl, Little Owl
Corvids	Crows, ravens, magpies and jays
Seabirds	Skuas, sea terns, auks, gannet
Gulls	Black-headed gull, Herring gull
Waders	Plovers, sandpipers
Small passerines	Sparrows and finches
Pheasants	Common Pheasant (wild pheasants, as defined above)

This assessment does not consider the direct or indirect risk of HPAI H5N1 transmission from released gamebirds to poultry, other captive birds or wild bird species or groups that are not listed, although some of the outputs may be applicable to wild birds with similar behaviours and abundances as those listed.

This assessment does not consider the direct or indirect risk of HPAI H5N1 transmission from poultry to captive or released gamebirds.

The risks from shooting gamebirds and risks from gathering up are not within the scope of this assessment.

Assumptions

This assessment assumes that pheasants can be infected by HPAI and show clinical signs such as ruffled feathers, reluctance to move, green faeces, neurological sings and/or sudden mortality (Brookes et al 2022). The incubation period in pheasants is expected to be short, between a few hours and seven days (commission decision 2005/94/EC) and HPAI is assumed to spread rapidly within the pheasant flock with high mortalities.

The results presented here for RQ1 apply to a release site where a small proportion of pheasants are infected prior to release. The aggregated probability for RQ1 is the probability that one or more wild birds of a given wild bird group within a given habitat release site are infected around the release site where a low proportion of the pheasants (as represented by p_1) are infected at point of release. After release, more of those pheasants will become infected by wild birds and/or by the "released and now wild" pheasants due to the medium probability that wild birds are infected. The aggregated probability for RQ2 relates to a release site where a medium proportion of the pheasants (as represented by p_1) are infected through wild bird contact after release.

This risk assessment does not consider the full picture across Great Britain in terms of the number of pheasant release sites. Clearly a release site where none of the released pheasants are infected only presents a risk to wild birds when released pheasants become infected after release through wild bird contact (RQ2). On the basis that the current risk (July to August 2022) to poultry is LOW, it may be assumed that a low proportion of the pheasant release sites across Great Britain involve release of infected pheasants in the case of RQ1. This increases to a medium proportion of the pheasant release sites across Great Britain in the case of RQ2 because the pheasants are wild birds for which the national risk is medium.

The methodology in this risk assessment is based on the assumption that a large number of pheasants are released at each site compared to the number of wild birds over a small area and that the released pheasants do not disperse too far (Turner 2007). The exact number of pheasants at a release site is not required for this risk assessment. While increasing the number of pheasants from one to 1,000, for example, increases the number of pheasant and wild bird contacts by a 1,000-fold (either direct contacts or indirect contact via aerosol or environmental contamination), the impact on the transmission risk may be lower because the pheasants are in excess of the wild birds at a release site by orders of magnitude.

The risk assessment does not assume that infection of any captive or released pheasants results in a large number of infected pheasants in the flock. Instead, the fraction of infected pheasants in a flock is based on current national risk levels (low for RQ1 and medium for RQ2) as worst cases.

Wild birds will not be displaced by pheasants and indeed are considered to be attracted by the feed and habitat management. For example, it is assumed that corvids, gulls and birds of prey would be exposed to carcases by scavenging and passerines would be exposed to droppings on the ground or on the feed spilt on the ground.

Transmission of HPAIV from pheasants to wild birds is assumed to be both direct bird-to-bird exposure and indirect exposure through respiratory secretions and faecal contamination in the environment for example, on soil and feed containers. While the virus will decay in the environment more rapidly in the months of July and August compared to autumn and winter, it is assumed here that high pheasant densities around the release site would mean frequent wild bird contacts with pheasant secretions/faeces and that environmental decay would have little impact. This is supported by the unprecedented transmission of HPAIV H5N1 through seabirds in Great Britain this summer despite high temperatures and long hours of sunlight and the continued detection of HPAI in poultry premises over the summer months. Therefore, decay of the virus in the environment is not explicitly considered here.

The exposure assessment developed here is based on the estimated number of **effective contacts** between wild birds and released pheasants. An effective contact is a direct or indirect contact that results in infection of the wild bird for example through close contact, contact with environmental contamination or from scavenging infected carcases. It is assumed here that that the number of wild bird contacts with pheasants at a site is directly related to the number of wild birds of a given species present at the release site. This is because the pheasants are in excess over wild birds at the release site. Given that thousands of pheasants are typically released at each site, this is a reasonable assumption. Indeed, the pheasants released in Great Britain for shooting contribute significantly to the wild bird biomass in Great Britain (Blackburn and Gaston, 2021), although the exact percentage contribution varies with season. According to Blackburn and Gaston (2021) around a quarter of British bird biomass annually is contributed by common pheasants and red-legged partridges, and that at their peak in August these two species represent about half of all wild bird biomass in Britain. Since pheasants greatly outnumber wild birds at the release site, the number of effective contacts between different wild bird individuals and pheasants is directly related to the wild bird abundance at a given habitat. Consider one wild bird among a flock of pheasants; the number of contacts it makes with pheasants increases with the number of pheasants released. However, since that one wild bird can only be infected once, the number of effective contacts made cannot exceed one. In contrast, increasing the number of wild birds directly increases the number of effective contacts. Therefore, the risk assessment approach used here does not need to know the number of pheasants released at each site, only the number of wild birds at a site. Although this would be expected to vary throughout Great Britain and in different seasons, we consider only July and August here when released pheasant numbers are maximum and therefore only account for the habitat around the release site.

The estimated number of effective contacts between wild birds and released pheasants is based on the estimated abundance of wild birds at the release site and the expected behaviour of those wild birds. It assumes that an effective contact results in wild bird infection and does not take into account the wild birds' immunological condition/natural resistance that could make wild birds more or less susceptible to HPAI H5N1 infection. We reduce the likelihood of infection of pigeons and passerines from released pheasants accordingly to take into account suspected greater resistance to infection. However, there is uncertainty in this. It should be noted that several pigeons and passerine species have been reported in the current epizootic. Moreover, the large number of sparrowhawk recoveries is consistent with infection of small passerines which are unlikely to be detected through other means.

It is assumed here that the wild bird abundance at a habitat, and the probability of pheasant presence in a habitat, reflects that in the months of July and August in Great Britain, and is based on this author's expert opinion.

In the exposure assessment, the combination of the qualitative probabilities of pheasant presence with the qualitative number of effective contacts is subjective and based on the authors' expertise.

Risk assessment

Terminology related to the assessed level of risk and uncertainty

For the purpose of the risk assessment, the risk levels are defined in Table 2, uncertainty in Table 3 and consequence in Table 4.

