Department
for Environment
Food & Rural Affairs

Highly pathogenic avian influenza (HPAI) H5 qualitative risk assessment:

Control of wild birds under general licences GL40 - 42 from January 2024 to December 2025.

Date: 27 December 2024

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Executive summary

Avian species in Great Britain considered to be a problem include certain corvids (jay, jackdaw, magpie, rook and carrion crow), pigeons (woodpigeon and feral pigeon), Canada goose, Egyptian goose and parakeets. Control of avian species by shooting could promote the movement both of the target bird species together with other bird species/assemblages in the immediate area. Although non-lethal pest control activities (scaring) also cause dispersion, shooting has a greater effect on flight distance. Control by shooting is covered under three licences, GL40, 41, and 42.

Control by shooting inevitably disturbs both the target bird species and other species in the vicinity increasing the possibility of interaction with rare and vulnerable avian species particularly on protected sites, including Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPAs), Special Area of Conservation (SACs) and Ramsars (wetlands of international importance). With high pathogenicity avian influenza (HPAI) H5 likely to be present in wild birds including problem species in Great Britain through the winter months and into spring, the aim of the risk assessment is to consider the spread of HPAI H5 to rare and vulnerable wild bird species on protected sites through management control by shooting.

The risk question is "*What is the risk that bird control allowed under the three bird licences (GL40, 41 & 42) could spread HPAI H5 to rare and vulnerable bird species when practiced on or near an SPA/SAC/SSSI/Ramsar between the months of February and May. What is the consequence to those populations and the features."* **Note February to March represent winter and April to May represent summer breeding season for the purposes of this rapid risk assessment (RRA).**

For the rare and vulnerable wild bird species, two avian seasons are considered in the risk assessment, namely breeding birds in the spring/summer (April to August) and overwintering assemblages in the autumn//winter (September to March). The breeding birds include terns, avocet, stone curlew and marsh harrier and the overwintering birds include the assemblages of waterfowl (ducks, geese and swans) and waders typically at estuary and coastal sites together with bittern and hen harrier. Other species also listed as SPA features include merlin, short-eared owl, northern goshawk, honey buzzard, sand martin, and grey heron. These have not yet been considered.

In terms of the behaviour and flight distances on disturbance of the avian target species, it is considered that the pigeons and corvids can be combined into a single group, with pigeons being considered here as the representative case because they may be disturbed in the highest numbers on shooting.

It is noted that corvids can associate in very large roosts with tens of thousands of birds including rooks, jackdaws and carrion crows, but these are rare and localised, and furthermore the risk assessment is based on 500 pigeons and 100 Canada geese, and the risks can be scaled up proportionately, that is dispersion of 5,000 rooks for example would give ten times the risk of 500 rooks.

Canada geese are considered as representative of geese, again because of their larger typical flock sizes (compared to Egyptian geese as the other goose pest). Greylag, pink-footed geese and white-fronted geese may also be controlled, and the risks would be similar to that of Canada geese, although the risk may need to be proportionately increased for flocks of geese larger than the 100 birds considered here.

The risk assessment here calculates a risk per individual disturbed target bird of infecting a rare/vulnerable wild bird species at a given habitat and combines this with the number of target birds disturbed during a management shoot event (i.e. per day) near the protected site. It is assumed 100 Canada geese, and 500 woodpigeons are dispersed per day at a shoot event near a protected site. The risk output is therefore *the probability of infection of one or more birds of a rare/vulnerable species per protected site per day with a bird management shooting event*.

It should be noted that the risks presented here are based on the disturbance of 100 Canada geese and 500 woodpigeons. It does not matter whether these are all disturbed at the same time, or over a period or days, weeks, or even the season (summer/winter). It also does not matter whether the 100 Canada geese or 500 woodpigeons are disturbed by being directly targeted in the shoot, or through shooting activity in general. It is the number of birds disturbed that is the main parameter in the risk estimates.

The risk output is best applied at the level of individual protected areas as it is the risk to the vulnerable/rare bird in each protected area which is important. Clearly if more than 100 Canada geese or 500 woodpigeons are disturbed in a given shoot then the risks should be increased proportionately.

The results are shown below.

Table 1 WINTER. Probability of infection of one or more of rare/vulnerable species per protected site per day with a bird management shooting event. Based on disturbance of 100 Canada geese and 500 woodpigeons per bird shooting event.

	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Wader assemblage	Terns
Canada goose (n = 100)	Low	High	N/A	N/A	Very high	Very high	N/A
Woodpigeon (n = 500)	Very low	Low	N/A	N/A	Medium	Medium	N/A

Table 2 SUMMER. Probability of infection of one or more of rare/vulnerable species per protected site per day with a bird management shooting event. Based on disturbance of 100 Canada geese and 500 woodpigeons per bird management shooting event.

	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Breeding waders (Avocets)	Terns
Canada goose (n = 100)	N/A	N/A	Very low	High	N/A	Medium	High
Woodpigeon (n = 500)	N/A	N/A	Low	Low	N/A	Low	Low

Clearly any form of disturbance which causes wild birds to disperse increases the risk of spreading HPAI H5 through increased or novel contacts with other wild bird species. This is borne out by the results of the risk assessment both in summer when birds are breeding (Table 2) and in winter when birds are more aggregated at winter roost sites (Table 1).

The risk to harrier species is high through disturbance of 100 Canada geese but low for disturbance of 500 woodpigeons. The main route to the harrier species is through scavenging infected carcasses (more likely those carcases of avian species infected by the target bird entering the protected site on disturbance than the target bird itself).

For example, it is considered that infected Canada geese would be effective at introducing HPAI H5 into waterbird assemblages including gulls and ducks at the wetland marsh harrier breeding sites, and even to the bog/moorland habitats of the hen harrier winter roosts. Corvids and pigeons could also act as bridging species through indirect transmission via contaminating the environment.

This is very difficult to assess in terms of estimating exposures. It is interesting to note, that despite their rarity three cases of H5N1 have been reported in Hen Harriers in Great Britain since 1 January 2021 with two Montagu's Harrier cases in northern Europe and a Western Marsh Harrier in Italy in December 2024.

The risk for breeding avocets is assessed to be medium from Canada geese. It is assumed that avocets are moderately resistant to HPAI H5N1 because there is not a single reported case of H5N1 in an avocet globally (to the author's knowledge) despite their known continuous exposure to black-headed gulls over the summer of 2023 at certain sites in Great Britain (for example Minsmere RSPB). Other breeding waders, however, may be more susceptible to HPAI H5 and therefore the risk to other breeding waders from Canada geese would be higher than medium.

The risk to bitterns is low not only because they are present in very low numbers at protected sites but also because they generally feed within the reed beds and have little contact with other birds, although they are known to eat smaller birds and in this risk assessment bridging species have not been considered with respect to bitterns. The risk to stone curlew from Canada geese is also very low because Canada geese are considered unlikely to land on terrestrial Breckland habitats which are considered too rough/cluttered for geese to use frequently.

In contrast the risks to wintering wader assemblages (including curlews and golden plovers) at wetland sites and to breeding terns from shooting Canada geese are high/very high. Not surprisingly, the risk to wildfowl assemblages from dispersing Canada geese by shooting is also very high.

Despite the assumed higher number of pigeons disturbed on shooting (500 pigeons compared to 100 Canada geese), the risks to rare/vulnerable wild birds are much greater from the Canada geese than from the woodpigeons. This is because the geese fly further, have a higher chance of being infected in the first place, and have greater contact with many of the threatened birds on the protected sites, particularly waterbirds.

The daily risks from shooting woodpigeons are medium for wildfowl and wader assemblages in winter and low for the harrier species. This would be the same for disturbance of winter corvid assemblages. Also, some corvids may scavenge, while

woodpigeons do not. This could increase the risk from corvids to vulnerable wild birds, for example scavenging harriers.

It should be noted that the risks are additive for each additional day of shooting. For example, while shooting woodpigeons has a medium probability per day of infecting wildfowl assemblages in winter, ten days of disturbance through shooting at that site would increase the risk to high (assuming ten medium probabilities give a high probability).

Disturbance of non-target species of geese and ducks may present higher risks of spread of HPAI to rare/vulnerable birds on the protected area than calculated here for Canada geese because they may be present in higher numbers with larger flocks. Without data for numbers of non-target ducks and geese at protected sites, a risk assessment is not attempted here for this route.

Thus, for example, the disturbance of a flock of 1,000 pink-footed geese would present a ten-fold higher risk than that from the 100 Canada geese considered here for each of the rare/vulnerable species in Table 1 and Table 2 (assuming the two geese species are equivalent in HPAI transmission and shedding).

While the predicted risks of infection of rare/vulnerable wild bird species through disturbance by shooting may be medium in the case of woodpigeons and high/very high in the case of shooting Canada geese, this is expected given it is well established that wild birds spread HPAI and given the huge numbers of wild bird cases reported across Great Britain (and globally) in the 2023/24 season.

Also, while shooting undoubtedly disturbs many avian species around protected areas, it cannot be ruled out that some of those birds would be disturbed away from the protected site/area just by chance. However, it should be noted that the additional journey to the protected site increases the risks incrementally by those in Table 1 and Table 2 and would result in proportionately more exposures to the rare and vulnerable species.

The benefit of predator control to breeding birds is not considered here. While there may be some benefits for breeding upland species in summer (golden plover, curlew, merlin, hen harrier) this is not so for coastal/wetland estuaries in winter where managing crows, for example, is unlikely to produce benefit. Pest bird management using other methods is not considered as only shooting disturbs birds and promotes movement, amplifying the risks produced by HPAIV.

How to use this risk assessment output

The RRA presented here is generic with two target bird scenarios (Canada goose and woodpigeon) in a summer and a winter period. The summer RRA model assumes a “medium” probability that nationally HPAI is in the general wild population in GB. The winter RRA model assumes a “very high” probability that nationally HPAI is in the general wild bird population in GB.

It should be noted that the whether the national wild bird risk in GB is medium, high or very high has relatively little impact on the predicted risks (simply due to the way that the risks combine in the risk calculation reflecting the qualitative nature of the method). Only when the national wild bird risk falls to low does the risk output become markedly lower. The main difference in the summer and winter scenarios is in the species of wild birds in the SPAs and their status, namely breeding in summer and forming feeding and roosting assemblages in winter.

Although the risk assessment formally considers two species of target birds, namely Canada geese and woodpigeons, it is important to note that these were chosen to generically represent two different groups of birds. In this respect, the risk assessment equally applies to other species of target bird depending on their relative exposure to HPAI in the environment and their susceptibilities to infection given exposure. Thus a “Canada goose type bird” has a medium probability of an individual bird being exposed given HPAI H5 is in the wild bird population and then a high probability of infection given exposure.

In contrast a “Woodpigeon type bird” has a low probability of an individual bird being exposed given HPAI is in wild bird population and then a medium probability of infection given exposure. Thus, the “Canada goose type bird” has an overall higher risk of spreading the virus than the “Woodpigeon type bird”. The risk assessment assumes these birds fly certain distances relative to the SPA on disturbance. It should be noted that this does not apply to kettling of geese because the geese cannot fly in such circumstances.

The total number of target and non-target bird species disturbed by the pest control event in the vicinity of the SPA is a key factor in the risk of transmission of HPAI to rare and vulnerable birds on the SPA. Clearly the more individual birds disturbed the greater the risk of spread. This is set out in Table 3 and Table 4 for 1 to 1,000 “Canada geese type birds” and in Table 5 and Table 6 for 1 to 5,000 “Woodpigeon type birds”.

Table 3: Winter. Probability of infection of one or more of rare/vulnerable species based on disturbance of increasing number of "Canada geese type birds" per unit time.

Number of Canada geese disturbed	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Wader assemblage	Terns
1	Very low	Low/Medium	N/A	N/A	Medium	Medium	N/A
10	Very low	Medium	N/A	N/A	High	High	N/A
100	Low	High	N/A	N/A	Very high	Very high	N/A
1,000	Medium	Very high	N/A	N/A	Very high	Very high	N/A

Table 4: Summer: Probability of infection of one or more of rare/vulnerable species based on disturbance of increasing number of "Canada geese type birds" per unit time.

Number of Canada geese disturbed	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Breeding waders (Avocets)	Terns
1	N/A	N/A	Very low	Low	N/A	Low/Very low	Low
10	N/A	N/A	Very low	Medium	N/A	Low	Medium
100	N/A	N/A	Very low	High	N/A	Medium	High
1000	N/A	N/A	Low	Very high	N/A	High	Very high

Table 5: Winter - Probability of infection of one or more of rare/vulnerable species based on disturbance of increasing number of "woodpigeon type birds" per unit time.

Number of woodpigeons disturbed	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Wader assemblage	Terns
1	Negligible	Very low	N/A	N/A	Low/Very low	Low/Very low	N/A
50	Negligible	Very low	N/A	N/A	Low	Low	N/A
500	Very low	Low	N/A	N/A	Medium	Medium	N/A
5,000	Very low	High	N/A	N/A	High	High	N/A

Table 6: Summer - Probability of infection of one or more of rare/vulnerable species based on disturbance of increasing number of "woodpigeon type birds" per unit time.

Number of woodpigeons	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Breeding waders (Avocets)	Terns
1	N/A	N/A	Very low	Very low	N/A	Very low	Very low
50	N/A	N/A	Very low	Very low	N/A	Very low	Very low
500	N/A	N/A	Low	Low	N/A	Low	Low
5,000	N/A	N/A	Medium	Medium	N/A	Medium	Medium

Background

General licences are permissive licences, meaning that users do not need to apply for them, but they must comply with their terms and conditions, when undertaking licensed acts. They allow users to kill or take certain species of wild birds for defined purposes such as preventing serious damage to certain commodities such as livestock and crops, for the purposes of conserving wild birds, plants and animals of conservation concern, or for public health and safety reasons.