Table 2 Terminology and definitions used for qualitative risk assessment (adapted from EFSA 2006; Bessel et al., 2020; De Vos et al., 2020)

Qualitative statement	Definition from EFSA
Negligible	Event is so rare that it does not merit to be considered
Very low	Event is very rare but cannot be excluded
Low	Event is rare but does occur
Medium	Event occurs regularly
High	Event occurs very often
Very high	Event occurs almost certainly

Table 3 Ratings used to describe the level of uncertainty (EFSA, 2015)

Name	Explanation
Low	No or limited information or data are lacking, incomplete, inconsistent or conflicting. No subjective judgement is introduced. No unpublished data are used.
Moderate	Some information or data are lacking, incomplete, inconsistent or conflicting. Subjective judgement is introduced with supporting evidence. Unpublished data are sometimes used.
High	The majority of information or data are lacking, incomplete, inconsistent or conflicting. Subjective judgement may be introduced without supporting evidence. Unpublished data are frequently used.

Table 4 Terminology used to describe the consequence assessment (FAO and WHO, 2021)

Level	Descriptor	Expanded description
1	Insignificant	Insignificant impact; little disruption to normal operation; low increase in normal operation costs
2	Minor	Minor impact for small population; some manageable operation disruption; some increase in operating costs
3	Moderate	Minor impact for large population; significant modification to normal operation but manageable; operation costs increased; increased monitoring
4	Major	Major impact for small population; systems significantly compromised and abnormal operation, if at all; high level of monitoring required
5	Catastrophic	Major impact for large population; complete failure of systems

Likelihood calculations

p The likelihood that each individual pheasant in a flock of captive pheasants is infected with HPAIV prior to release (p_1 for RQ1) and after release (p_2 for RQ2).

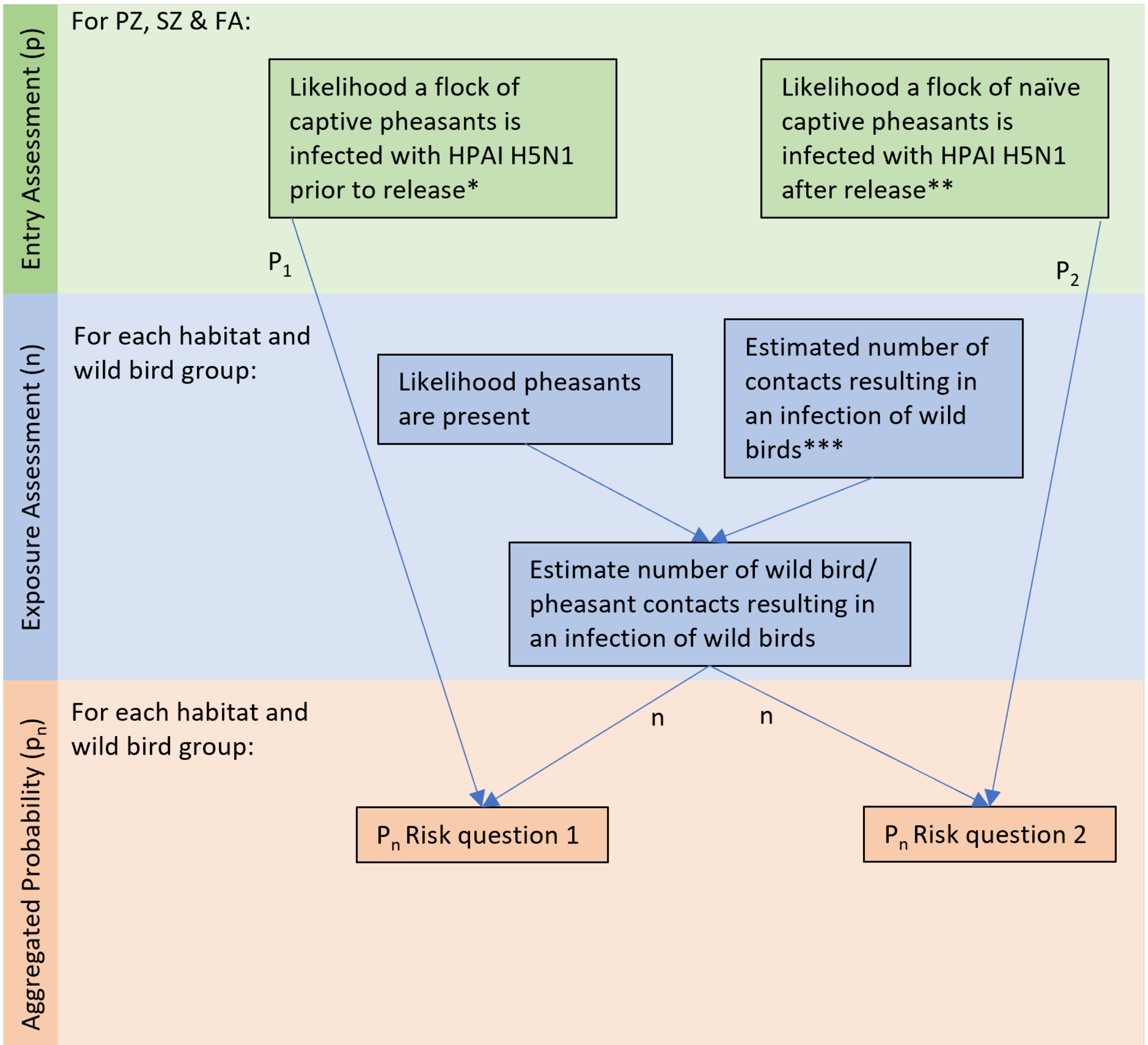
n Estimated number of effective contacts (meaning released pheasant andwild bird contacts that result in infection of wild birds).

p_n Aggregated likelihood.

This assessment considers the likelihood of infection of different groups of wild birds (Table 1) from released pheasants in different habitats. The risk pathways for the entry and exposure assessments are shown in Figure 4.

For each risk question, the aggregated likelihood, p_n, is calculated qualitatively using the qualitative likelihood per unit, p, and the quantitative number, n, of effective contacts using the method of Kelly et al. (2018) as shown later in Figure 5.

Figure 4 Pathways showing estimation of aggregated likelihood based on Kelly et al. (2018).



* The national likelihood that poultry with poor biosecurity are infected with HPAI H5N1

** The national likelihood that wild birds are infected with HPAI H5N1

*** Assuming infected pheasants are present in high numbers, and estimated based on expert opinion of abundance and behaviours of wild birds

Entry assessment

At this unprecedented late stage of this year's epizootic (July and August 2022), the wild migratory waterfowl which are presumed to have introduced HPAI H5N1 virus into Great Britain in the autumn of 2021 have long since departed, so the focus in the entry assessment is not on the likelihood of introduction of new strains of HPAI H5N1 virus from outside Great Britain. Instead, the entry assessment considers the likelihood that individual captive pheasants (risk question 1) and released pheasants (risk question 2) are infected in an infected flock.