Renewal considerations

The current two-year licences are due to expire at the end of 2023 and new two-year licences need to be established for 1st January 2024.

Great Britain is currently experiencing the worst outbreak of highly pathogenic avian influenza (HPAI). Considered here is an emerging concern that problem bird control allowed under the three bird licences could promote the spread of HPAI to rare and vulnerable bird species and have impact on those populations. This might suggest amendments to the above licences (as was undertaken for GL43 for the release of gamebirds Gamebirds: decision to issue the gamebird general licence for 2023 to 2025 - GOV.UK (www.gov.uk)).

Defra as the appropriate authority must consult Natural England prior to making a decision to issue new general licences as required by the Habitats Regulations 2017 and Wildlife and Countryside Act 1981. NE will use the risk assessment to inform their advice to Defra, alongside APHA's Review of the evidence base for inclusion of avian species in the three general licences.

The three general licences are:

WML GL40: general licence to kill or take certain species of wild birds to conserve endangered wild birds and flora or fauna. WML GL40: general licence to kill or take certain species of wild birds to conserve wild birds and flora or fauna of conservation concern. Species covered: carrion crow, jay (woodland species only), magpie, Canada goose, Egyptian goose, monk parakeet, ring-necked parakeet, sacred ibis, Indian house-crow.

WML GL41: general licence to kill or take certain species of wild birds to preserve public health or public safety. Species covered: jackdaw, feral pigeon, Canada goose, monk parakeet.

WML GL42: general licence to kill or take certain species of wild birds to prevent serious damage and prevent the spread of disease. Species covered: carrion crow, jackdaw, magpie, feral pigeon, rook, woodpigeon, Canada Goose, monk parakeet, ring-necked parakeet, Egyptian goose, Indian House crow.

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.

Scope of the risk assessment

The risk assessment should cover the following areas:

1) Geographical extent – England
2) Protected sites – sites of special scientific interest (SSSIs), special areas of conservation (SACs), special protected areas (SPAs) and wetlands of international importance designated under the Ramsar Convention (Ramsar)
3) All birds that are listed as qualifying features of the protected sites
4) Methods employed under the general licences that create disturbance / deterrents
5) Target bird species – those species which can be controlled under the General licences
6) Biosecurity measures currently in the General licence?
7) Impacts on non-target species – co-location of species
8) Seasons - impact of peak activity of control of problem birds. Early spring as SPA feature bird species commence breeding, and late winter when pest control coincides with wintering aggregations.

The Ramsar Convention, also known as "The Convention on Wetlands", is an international environmental treaty signed on 2 February 1971 in Ramsar, Iran, under the auspices of UNESCO. It came into force on 21 December 1975, when it was ratified by a sufficient number of nations.

Risk question

The risk question is "*What is the risk that bird control allowed under the three bird licences (GL40, 41 & 42) could spread HPAI H5 to rare and vulnerable bird species when practiced on or near an SPA/SAC/SSSI/Ramsar in Spring (between the months of February and May).* **Note February to March represent winter and April to May represent summer breeding season for the purposes of this RRA.** *What is the consequence to those populations and the features."*

Risk output units

The risk of spread to rare and vulnerable bird species is defined as the probability of infection of one or more of those rare/vulnerable species per SPA site per day with a bird control shooting event.

If shooting is performed on more than one day (per summer or per winter) then this risk needs to be aggregated over the number of days disturbance occurs.

Rare/vulnerable avian species to consider

The rare or vulnerable birds to consider, together with their winter and summer habitats are set out in Table 7. Moorland birds such as nesting curlews and golden plover are not likely to contact geese or pigeons and are not considered. However, hen harriers are considered because they scavenge and/or feed on birds and would have much greater exposure. Curlews and golden plovers are considered in the wader assemblage in winter. In terms of seasons in the risk question, it should be noted that February to March represent winter and April to May represent summer breeding season for the purposes of this RRA.

Table 7: Rare/vulnerable bird species to consider

Affected wild bird species	Winter habitat	Summer habitat	Notes
Golden plover	Estuary/coast	Moorlands	Wintering golden plovers covered under wader assemblage
Curlew	Estuary/coast	Moorlands	Wintering curlew covered under wader assemblage
Hen Harrier	Moorlands, grasslands	Moorlands	

Affected wild bird species	Winter habitat	Summer habitat	Notes
Marsh Harrier	Wetlands	Wetlands	
Merlin	Moorlands	Moorlands	
Hobby	N/A	Heathland/Wetland	Ignore, little contact with problem species, and hobbies range over large distances
Peregrine	Moorlands	Moorlands	Ignore because preys directly on most of the problem species (particularly pigeons and corvids) anyway, and hunts over wide area so little additional risk, although shooting would put problem bird species (and other species) to flight where peregrine would catch them on the wing.
Bittern	Wetlands	Wetlands	

Affected wild bird species	Winter habitat	Summer habitat	Notes
Stone Curlew	Breckland winter roosts	Brecklands	
Nightjar	N/A	Brecklands	
Woodlark	Part of population over winters in England on heathland and surrounding pasture and arable land	Brecklands	
Wintering aggregations of waders	Wetlands/coastal estuaries	N/A	
Wintering aggregations of waterfowl	Wetlands/coastal estuaries	N/A	
Summer breeding terns	N/A	Coast shingle, wetlands	

Routes to consider

There are three routes to consider:-

1. Specific dispersion of the target bird species itself
2. General dispersion of non-target wild bird species within the site
3. Scavenging of carcasses of shot/injured target bird species

Note Scavenging of carcasses of non-target wild bird species, infected by dispersed target species, is covered for scavengers like the marsh harrier under route 1, see Table 18 for example.

Route 1: Specific dispersion of the target bird species itself

Risk assessment approach

The approach is to estimate the probability (p) of infecting one or more rare/vulnerable birds (of each species) per target bird dispersed by shooting and combine this with the number (n) of target birds consequentially dispersed in that area around the protected site (Table 11) to give an aggregated probability (p_n) of infection of one or more rare/vulnerable birds in the protected site. Currently the RRA is only considering one species (or group) of target bird per assessment and does not for example consider shooting one carrion crow might disturb 500 pigeons. However, this would be covered in the pigeon risk assessment which is why the RRA is focusing on the more gregarious target bird species.

p The probability of infecting one or more rare/vulnerable birds (of a given species) per bird dispersed on shooting.

n Estimated number of birds dispersed per day at a shoot near to a protected area.

p_n Aggregated probability that one or more rare/vulnerable birds (of a given species) are infected per shoot event near to a protected area.