The HPAI H5 virus has been circulating over the summer in breeding sea birds including gannets, auks, skuas, terns and gulls which breed in colonies either on cliffs or in coastal lagoons. These birds have now started to range further from the colonies as juveniles fledge. During July and August 2022 there are also cases of H5N1 in resident ducks, geese, gulls, moorhens and mute swans inland together with some raptor species, albeit in relatively small numbers compared to coastal areas.

Likelihood, p_1, a captive pheasant is infected with HPAI H5N1 prior to release and is released while infectious

The national probability that poultry with poor biosecurity are infected with HPAI H5N1 was LOW albeit with high uncertainty in July and August 2022. While this represents the probability that a flock is infected in Great Britain, this probability is also used here for the probability that an individual captive pheasant in an infected flock is infected at point of release. There is high uncertainty because of the variety of biosecurity levels between pheasant release pens such as whether they are open- or closed-topped prior to release.

Captive pheasants are inspected on release and are indicator species meaning they show clinical signs and have high mortality. Therefore, some suspected infected pheasants are likely to be identified before release and mitigation measures implemented to prevent release and stamp out disease in the flock. However, the infected pheasants may be released just hours after infection such that they are not showing clinical signs, and there may be high base-level daily mortality in pheasants, so disease is not suspected or reported. For this reason, it is considered that the likelihood of a captive pheasant being infectious upon release cannot be lower than low. There is considerable uncertainty around the detection of clinical signs of H5N1. There are no clinical signs during the incubation period which in Galliformes including pheasant is expected to be short between a few hours and 7 days (commission decision 2005/94/EC). Also, the relatively high baseline mortality rates could result in pheasant deaths from HPAI not constituting excessive deaths (Brookes et al., 2022).

For the purpose of the aggregated risk calculation, it is assumed that the probability, p_1, that each of the individual pheasants in the infected flock is infected at point of release is LOW (high uncertainty).

The likelihood that a flock of captive pheasants is infected with HPAI H5N1 and subsequently released in a Protection Zone (PZ) or Surveillance Zone (SZ) is considered NEGLIGIBLE (low uncertainty) since in these areas it would be illegal to release pheasants or to move them from a captive site to a release site without a licence (Defra, 2019).

Likelihood, p_2, that a pheasant in a released flock of pheasants is infected with HPAI H5N1 after release

This pathway considers pheasants that were not infected with HPAI H5N1 while captive and are naïve to the disease upon release. After release, gamebirds are considered to be wild birds. Released pheasants are not expected to dispel far from their release sites (Turner, 2007). The level of management that released pheasants receive will vary by release site; birds may be able to re-enter release pens and may continue to be fed by gamekeepers. Therefore, released pheasant behaviour will differ from other wild birds, and possibly from wild pheasants that were released in previous seasons. Continued management could also mean shared personnel, feed and equipment from one release pen to another. The probability of infection in wild birds across Great Britain is currently (August) MEDIUM, and the likelihood of infection of released pheasants from wild birds is considered to be the same, with high uncertainty since this will not be uniform across Great Britain. Indeed, this risk will be specific to each release site and the released pheasants' home range; release sites in some areas may be at more or less risk depending on geography, wild bird abundance and infection pressure and management practices.

Released pheasants may also be infected by other released pheasants they share a home range with – including those that were infected while they were captive. The likelihood that a released pheasant is infected by captive pheasants that were infected in captivity and released while infectious is considered to be LOW (high uncertainty) in a FA, and NEGLIGIBLE (low uncertainty) in a PZ or SZ (see above).

The entry level assessment considers that the likelihood that an individual pheasant in a released flock of pheasants is infected with HPAI H5N1 after release in a FA as MEDIUM (high uncertainty). The likelihood that an individual pheasant in a released flock of pheasants is infected with HPAI H5N1 after release in a PZ or SZ is considered MEDIUM (moderate uncertainty). Accepting that it is illegal to release them once the PZ/SZ is in place, the keeper may have started to release them, in good faith, before the zones are implemented. The reduced level of uncertainty in these areas is because the presence of a PZ or SZ means that there is a known infection pressure in that particular area. For the purpose of the aggregated risk calculation, it is assumed that the probability, p_2, that each individual pheasant in the infected flock is infected after release is MEDIUM.

Exposure assessment

Estimated number of contacts resulting in an infection between wild bird groups and pheasants, assuming infected pheasants are present in high numbers in each habitat

The number of effective contacts between wild birds and pheasants which we would expect to result in wild bird infection if all pheasants were infected is estimated qualitatively for each bird group in each habitat. This is not a probability of exposure, but a qualitative estimate of the number of effective contacts. For the purpose of this risk assessment the qualitative estimates of the number of contacts in are interpreted quantitatively for use in the determination of the aggregated likelihood (Appendix), as shown in Table 5.

Table 5 Qualitative terminology used to describe the estimated number of contacts between wild birds and infected pheasants at a release site that result in an infection. The quantitative interpretation is used to determine the aggregated likelihood (Appendix).

Estimated number of wild bird-pheasant contacts that result in wild bird infection	Qualitative interpretation of numbers of effective contacts
0	Negligible
1	Very low
2 to 10	Low
10 to 100	Medium
100 to 1,000	High
1,000 to 10,000	Very high

The estimated number of effective contacts in Table 6 is based on the estimated number of wild birds in each group that might be present at the release site combined with the likelihood of contact of a wild bird with pheasants due to behaviour and feeding strategy of the wild bird. These estimates specifically relate to the months of July and August in Great Britain. For example, many passerine species such as warblers tend not to feed on the ground but instead feed in the foliage of trees in woodland habitats. They would therefore not be exposed to pheasants which feed on the ground. However other passerines such as finches and sparrows would feed on the ground often in large numbers and would be attracted to the pheasant feeding areas. Overall, the number of effective passerine contacts with pheasants in woodland (given pheasants are present) is estimated to be very high (Table 6).

Although wintering diving duck species may spend a lot of time in deep water, away from pheasants, resident dabbling ducks (mallards, gadwall), mute swans and Canada geese spend time foraging on the banks. These birds are abundant in Great Britain over the summer at fresh water/wetland sites and could mingle with pheasants (given they are present in large numbers) coming to drink. As a result, the number of effective contacts for Anseriformes is high to very high (Table 6). Similarly, corvids and gulls spend much time feeding on the ground where they may contact pheasant faeces, while birds of prey, gulls and corvids could feed upon pheasant carcases.

As set out in the Assumptions section above, the number of wild birds present directly impacts the contact rate between wild birds and pheasants. For example, the presence of geese on farmland in summer in Great Britain is relatively uncommon compared to winter (when migratory geese such as pink-footed goose and brent goose are present on farm fields in very large numbers). The number of contacts of Anseriformes with released pheasants on farmland is therefore estimated to be medium (Table 6).

Game management in Portugal was associated with higher abundance of raptors and ground-nesting birds on partridge shoots (Sage et al. 2020). This could reflect both increase food and habitat suitability. Buzzards have increased in the UK alongside pheasant releasing in recent decades suggesting a link (Sage et al. 2020) although other factors may be responsible. Release managers reported tawny owl, sparrowhawk and buzzard as the main problems at release sites with some buzzards specialising in taking pheasant poults. Some of the techniques thought to improve woodlands for pheasants (for example, coppicing, skylighting, shrubby edges and wide rides may be beneficial to other wildlife particularly birds, including songbirds and warblers in the pheasant woods (Sage et al. 2020). Additionally, Sage et al. (2020) reported a greater abundance of songbirds and more species in winter game woods than non-game woods. Providing supplementary food for released gamebirds through feeders is practised on most release-based shoots. A wide range of farmland birds and mammals use these feeders improving over-winter survival and breeding numbers of seed-eating farmland birds.

As described in the Assumptions section above, the number of **effective** wild bird and pheasant contacts in Table 6 (that is contacts between different wild bird individuals and pheasants which result in infection) is directly related to the wild bird abundance and behaviour at a given habitat. This is because the pheasant numbers are assumed to be in excess of wild birds at the release sites.

Table 6 Estimated number of effective wild bird contacts (direct or indirect) with infected released pheasants at a release site assuming infected pheasants are present at the habitat in high numbers, irrespective of the habitat preference of pheasants.

Habitat Type	Anseriformes[1]	Pigeons	Birds of prey[2]	Owls	Passer-ines	Corvids	Seabirds	Waders	Gulls	Pheasants
Coastal Habitats	Medium	Medium	Low	Low	Low	Medium	Medium	Very high	Very high	Low
Farmland	Medium	Very high	Medium	Medium	High	Very high	Neg	Low	Very high	Very high
Freshwaters	High	Low	Low	Low	Low	Medium	Neg	High	High	Low
Grasslands	Medium	Medium	Medium	Medium	Medium	High	Neg	Medium	Medium	High
Heathlands	Neg	Medium	Medium	Medium	Medium	High	Neg	Neg	Neg	High
Mountains	Very low	Very low	Medium	Low	Medium	Medium	Neg	Low	Neg	High
Rocky Habitats	Neg	Neg	Medium	Low	Medium	Low	Neg	Low	Low	High
Scrub	Neg	Medium	Medium	Low	Medium	Medium	Neg	Neg	Neg	High
Wetlands	Very high	Medium	Medium	Low	Medium	Medium	Neg	Very high	Very high	Low
Woodlands	Neg	Very high	Medium	Medium	Very high	Very high	Neg	Neg	Neg	Very high
Urban Habitats	Medium	High	Low	Low	Medium	High	Neg	Neg	High	Low

[1] Resident ducks, geese and swans (notably mallards, some gadwall, shelduck, mute swans and Canada geese) present in Great Britain in July and August and not the autumn migratory waterbirds.

[2] Does not take into account that birds of prey scavenge pheasant carcasses and hence are exposed to high doses of virus because this is taken into account in Table 11. Although gulls and corvids would also scavenge pheasant carcases, they also use other food sources and unlike birds of prey they do not only feed on carrion or live animals.

Likelihood pheasants are present in particular habitats

The likelihood that pheasants are present or released in a particular habitat is set out for each habitat in Table 7. This is important for the risk assessment because it addresses the likelihood that pheasants would be present in a habitat where they could interact with each of the specific groups of wild birds. This is irrespective of where the pheasants were released. For example, if they were released at a coastal site, they would tend to head to the nearest farmland field or woodland rather than remain exposed in coastal habitats. In general, the probabilities in Table 7 would reflect release sites because pheasants are generally released directly into suitable habitats. Pheasants typically frequent woodlands and farmland with some spill over into grasslands and scrub habitat. Specifically, pheasants are birds of the woodland edge (Sage et al. 2020) and game managers tend to locate release pens and focus any management work in these areas, including improved shrub cover and wood edge characteristics.

Table 7 Likelihood that pheasants are present in each habitat type (where they can interact with the specific wild birds species that live in that habitat) during summer in **Great Britain** (based on expert opinion)

Habitat type	Likelihood of presence of pheasants
Coastal habitats	Negligible
Farmland	Very high
Freshwaters	Low
Grasslands	Medium
Heathlands	Medium
Mountains	Very low
Rocky habitats	Very low
Scrub	Low
Wetlands	Low
Woodlands	Very high
Urban habitats	Low

Estimated number of contacts resulting in an infection between wild bird groups and pheasants

Table 8 estimates the number, n, of effective contacts between wild birds and pheasants at each habitat, taking into account the likelihood that pheasants are present at such habitats (Table 7) and the number of contacts (Table 6) given that they were present in high numbers, and all are infected. This is a subjective process as we are combining a likelihood and a number of contacts. In effect the likelihood of pheasants being present in Table 7 scales the value of n in Table 6 (a negligible likelihood results in a negligible n; low or medium likelihood reduces n by a factor of 10; for high or very high likelihoods, n is the same as Table 6).

It should be stressed that the number of effective contacts between wild birds and pheasants in Table 8 (to be used in the aggregated risk calculation) does not equal the number of infected birds because only a proportion of the contacts are with infected pheasants, the same wild bird may have more than one effective contact, and the total number of effective contacts will be limited by the number of wild birds at the release site during July and August. Table 8 assumes all contacts are with infected pheasants. Thus, the probabilities p_1 and p_2 correct for the proportion of contacts which are actually with infected pheasants in the calculation of the aggregated risk.

Table 8: Estimated number of effective contacts between wild birds and released pheasants. This is calculated by combining the likelihood of pheasants being present (Table 7) with the number of contacts these pheasants would be expected to have with wild birds (Table 6). Tables 6 assumes all pheasants are infected with H5N1 and shedding virus.

Note that Table 6 has already taken into account the wild bird abundance at each habitat during the months of July and August in Great Britain.