The aggregated likelihood, p_n, is calculated qualitatively by combining p and n using the method of Kelly et al. (2018) as shown using Figure 1.

The probability, p, per individual target bird is calculated for each target/rare bird combination by multiplying the qualitative probabilities for six steps set out in Table 8 using the matrix of Gale et al. (2014). This matrix is less conservative and better suited to pathways with multiple steps in that is assumes “low x low” equates to “very low” and not to “low”. It is further assumed here that multiplying several “medium” probabilities together gives a “low” probability.

To understand this, it should be noted that all probabilities are less that one, i.e. fractions, and that multiplying two fractions always gives a smaller fraction. In a quantitative world, for example high x high might by 0.8 x 0.8 = 0.64 which is still high. However low x low might be 0.001 x 0.001 = 0.000001 which is very low. Similarly low x high tends to low, for example 0.001 x 0.8 = 0.0008.

Table 8: Probability (p) per target bird that dispersed target bird infects the rare bird on the protected site.

Step	Probability
Probability HPAI is in wild birds	Very high in winter, Medium in summer - It is assumed that the probability that HPAI is in at least one wild bird in the area is very high in winter based on the national GB risk over the winter, but lower in the summer months.
Probability an individual target bird has been exposed to virus at the time of the management shoot	Takes into account general likelihood of exposure of the target bird species based on its behaviour, feeding and social interaction with other wild birds around the SPA. Assumed to be low for corvids/pigeons as they are considered spillover hosts of disease in waterbirds, but medium for Canada geese.
Probability target bird is infected and sheds virus given exposure	Takes into account susceptibility to HPAI and known shedding efficacy of target bird.
Probability target bird seeks sanctuary on the seeks sanctuary on the SPA after disturbance by shooting	Takes into account the distance flown by the target bird on disturbance by shooting as set out in Table 11 relative to minimum disturbance distance as set out in safe working distance for the rare bird habitat in Table 12. Inverse square law with distance from the shoot site to the SPA taking into account safe working distance in Table 12 may be used to assess reduction in numbers flying over SPA by aerial dispersion. Some target bird species may scatter in all directions before regrouping depending on conditions, while other target bird species are attracted to certain habitats, for example Canada geese are attracted to wetlands, and marshes while pigeons are less attracted to water.
Probability target bird contacts rare bird species	This is the key interaction between the disturbed target bird and the rare wild bird. Takes into account the habitat and behaviour of the rare bird on the SPA, and

Step	Probability
given both are on the given habitat at the SPA	whether the target birds just fly over the SPA, land in the water, runs to cover in reedbeds, or trees. Exposure of the rare bird could be indirect (through faeces in the water) or direct contact (scavenging) or through other bridging species. The degree of exposure of the rare bird depends on whether it scavenges dead birds, catches live birds, or is exposed through the environment. Beak to beak contact could occur for example between crows and gulls. This also includes the number of rare/vulnerable birds present per site which could be zero, a few, or more, depending on the season and the species. For example, some birds may only be present in the summer (breeding season) and could be there in large numbers, for example vulnerable seabirds at a colony. This takes into account the number of rare or vulnerable birds at the site, so much higher change of a single target bird contacting a wader or waterbird at a winter assemblage than a rare bittern in a reed bed for example.
Probability rare bird is infected given exposure to HPAI	This is based on the number of known cases of HPAI in that rare wild bird species (or bird order if data are lacking).
Overall probability (p)	Calculated as combination of risks

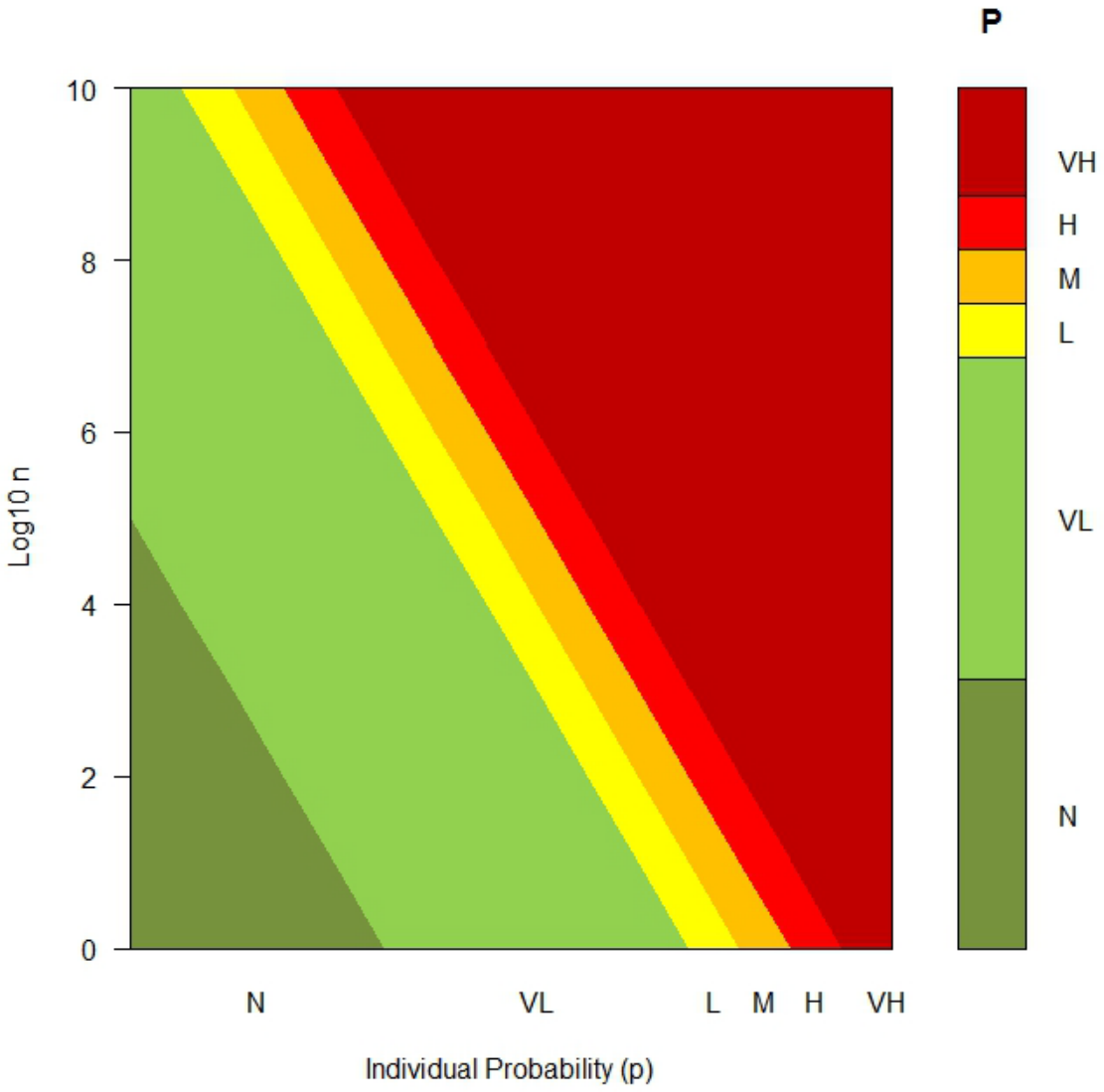

Figure 1: Contour plot for the aggregated probability (adapted from Kelly *et al*. 2018). To use this plot, the "per target bird" risk is marked on the x-axis and a vertical line drawn. The y-axis represents the logarithm of the number of target birds which are disturbed "per shoot". So, for example, the logarithm of 500 wood pigeons is 2.7. To calculate the aggregated probability of infection of at least one vulnerable species by 500 woodpigeons, draw a horizontal line at 2.7 on the y-axis and where this intercepts with the vertical line representing the "per target bird" risk read off the colour. The vertical scale on the right then indicates the aggregated risk based on the colour at the intercept.

Terminology related to the assessed level of risk and uncertainty

For the purpose of the risk assessment, the risk levels are defined in Table 9, uncertainty in Table 10 and consequence in Table 11. It is important to note that the output risks do not reflect the frequencies inferred in Table 9, they merely represent the probability of one or more rare/vulnerable birds being infected per shoot.

Table 9 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 10 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.

Disturbance behaviour and flock size (n) of target bird species

The numbers of target bird of each species typically disturbed on shooting are set out in Table 11 based on relative numbers of target birds expected at a typical shooting site near a generic protected site during a day. For example, corvids such as carrion crows and jays are generally solitary or present in pairs while jackdaws associate in small flocks and rooks are highly gregarious with around 50 birds in a rookery. It is noted that mixed winter corvid roosts including both rooks and jackdaws can in exceptional cases number in the thousands. Pigeons can be present in large flocks when feeding in suitable fields or roosting. Canada geese are often found in large flocks, while Egyptian geese generally move in pairs. Clearly the numbers of birds will vary with location of the protected site and the season and the numbers in Table 11 represent a generic site. Most of the problem birds covered under the licences are resident in England, although rooks and woodpigeons may migrate to and from Europe, but not in the regular way that spring and autumn migrants do.

Table 11: Assumed numbers of target birds dispersed on shooting at a site near a generic SPA on a typical day together with estimate of distance moved.

Target species	Numbers (n) dispersed at a site on shooting – assumes birds are not shot – per day with a shooting event.	Distance moved on disturbance by shooting
Carrion crow	2	No data on corvids, but unlikely to move far, also likely to find suitable habitat easily, assume 500 m
Jay	2	
Jackdaw	10 to 20	
Magpie	5	
Rook	50 to 100, although there can be much higher numbers in some mixed winter roosts which include jackdaws.	

Canada goose	100	Median 2.3 km for snow goose
Egyptian goose	2	
Feral pigeon	100	No data but fast fliers and may move considerable distance on disturbance, assume 500 m
Woodpigeon	500	

Woodpigeon shooting for pest control, essentially crop protection, is undertaken in a rather contradictory manner. Shooting of woodpigeons is very often primarily undertaken for 'sport', with protection of crops a by-product. Whether woodpigeons are shot for sport or crop protection does not affect the predicted risks to wild birds.

Parakeets have a relatively limited, largely urban range and are generally arboreal. They would therefore have less contact with other bird species compared to ground-dwelling birds or wetland birds. Parakeets would not be shot in urban areas and whilst a lot of parakeets are shot in fruit trees in Kent and could be scavenged, dead parakeets from HPAI could also equally be scavenged irrespective of whether they were shot or not. For these reasons, they are not considered here. There are occasional occurrences of sacred ibis escaping from captivity and Indian house crows are absent from the UK. These species are not considered.

From Table 11 it is concluded that the five corvid species and the two pigeon species can be grouped, on the basis of distance moved, into a single target species for the purpose of risk assessment. In terms of interaction with rare birds, the five corvids and two pigeons would behave similarly with regard to habitat. All could be found in fields, farmland, woodland, moorland and would be attracted to water areas for drinking or foraging. While corvids, carrion crows and magpies in particular, could scavenge dead carcases of infected wild birds this is not relevant to this risk assessment.

In summer, crows and magpies could be attracted to nesting birds' nests to eat the eggs or chicks and certainly nesting curlews will chase off marauding ravens. Avocets and other waders are particularly aggressive in chasing off gulls, corvids and raptors which enter their breeding areas. However, this would be a feature of these predatory bird species irrespective of whether they were dispersed on shooting, that is they would target those breeding areas anyway.

Furthermore, the marauding corvids normally attempt to raid nests opportunistically and certainly not in the numbers presented in Table 11.

Therefore, the risk assessment can be simplified into dispersion by shooting of two groups of target species:-

- Pigeons/corvids
- Canada geese

Since woodpigeons are in the highest numbers (Table 11) this risk assessment looks at two target species, namely woodpigeons and Canada geese. Moreover, shooting is non-specific in which species of bird it disturbs, although with woodpigeons, other species may not be present, certainly not in high numbers. So, while shooting magpies for example targets magpies, all the birds in that area will be disturbed. Therefore, from a risk assessment perspective, there is little point considering each of the five corvid species separately or indeed separately from pigeons particularly since corvids and pigeons are generally ubiquitous and share similar rural habitats (namely farmland, woodland, wetlands).

Canada geese need to be considered separately because they are less ubiquitous, being confined to fields and wetlands, and specifically associate with other waterbirds and fly further than pigeons and corvids when disturbed (Table 11). Table 8 is needed for each target bird species for each rare bird species for each of the two seasons. It is habitat specific based on the protected site.

Where the risks are set out for pigeon, this could also be read across to large corvid gatherings, although large corvid gatherings are much less common than pigeon foraging/roost gatherings. Jackdaws often mix with rooks to further boost corvid numbers at foraging sites and in turn these can mix with pigeon flocks. In winter, rooks can join up with other corvids (particularly jackdaws) to roost together. Some of these can be very large. In East Anglia, tens of thousands of Rooks, Jackdaws and Carrion Crows gather at the RSPB reserves of Lakenheath Fen and Buckenham Marshes (https://www.bto.org/our-science/projects/birdtrack/news-archive/2016/focus-onwinter-corvid-roosts).

It should be noted that, rooks and jackdaws are not controlled for conservation purposes under GL40 but controlled to prevent serious damage to livestock and crops, including spread of disease to livestock under GL42.

The risks presented here are based on the disturbance of 100 Canada geese and 500 woodpigeons. It does not matter whether these are all disturbed at the same time, or over a period or days, weeks, or even the season (summer/winter).