Habitat Type	Anseri - forme s	Pigeons	Birds of prey	Owls	Passer - ines	Corvids	Sea-birds	Waders	Gulls	Pheas-ants
Coastal Habitats	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Farmland	Medium	Very high	High	Medium	High	Very high	Neg	Low	Very high	Very high
Freshwaters	Medium	Very low	Very low	Very low	Very low	Low	Neg	Medium	Medium	Very low
Grasslands	Low	Low	Low	Low	Low	Medium	Neg	Low	Low	Medium
Heathlands	Neg	Low	Low	Low	Low	Low	Neg	Neg	Neg	Medium
Mountains	Very low	Very low	Very low	Very low	Very low	Very low	Neg	Neg	Neg	Low
Rocky Habitats	Neg	Neg	Very low	Very low	Very low	Very low	Neg	Very low	Very low	Low
Scrub	Neg	Low	Low	Very low	Low	Low	Neg	Neg	Neg	Medium
Wetlands	High	Low	Low	Very low	Low	Low	Neg	High	High	Very low
Woodlands	Neg	Very high	High	Medium	Very high	Very high	Neg	Neg	Neg	Very high
Urban Habitats	Low	Medium	Very low	Very low	Low	Medium	Neg	Neg	Medium	Very low

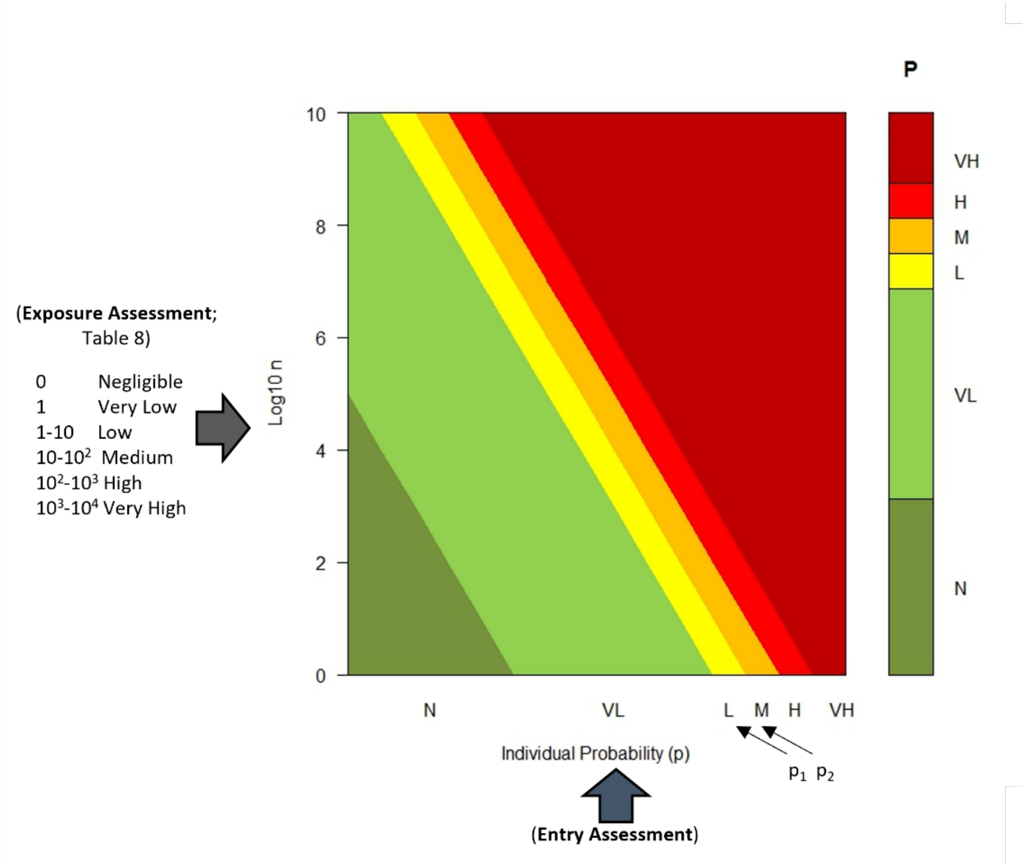
Results: Aggregated likelihood of infection of one or more wild birds at a release site

Calculation of aggregated probabilities

The aggregated probability, p_n, is the likelihood that one or more wild birds are infected through contact with pheasants given there are n wild bird/pheasant contacts and the likelihood of pheasants being infected is p_1 (RQ1) or p_2 (RQ2). The units are “per infected release site in July and August”.

The aggregated probability, p_n, is calculated qualitatively by aggregating the qualitative likelihood per unit (p_1 or p_2 in the entry assessment), and the quantitative number, n, of units (exposure assessment) using the method of Kelly et al. (2018) as shown in Figure 5. Full details can be found in the Appendix.

Figure 5: Contour plot for the aggregated probability (adapted from Kelly et al. 2018)



Risk question 1

In July and August 2022, what is the probability (risk) that a flock of captive pheasants are infected with HPAI H5N1 prior to release, are infectious at the point of, or shortly after, release and go on to infect one or more wild birds after release?

Is the probability (risk) different in a PZ/SZ and in the free area?

Are there any wild bird species or habitats for which there is increased risk?

The probability, p_1, that each individual captive pheasant is infected with HPAI H5N1 at the point of release (July to August) is the same as the current (25 August 2022) national risk that poultry with sub-optimal biosecurity are infected with H5N1. This is **LOW** with high uncertainty.

In Table 9, the aggregated likelihood of disease transmission to other wild bird species at a release site is estimated from Figure 5 (workings shown in Table 14 Appendix A). This takes into account the LOW likelihood that each pheasant in the infected flock is infected with H5N1 at point of release and the qualitative estimate of the number, n, of wild bird contacts with pheasants that result in infection as set out for each bird order in each habitat in Table 8. The units of this likelihood are “per infected release site during the months of July and August 2022”.

The aggregated likelihoods of transmission to other wild birds (per infected release site) in Table 9 are **very high** for gulls, corvids and wild pheasants. For birds of prey the exposure is high, but the risk of spread to birds of prey is increased to v**ery high** because they eat the carcases of pheasants and so are likely to be exposed to higher viral loads. Waders could have **high** exposure to infected pheasants in July and August at wetlands and **medium** exposure at freshwater sites. For seabirds, the likelihood of exposure to HPAIV from released pheasants is **negligible**. For pigeons the actual exposure is very high, but the risk of spread to pigeons is reduced to **medium** because of their greater resistance to HPAI compared to other wild bird species. Similarly for passerines (finches and sparrows) the likelihood is reduced from very high to **medium** because they are suspected to be more resistant than other bird species to HPAIV, although these is no evidence and indeed the number of sparrowhawk cases suggests otherwise. Resident Anseriformes (ducks, geese and swans) could be exposed to pheasants through farmland, freshwater sites, grasslands and wetlands, and the exposure is considered **high**.

Aggregated probabilities for each bird group in each habitat are shown in Table 9. Habitats of concern include farmland, and woodland on which there are very high likelihoods of transmission of HPAIV from released pheasants to wild birds

Table 9: Results for risk question 1 - Aggregated likelihood of H5N1 transmission to wild birds according to bird group and habitat at a release site taking into account the number, n, of effective wild bird/pheasant contacts at each habitat from Table 8 for July and August. Aggregated likelihood, p_n, calculated according to Figure 5 with probability, p_1, (based on entry assessment) of LOW.