It also does not matter whether the 100 Canada geese or 500 woodpigeons are disturbed by being directly targeted in the shoot, or through shooting activity in general. It is the number of birds disturbed that is the main parameter in the risk estimates.

The risk output is best applied at the level of individual protected areas as it is the risk to the vulnerable/rare bird in each protected area which is important. Clearly if more than 100 Canada geese or 500 woodpigeons are disturbed in a given shoot then the risks should be increased proportionately.

Distances flown by target species on disturbance by shooting

This is taken from the review by National Wildlife Management Centre (2017).

Firearms (shotguns) used in wildfowling have an effective range of 30-40m (Evans & Day 2001). Most waterfowl react to gunshots within a range of 80m (van den Tempel 1992 cited in Evans and Day 2001), although some species can be disturbed from a distance of 500m (Madsen 1995). Shooting activity can affect the distribution and movements of birds in two principal ways, through immediate and long-term disturbance.

The most frequently described behaviour (although this does not imply that it is the most frequently undertaken behaviour) is the movement of birds within the site they are occupying. Swimming or flying from shallower to deeper water is often described. At a large coastal wetland in Denmark, dabbling ducks usually moved less than 3km to another part of the site, in response to the start of shooting. Mute swans (a non-quarry species), wigeon, teal, golden plover and lapwing were seen to move between 500 to 1,200m from their original location (Bregnballe & Madsen, 2004). Madsen (1998a) quotes flight times of less than 5 minutes for wigeon in response to shooting. Nearly all of the coots present on a lake in Denmark were seen to move away from the area where shooting occurred, but the total numbers of coots on the lake did not decrease.

Longer flight distances have been noted. Golden plover and lapwing departed the site and flew to areas located over 8km from the site and greylag geese were seen to move more than 9km to night roosting or pre-roosting sites. Also in Denmark, pink-footed geese were seen to relocate up to 25km following disturbance from shooting (Madsen 1986 cited in Fox and Madsen 1997).

Korschgen *et al*. (1985) cited in Hockin *et al*. (1992) found that diving ducks undertook an additional 1 hour per day of flying because of disturbances (in this case from boating

activity not shooting) but it is not stated whether this is the sum of many short flights within the same site or a single long flight leaving the site.

In a study designed to look at distances flown following shooting disturbance by snow geese in Canada, Bechet *et al*. (2004) using radio tagging found that flight distances were 3.9 times further following shooting than other types of disturbance and the median distance flown increased from effectively 0km following non-shooting or scaring disturbance to 2.3km, but flights of up to 30km were seen as a result of all types of disturbance.

In a similar study in North America, Dooley *et al*. (2010) used radio-tracking to look at the distance flown by mallards as a result of disturbance due to humans walking and to shooting. Only 16 out of 278 Mallards flew more than 10km in response to any disturbance, although they did move further as a result of shooting.

The distances flown are dependant, at least in part, on the location and quality of alternative sites, and this may be because otherwise useable local sites are effectively inaccessible due to shooting. Pink-footed geese in Denmark were prepared to relocate 25km to roost in years when there was hunting but would otherwise roost in an adjacent lake to the fields where they had been feeding (Madsen 1986 cited in Fox and Madsen 1997).

At the start of the season, or when shooting only occurs intermittently (Bregnballe & Madsen, 2004), more substantial redistribution of birds is likely to occur, as numbers have had chance to build up. It was frequently noted that numbers of waterfowl took weeks to return to pre-hunting levels following intermittent shooting (Bregnballe & Madsen 2004, Andersson 1977 and Jettka 1986, both cited in Fox and Madsen 1997).

Shooting of pigeons and corvids (and other non-lethal scaring) generally occurs at feeding sites where there is crop damage, i.e. in agricultural fields. It is intended to both kill birds and scare them away from the affected site and can be effective (to a degree) in this regard, so disturbance-related movement can be expected. While there is extensive literature on the efficacy of different bird control techniques, none was found that appropriately described the immediate effects of shooting disturbance in terms of bird dispersal movements.

General observations, however, indicate that pigeons and corvids will behave similarly to the other species described in this review in response to shooting; but at a smaller spatial scale. This will involve short and medium-term effects and long-term impacts. Short term effects include taking flight and moving to alternative favoured locations and not spreading out randomly across the landscape. Corvids are known to fly 2.5 km between breeding or winter roosting sites and feeding sites (Green 1985; Feare *et al*.

1974) but they (and woodpigeons) will be less limited than waterfowl in finding alternative feeding or roosting sites so will be unlikely to move far when disturbed; generally, to the nearest safe loafing site or alternative feeding site.

In addition to utilising habitat, both neighbouring and within, poultry premises, corvids and woodpigeons also utilise habitats favoured by waterbirds. Corvids and woodpigeons regularly forage in fields used by waterbirds, such as geese and gulls which are considered as high risk for HPAI; sometimes present simultaneously. Increased shooting-induced movements of waterbirds between wetlands and farmland, and of corvids and woodpigeons around farmland will provide increased opportunities for mixing and of potential transmission of AI between the two groups, and subsequently to poultry units.

The recommended safe working distances in the GL40 licence are used as an indication of the minimum distance at which shooting would be allowed in the vicinity of rare and vulnerable species. These are presented in Table 12.

Table 12: Recommended safe working distances, shown by species according to Table 4 in GL40.

Species	**Recommended safe working distance (metres)**
Avocet	300m around nest sites
Black-tailed godwit	500m around nest sites
Common tern	200m around nest sites
Hen harrier	500m around the nest site when birds are incubating 750m around the nest when chicks are present 500m around a non-breeding communal bird of prey roost site
Herring gull	300m around colonies
Honey buzzard	750m around nest sites
Lesser black-backed gull	300m around colonies
Little tern	200m around nest sites
Merlin	750m around nest sites
Peregrine	750m around nest sites

Species	Recommended safe working distance (metres)
Sandwich tern	200m around nest sites
Short-eared owl	150m around the nest when birds are incubating 500m around the nest when chicks are present
Stone-curlew	500m around nest sites

In summary shooting could occur between 150 m and 750 m of the protected bird species set out in Table 12.

Risk assessments for shooting of Canada geese as a problem species.

The risk assessments for Canada geese to each rare/vulnerable wild bird species according to Table 8 are set out in the following tables.

Table 13: Canada geese to nesting terns - summer: Probability (per target bird) that dispersed bird infects the rare bird

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low – inland birds less affected with HPAI in summer
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus

Probability target bird seeks sanctuary on the SPA on shooting	Very high	Dispersion of 2.3 km in Table 11 relative to 200 m safe working distance of common tern (Table 12). Geese are very likely to fly to water area on disturbance.
Probability target bird contacts rare bird species given bird is on site	Medium	Geese would land near tern islands to drink or feed, but not specifically interact with them. Terns present in medium to high numbers at nesting colonies.
Probability rare bird is infected given exposure	High	Many cases of HPAI reported in tern species
Overall probability	Low*	Low

*Assumes three mediums equals a low, hence medium end of low.