Habitat type	Anseri-formes	Pigeons[1]	Birds of prey[1]	Owls	Passer-ines[2]	Corvids	Sea-birds	Waders	Gulls	Pheas-ants	Total
Coastal habitats	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Farm-land	Medium	Medium	**Very high**	Medium	Low	**Very high**	Neg	Low	**Very high**	**Very high**	**Very high**
Fresh-waters	Medium	Low	Medium	Low	Low	Low	Neg	Medium	Medium	Low	Medium
Grass-lands	Low	Low	Medium	Low	Low	Medium	Neg	Low	Low	Medium	Medium
Heath-lands	Neg	Low	Medium	Low	Low	Low	Neg	Neg	Neg	Medium	Medium
Moun-tains	Low	Low	Medium	Low	Low	Low	Neg	Neg	Neg	Low	Low
Rocky habitats	Neg	Neg	Medium	Low	Low	Low	Neg	Low	Low	Low	Low
Scrub	Neg	Low	Medium	Low	Low	Low	Neg	Neg	Neg	Medium	Medium
Wet-lands	**High**	Low	Medium	Low	Low	Low	Neg	**High**	**High**	Low	**Very high**
Wood-lands	Neg	Medium	**Very high**	Medium	Medium	**Very high**	Neg	Neg	Neg	**Very high**	**Very high**
Urban habitats	Low	Low	Medium	Low	Low	Medium	Neg	Neg	Medium	Low	Medium
Total	**High**	Medium	**Very high**	Medium	Medium	**Very high**	Neg	**High**	**Very high**	**Very high**	**Very high**

Total: assumes that three or more highs give a very high.
[a]Increased as birds of prey eat carcases of pheasants and so are exposed to higher viral loads
[2]Decreased as pigeons and passerines are suspected to be less susceptible to HPAIV

Risk question 2

In July and August 2022, what is the probability (risk) that a flock of released, naïve pheasants are infected with HPAI H5N1 after release and go on to infect one or more wild birds?

Is the probability (risk) different in a PZ/SZ and in the free area?

Are there any wild bird species or habitats for which there is increased risk?

The probability, p_2, that each pheasant in a released flock is infected with HPAI H5N1 after release is assumed to be **medium** with high uncertainty in the Free Area, and moderate uncertainty in a PZ and SZ. The medium probability that each pheasant in a flock is infected is consistent with the very high probability that one or more wild or released pheasants at an infected release site becomes infected on release (Table 9).

In Table 10, the aggregated likelihood of disease transmission to other wild bird species at a release site is estimated from Figure 5 (workings shown in Table 15 in Appendix A). This takes into account the MEDIUM likelihood, p_2, that each pheasant is infected with H5N1 after release and the qualitative estimate of the number, n, of wild bird contacts with pheasants that result in infection as set out for each bird order in each habitat in Table 8. The units of this likelihood are “per infected release site during the months of July and August 2022”.

The aggregated likelihoods of transmission from released pheasants to one or more wild birds (per infected release site) in Table 10 are, with the exception of seabirds, pigeons and passerines, **very high** for all bird groups considered (Anseriformes, birds of prey, owls, corvids, waders, gulls and wild pheasants). The exposure of pigeons to infected pheasants is also very high but the risk is reduced to **medium** because of their suspected lower susceptibility to HPAIV H5. Similarly for passerines (finches and sparrows) the likelihood is reduced from very high to **high** because they are suspected to be more resistant than other bird species to HPAIV. The likelihood of exposure to seabirds is **negligible**.

Table 10: Results for risk question 2 - Aggregated likelihood of H5N1 transmission to wild birds according to bird group and habitat at a release site, taking into account the number, n, of effective wild bird/pheasant contacts at each habitat from Table 8 for July and August. Aggregated likelihood, p_n, calculated according to Figure 5 with probability, p_2 (based on entry assessment) of MEDIUM.

Habitat type	Anseri-formes	Pigeons [2]	Birds of prey[1]	Owls	Passer-ines[2]	Corvids	Sea-birds	Waders	Gulls	Pheas-ants	Total
Coastal habitats	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Farm-land	**High**	Medium	**Very high**	**High**	Medium	**Very high**	Neg	Medium	**Very high**	**Very high**	**Very high**
Fresh-waters	**High**	Medium	**High**	Medium	Medium	Medium	Neg	**High**	**High**	Medium	**Very high**
Grass-lands	Medium	Medium	**High**	Medium	Medium	**High**	Neg	Medium	Medium	**High**	**High**
Heath-lands	Neg	Medium	**High**	Medium	Medium	Medium	Neg	Neg	Neg	**High**	**High**
Moun-tains	Medium	Medium	**High**	Medium	Medium	Medium	Neg	Neg	Neg	Medium	Medium
Rocky habitats	Neg	Neg	**High**	Medium	Medium	Medium	Neg	Medium	Medium	Medium	Medium
Scrub	Neg	Medium	**High**	Medium	Medium	Medium	Neg	Neg	Neg	**High**	Medium
Wet-lands	**Very high**	Medium	**High**	Medium	Medium	Medium	Neg	**Very high**	**Very high**	Medium	**Very high**
Wood-lands	Neg	Medium	**Very high**	**High**	Medium	**Very high**	Neg	Neg	Neg	Very high	**Very high**
Urban habitats	Medium	Medium	**High**	Medium	Medium	**High**	Neg	Neg	**High**	Medium	**Very high**
Total	**Very high**	Medium	**Very high**	**High**	**High**	**Very high**	Neg	**Very high**	**Very high**	**Very high**	**Very high**

Very high: three or more highs give a very high.
High: ten or more mediums gives a high.

[1]Increased as birds of prey eat carcases of pheasants and so are exposed to higher viral loads. Although gulls and corvids would also scavenge pheasant carcases, they may also use other food sources and unlike birds of prey they do not only feed on carrion or live animals.
[2]Decreased as pigeons and passerines are suspected to be less susceptible to HPAIV

Aggregated likelihoods for each bird group in each habitat are calculated in Table 10. All habitats other than coastal habitats, mountains, scrub and rocky habitats are of concern: farmland, freshwaters, wetlands, urban habitats, and woodland are considered to have **very high** likelihoods of transmission of HPAIV from released naïve pheasants to wild birds.

Summary of results

The results for each bird group from risk question 1 (Table 9) and risk question 2 (Table 10) are summarised in Table 11.

Table 11 Summary of results by bird group. Aggregated likelihoods of at least one H5N1 transmission to wild birds per release site during July and August across all habitats using the sums for risk question 1 (Table 9) and risk question 2 (Table 10).

Bird group	Risk Question 1	Risk Question 2
Anseriformes	High	Very high
Pigeons	Medium[a]	Medium[a]
Birds of Prey	Very high	Very high
Owls	Medium	High
Passerines	Medium[a]	High[a]
Corvids	Very High	Very high
Seabirds	Negligible	Negligible
Waders	High	Very high
Gulls	Very high	Very high
Wild pheasants	Very high	Very high

[a]Taking into account that risks were reduced as pigeons and passerines are suspected to be more resistant to H5N1

[b]Increased from high to very high as birds of prey are exposed to higher viral loads of H5N1

Table 12: Summary of results by habitat. Aggregated likelihoods of at least one H5N1 transmission to wild birds per release site during July and August across all habitats using the sums for risk question 1 (Table 9) and risk question 2 (Table 10).

Habitat type	Risk Question 1	Risk Question 2
Coastal habitats	Negligible	Negligible
Farmland	Very high	Very high
Freshwaters	Medium	Very high
Grasslands	Medium	High

Heathlands	Medium	High
Mountains	Low	Medium
Rocky habitats	Low	Medium
Scrub	Medium	Very high
Wetlands	Very high	Very high
Woodlands	Very high	Very high
Urban habitats	Medium	Very high

Consequence assessment

The total number of breeding birds in the UK was estimated to be 83 million pairs in 2016, according to the latest Avian Population Estimates Panel (APEP) report, the majority of which are passerines (Woodward et al., 2020). The release of over 40 million pheasants adds considerably to these numbers and provides a large number of susceptible birds which could become infected with HPAI, although this is limited to focal geographical areas surrounding release sites and so limits the impact across Great Britain.

The economic impacts of a notifiable disease such as HPAI H5N1 and the impacts on the welfare of wild birds, including pheasants, are inherently high.

For risk question 1, the unknowing release of infected pheasants in which infection has not been detected will have a high impact in the vicinity of the release site, both to the pheasants themselves and to the wild birds. Since these pheasants are released and considered wild birds, there is no requirement to implement a PZ or SZ and therefore the meat from such birds will be difficult to trace. Public health risk according to UKHSA and FSA is very low for the general public but low for people in close contact with birds.

For both risk questions the consequences of wild birds going on to be infected by wild pheasants will vary depending on the type of bird and the ecosystem, and the impact on conservation and biodiversity may be significant for some species of birds if they are present around release sites and low in numbers across Great Britain. It should be considered, however, that these impacts also apply to wild bird infections with HPAI H5N1 from other sources, since the virus is currently present and circulating in wild bird populations in Great Britain.

Although the current risk assessment only considers the situation as of July and August, these impacts could become more profound in the Autumn months with the mixing of migratory birds and different virus strains.

The consequences in this assessment could be better estimated if more information about the exact locations of pheasant release sites and the numbers of pheasants released from these were available from registered keepers. The consequences to wild birds could be reduced by considering controls around positive release sites or improved understanding of the veterinary checks that take place prior to release, along with a clearer understanding of the movement of carcases of shot wild game from areas with high prevalence of avian influenza in wild birds.

Given the potential welfare, economic and conservation impacts of HPAI transmission from released pheasants to other wild birds, this assessment considers the consequence to be **major (moderate uncertainty).** The uncertainty is due to the lack of previous HPAI epizootics of this duration, differences between infection pressures in different habitats and areas of conservation importance and the unknown short- and long-term effects that a sustained epizootic may have on the gamebird and shooting industry.

Uncertainty

The uncertainty levels are defined in Table 3. This risk assessment is by nature complex in the number and variety of interactions that occur between wild birds and pheasants in different habitats, and the approach represents a simplification of the actual transmission processes.

Risk question 1 uses the low likelihood, p_1, that each individual pheasant is infected at point of release, and this has high uncertainty, which translates through into the likelihood estimated for Risk question 1. That high uncertainty, however, relates to the fact that p_1 could be higher than low (such as medium) and therefore that high uncertainty does not in any way undermine the high/very high risks estimated here for transmissions to wild birds (Table 9). There is less uncertainty in the **medium** value for p_2 for the released pheasants since the released pheasants are wild birds and there is no biosecurity with transmission likely between the high densities of pheasants remaining around the release sites for food.

The major uncertainty in this risk assessment is in the abundance and susceptibility of wild birds and the number, n, of contacts between wild birds and pheasants at a release site that result in an infection over the months of July and August (Table 6). This can be addressed by a “sense check”. For example, a high number of effective wild bird/pheasant contacts in Table 9 and Table 10 is defined as 100 to 1,000 per site (Table 5). Though this may seem high, it is over a two month period (July and August 2022) at a site with potentially thousands of pheasants released, where feeding may still be taking place and wild birds are attracted to the site continually. A low risk level (p_1) is consistent with 1% of those pheasants being infected which is 100 infected pheasants at a site with 10,000 released pheasants. Therefore, over a period of 62 days (July/August 2022), taking 620 contacts as an example (roughly mid-way between 100 and 1,000 contacts at the site as defined for high) equates to just 10 wild bird contacts with infected pheasants at a release site per day. Since there are 100 infected pheasants in this scenario, we assume that a single infected pheasant only makes 0.1 wild bird contacts per day (which is one contact every ten days).

A high number, n, of effective contacts in Table 9 and Table 10 applies to bird groups in habitats where those wild bird species are relatively abundant. So, 10 wild bird contacts with infected pheasants (either direct or indirect) per day is realistic. Similarly, 0.1 wild bird contacts per infected pheasant per day is realistic. For a very high number, n, of effective contacts (1,000 to 10,000 per site in Table 5) and this would increase to 1 wild bird contact per infected pheasant per day which is realistic for abundant bird species in some habitats.

It is of note that each infected pheasant only sheds HPAIV for a few days. However, the carcase may be scavenged by gulls, corvids and raptors species. If several corvids or gulls peck at the same carcase then that single carcase makes multiple wild bird exposures. Similarly, faeces from a single infected pheasant dropped on food near the feeder and immediate environment could result in multiple wild bird effective exposures. Furthermore, transmission will be sustained in the released pheasants because they generally remain at the release site in high densities and congregate at feeders prior to dispersal. Indeed, the likelihood of infection of one or more wild pheasants has been estimated to be very high (Table 9).

It is proposed that, due to the limited data available and the reliance on assumptions, particularly around abundance and wild bird contacts with pheasants, the uncertainty in this assessment is **high**.

Areas for further work

Further work could assess the number of infected pheasant release sites across Great Britain. There are limited data on pheasant numbers and the locations of release sites, which could be collected at premises registration. On the basis that the risk to poultry with poor biosecurity is low, some 1% of these sites may be infected at point of release. According to the results of the RRA here, each of these would present a very high risk of infecting certain groups of wild birds particularly in woodland habitats.

The impact of the lack of imports of pheasants from France this year on pheasant numbers released is also unknown and would be helpful in assessing the risk of pheasant release on a national level. Available data on wild bird numbers and behaviours are also a limitation of this assessment, particularly with regards to the assumptions surrounding the abundance around a release site, and the number of contacts wild birds are likely to have with pheasants. Contact rates between species, particularly wildlife, are difficult to observe generally (Bacigalupo et al. 2020) although contact rates have been studied between wild birds and free-range ducks in France (Gall-Ladevèze et al. 2022).