Aggregated risk of infection of at least one tern per shoot day being infected on SPA based on n = 100 Canada geese (Table 11) with low (medium end of low) per bird risk (Table 13) is **high** from Figure 1 with low uncertainty. Thus, vertically extending "low" from the x-axis intercepts with 2.0 (calculated as $\log_{10} 100$) extending horizontally on the y-axis in the red coloured contour. This can be read off as a "high" aggregated risk on the scale on the right of the figure.

Table 14: Canada geese to waterfowl assemblage - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 200 m of SPA.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the target shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands

Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Very high	Dispersion of 2.3 km in Table 11 relative to 200 m. Geese are very likely to fly to water area on disturbance.
Probability target bird contacts rare bird species given bird is on site	High	Geese would land near water to drink or in fields with other waterfowl to feed. Waterbird present in very high numbers at winter assemblages so plenty of opportunity for Canada goose to contact at least one.
Probability rare bird is infected given exposure	Very high	Many cases of HPAI reported in waterfowl species
Overall probability	Medium	Low

Aggregated risk of infection of at least one waterbird per shoot day being infected in winter on SPA based on n = 100 Canada geese (Table 11) with medium per bird risk (Table 14) is **very high** from Figure 1 with low uncertainty.

Table 15: Canada geese to wader assemblage - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 200 m of SPA.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the target shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands

Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	High	Dispersion of 2.3 km in Table 11 relative to 200 m. Geese are very likely to fly to water area on disturbance
Probability target bird contacts rare bird species given bird is on site	Very high	Geese would land in fresh-water lagoons to feed or in fields with waders to feed. It is noted many waders will be on estuarine mudflats where Canada geese tend not to go, but only at low tide, with waders roosting with geese at high tide in surrounding freshwater pools or marshes. Also, huge numbers of waders at winter assemblages so very high chance of a Canada goose contacting at least one (unlike for bitterns).
Probability rare bird is infected given exposure	High	Many cases of HPAI reported in wader species
Overall probability	Medium	Low

Aggregated risk of infection of at least one wader per shoot day being infected on SPA in winter based on n = 100 Canada geese (Table 11) with medium per bird risk (Table 15) is **very high** from Figure 1 with low uncertainty.

Table 16: Canada geese to nesting avocets - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 300 m of SPA (Table 12).

Step	Probability	Uncertainty and notes

Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Very high	Dispersion of 2.3 km in Table 11 relative to 300 m (Table 12). Canada geese are very likely to fly to water area on disturbance.
Probability target bird contacts rare bird species given bird is on site	High	Canada geese would land near or in water to drink and feed. Avocets may be present in high numbers at breeding sites for example on reserves such as Minsmere RSPB.
Probability rare bird is infected given exposure	Low	High - No cases of HPAI reported in avocet species globally despite close contact with infected black-headed gulls at Minsmere in summer 2023 for example
Overall probability	Very low*	High because of assumption avocets are resistant

*Assumes two mediums and a low, equals very low, but at low end of very low

Aggregated risk of infection of at least one nesting avocet per shoot day being infected on SPA in winter based on n = 100 Canada geese (Table 11) with very low per bird risk (but at low end of very low) (Table 16) is **medium** from Figure 1 with high uncertainty.

Table 17: Canada geese to bittern - winter: Probability (per target bird) that dispersed bird infects the rare bird

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Very high	Dispersion of 2.3 km in Table 11 relative to 200 m safe working distance of common tern (Table 12). Note that bitterns may be in reedbeds near to common tern nesting on wetlands. Geese are very likely to fly to water area on disturbance.
Probability target bird contacts rare bird species given bird is on site	Very low	Medium - Geese may associate with birds close to reed bed edges where bitterns sometimes feed, but bitterns are present in very low numbers and rarely come out of the reed bed hence very low probability of contact of Canada goose with a bittern. Bitterns come out of the reeds when water is iced over, and they cannot feed which could increase risk of exposure to geese on the ice.

Probability rare bird is infected given exposure	High	Cases of HPAI reported in heron species
Overall probability	Very low	Medium

Aggregated risk of infection of at least one bittern per shoot day being infected on SPA based on n = 100 Canada geese (Table 11) with very low per bird risk (Table 17) is **low** from Figure 1 with medium uncertainty.

Table 18: Canada geese to nesting marsh harrier - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 750 m of Marsh Harrier nest.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	High	Dispersion of 2.3 km in Table 11 relative to 750 m safe working distance of hen harrier chicks (Table 12). Geese are very likely to fly to water area on disturbance and marsh harriers will nest in surrounding reed beds
Probability target bird contacts rare bird	High	Marsh harrier would scavenge carcase of Canada goose if it died on the SPA. There is only a low probability that the infected Canada

species given bird is on site		goose will die from HPAI on the SPA on the day of the shoot. However, infected Canada goose will infect some of the many other waterbird species on the SPA which will die and be scavenged by the Marsh Harrier. Hence risk is high through multiple bridging species at the wetland site.
Probability rare bird is infected given exposure	High	Cases of HPAI reported in raptor species, including related hen harrier in GB
Overall probability	Low*	Medium

*Assumes two mediums equal low, but medium end of low.

Aggregated risk of infection of at least one nesting marsh harrier per shoot day being infected on SPA based on n = 100 Canada geese (Table 11) with low (medium end of low) per bird risk (Table 25) is **high** from Figure 1 with medium uncertainty.

Table 19: Canada geese to hen harrier - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 500 m of Hen Harrier roost.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus

Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 2.3 km in Table 11 relative to 500 m safe working distance of roosting hen harrier (Table 12). Not all geese will fly to the SPA given 500 m distance, although they will be attracted to any water bodies on bogs and moors where hen harriers roost.
Probability target bird contacts rare bird species given bird is on site	Medium	Hen harrier would scavenge carcase of Canada goose if it died on the SPA. There is only a low probability that the infected Canada goose will die from HPAI on the SPA on the day of the shoot. However, the infected Canada goose may infect some of the other bird species on the SPA which will die and be scavenged by the Hen Harrier. This could include pheasants and waterbirds such as herons, coots and moorhens depending on the habitat of the roost (moorland, bog). This risk is lower than at wetland sites. Hence risk is medium through multiple bridging species at the wetland site. Prey species such as pipits could also be infected by the Canada goose although there is no information on this, other than a reed warbler case.

Probability rare bird is infected given exposure	High	Cases of HPAI reported in raptor species, including related hen harrier in GB
Overall probability	Low*	Medium

*Assumes three mediums equal low, although at upper end.

Aggregated risk of infection of at least one wintering hen harrier per shoot day being infected on SPA based on n = 100 Canada geese (Table 11) with low per bird risk (Table 19) is **high** from Figure 1 with medium uncertainty.