There are several areas throughout this assessment where more information could yield more robust estimates and reduce uncertainty. For example, the susceptibility and ability of wild birds to shed virus is unknown for many species, particularly since sampling focuses on dead wild birds and may not detect birds that acquire and shed virus but do not die from disease. More information on the susceptibility of passerine species to infection in particular is needed. Serological studies across a broad range of wild bird species would be informative.

Conclusions

It is concluded that in this unprecedented year of continual circulation of HPAI H5N1 in wild birds, the release of large numbers of captive pheasants during July and August 2022 results in a very high likelihood of infecting one or more wild birds with HPAI H5N1 in the vicinity of release sites in many types of habitat. Particularly where feeding is continued post-release and the sites are therefore more attractive to wild birds. However, it is acknowledged that there is high uncertainty inherent in this assessment with a lack of data and a reliance on assumptions, many of which have been unavoidable due to the unprecedented nature of the 2021 and 2022 HPAI epizootic. As well as the welfare impact of pheasants becoming infected with HPAI, these susceptible populations could result in maintenance of HPAI H5N1 in the other wild bird populations and ultimately lead to increased infection pressure to resident wild birds over the late summer and early autumn, before migratory waterfowl species arrive in Great Britain, with implications for the success of the shooting season as well as wild bird conservation.

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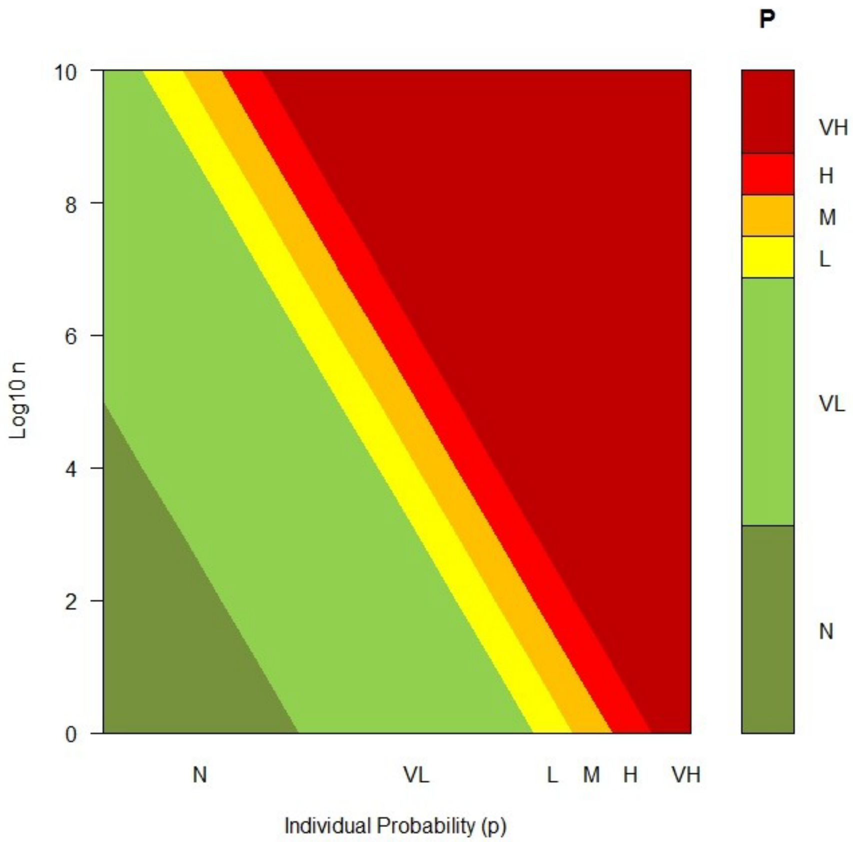
Appendix A: Calculation of aggregated probabilities

The aggregated probability, p_n, is the probability that one or more wild birds are infected through contact with pheasants given there are n wild bird/pheasant contacts and the proportion of pheasants infected is p_1. The units are “per release site in July and August”.

The aggregated probability, p_n, may be calculated qualitatively using the qualitative probability per unit, p_1, and the quantitative number, n, of units using the method of Kelly et al. (2018) as shown in Figure 6

Figure 6 Contour plot for the aggregated probability (adapted from Kelly et al. 2018)



Risk question 1: Calculation of aggregated probability, that is the probability that one or more wild birds are infected from pheasants released at a release site during July and August in Great Britain.

Here the "unit" is the probability, p_1, of infection of a wild bird per effective contact with a pheasant at a release site. An effective contact is a contact which would be expected to result in infection if the pheasant was infectious and the wild bird naïve. Given the highly infectious nature of H5N1, the probability of infection per effective contact with a pheasant therefore equates to the probability that a wild bird and pheasant contact is with a pheasant that is infectious, that is the probability that a pheasant is infected on release. Thus, p_1 for risk question 1 is simply the LOW probability that captive pheasants are infected before release, while n is the number of effective wild bird and pheasant contacts during July and August at the release site as set out for each bird group in each habitat in Table 8. The number, n, is estimated qualitatively with Figure 6 as a guide as set out in Table 14. Thus from Figure 6 for a LOW p_1, the aggregated probability, p_n, equates to the number of contacts, n.

Table 13: Risk question 1: Approach for estimation of aggregated probabilities, **Pn**, based on Figure 6 and assuming a LOW probability, p_1, that pheasants are infected before release.

p_1	Estimated number of wild bird contacts with a pheasant flock that result in an infected wild bird	Qualitative interpretation of numbers of effective contacts	P_n
Low	0	Negligible	Negligible
Low	1	Very low	Low
Low	2 to 10	Low	Low
Low	10 to 100	Medium	Medium
Low	100 to 1,000	High	High
Low	1,000 to 10,000	Very high	Very high

Risk question 2: Calculation of aggregated probability, that is the probability that one or more wild birds are infected from pheasants amplifying H5N1 after release at a site during July and August in Great Britain.

For the purpose of risk question 2, the probability p_2 that a pheasant is infected is set to MEDIUM to reflect spread of the virus in the released pheasant population. This is consistent with the medium risk of infection in wild birds in Great Britain in July and August 2022.

Table 14: Risk question 2: Approach for estimation of aggregated probabilities, P_n, based on Figure 6 and assuming a MEDIUM probability, p_1, that pheasants are infected after release.

Probability (p_2)	Estimated number of wild bird contacts with a pheasant flock that result in an infected wild bird	Qualitative interpretation of numbers of effective contacts	P_n from Figure 6
Medium	0	Negligible	Negligible
Medium	1	Very low	Medium
Medium	2 to 10	Low	Medium
Medium	10 to 100	Medium	High
Medium	100 to 1,000	High	Very high
Medium	1,000 to 10,000	Very high	Very high