Table 20: Canada geese to stone curlew - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 500 m of stone curlew nest.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Medium	Canada geese would have regular exposure to other infected birds on wetlands
Probability target bird is infected and sheds virus given exposure	High	Low – geese are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 2.3 km in Table 11 relative to 500 m safe working distance of nesting stone curlew (Table 12). Not all geese will fly to the SPA given 500 m distance, although they will be attracted to any water bodies on the Brecklands.

Probability target bird contacts rare bird species given bird is on site	Very low	Stone curlews are not likely to be near to Canada geese at their nesting sites and the probability a Canada goose lands near a Stone Curlew is very low. This is because stone curlew habitat is not attractive to Canada geese, so the two species are unlikely to coincide.
Probability rare bird is infected given exposure	High	Medium
Overall probability	Very low	Medium

Aggregated risk of infection of at least one nesting stone curlew per shoot day being infected on SPA based on n = 100 Canada geese (Table 11) with very low per bird risk (Table 20) is **very low** from Figure 1 with medium uncertainty.

Risk assessments for shooting of woodpigeons as pests

The risk assessments for woodpigeons to each rare/vulnerable wild bird species according to Table 8 are set out in the following tables.

Table 21: Woodpigeon to nesting terns - summer: Probability (per target bird) that dispersed bird infects the rare bird

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low – inland birds less affected with HPAI in summer
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 200 m safe working distance of common tern (Table 12). Not all pigeons will fly to the SPA given 200 m distance.
Probability target bird contacts rare bird species given bird is on site	Medium	Pigeons may land near tern islands to drink or feed. Terns present in medium to high numbers at nesting colonies so contact with a pigeon occurs regularly.
Probability rare bird is infected given exposure	High	Many cases of HPAI reported in tern species
Overall probability	Very low*	Medium

*Assumes three mediums equals a low.

Aggregated risk of infection of at least one tern per shoot day being infected on SPA based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 21) is **low** from Figure 1 with medium uncertainty.

Table 22: Woodpigeon to waterfowl assemblage - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 200 m of SPA.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 200 m. Not all pigeons will fly to the SPA given 200 m distance.
Probability target bird contacts rare bird species given bird is on site	High	Pigeons may land near water to drink or in fields with waterfowl to feed. Waterbird present in very high numbers at winter assemblages so plenty of opportunity for pigeon to contact at least one.
Probability rare bird is infected given exposure	Very high	Many cases of HPAI reported in waterfowl species
Overall probability	Very low*	Medium

* Based on two mediums and a low (but at low end of very low).

Aggregated risk of infection of at least one waterbird per shoot day being infected in winter on SPA based on n = 500 woodpigeons (Table 11) with very low (low end of very low) per bird risk (Table 22) is **medium** from Figure 1 with medium uncertainty.

Table 23: Woodpigeon to wader assemblage - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 200 m of SPA.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 200 m. Not all pigeons will fly to the SPA given 200 m distance.
Probability target bird contacts rare bird species given bird is on site	High	Pigeons may land in freshwater lagoons to drink or in fields with waders to feed, but many waders on estuarine mudflats where pigeons won't go. However, more chance of mixing at high tide if waders fly to coastal marshes. Also, huge numbers of waders at winter assemblages so very high chance of a pigeon contacting at least one (unlike for bitterns).

Probability rare bird is infected given exposure	High	Many cases of HPAI reported in wader species
Overall probability	Very low*	Medium

*Assumes low and two mediums equals very low, although low end of very low.

Aggregated risk of infection of at least one wader per shoot day being infected on SPA in winter based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 23) is **medium** from Figure 1 with medium uncertainty.

Table 24: Woodpigeon to nesting avocets - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes shooting within 300 m of SPA (Table 12).

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 300 m (Table 12). Not all pigeons will fly to the SPA given 300 m distance.
Probability target bird contacts rare bird species given bird is on site	Medium	Pigeons may land in freshwater lagoons to drink or in fields with waders to feed. Avocets may be present in relatively high numbers at breeding sites for example on reserves such as Minsmere RSPB

		hence contact with pigeons could occur regularly.
Probability rare bird is infected given exposure	Low	High - No cases of HPAI reported in avocet species globally despite close contact with infected black-headed gulls at Minsmere in summer 2023 for example
Overall probability	Very low*	High because no data on avocets susceptibility

*Assumes two lows x four mediums equals very low.

Aggregated risk of infection of at least one nesting avocet per shoot day being infected on SPA in winter based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 24) is **low** from Figure 1 with high uncertainty.

Table 25: Woodpigeon to bittern - winter: Probability (per target bird) that dispersed bird infects the rare bird

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 200 m safe working distance of common tern (Table 12). Note that bitterns may be in reedbeds near to common tern

		nesting on wetlands. Not all pigeons will fly to the SPA even with just 200 m distance.
Probability target bird contacts rare bird species given bird is on site	Very low	Pigeons don't go into reed beds. They may associate with birds close to reed bed edges where bitterns sometimes feed, but bitterns are present in very low numbers and rarely come out of the reed bed hence very low probability of contact of pigeon with a bittern. Bitterns come out of the reeds when water is iced over and they cannot feed, which would not increase risk of exposure to pigeons.
Probability rare bird is infected given exposure	High	Cases of HPAI reported in heron species
Overall probability	Negligible	Medium

Aggregated risk of infection of at least one bittern per shoot day being infected on SPA based on n = 500 woodpigeons (Table 11) with negligible per bird risk (Table 25) is **very low** from Figure 1 with medium uncertainty.

Table 26: Woodpigeon to nesting marsh harrier - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 750 m of Marsh Harrier nest.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Low	Dispersion of 500 m in Table 11 relative to 750 m safe working distance of hen harrier chicks (Table 12). Not all pigeons will fly to the SPA given 750 m distance.
Probability target bird contacts rare bird species given bird is on site	Medium	Marsh harrier would scavenge carcase of pigeon if it died on the SPA. There is only a low probability that the infected pigeon will die from HPAI on the SPA on the day of the shoot. However, there is a medium probability that the infected pigeon will infect some of the many other waterbird species on the SPA which will die and be scavenged by the Marsh Harrier. Hence risk is medium through multiple bridging species at the wetland site.

Probability rare bird is infected given exposure	High	Cases of HPAI reported in raptor species, including related hen harrier in GB
Overall probability	Very low*	Medium

*Assumes two lows and three mediums equal very low.

Aggregated risk of infection of at least one nesting marsh harrier per shoot day being infected on SPA based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 25) is **low** from Figure 1 with medium uncertainty.

Table 27: Woodpigeon to hen harrier - winter: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 500 m of Hen Harrier roost.

Step	Probability	Uncertainty and notes
Probability HPAI is in wild birds	Very high	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Low	Dispersion of 500 m in Table 11 relative to 500 m safe working distance of roosting hen harrier (Table 12). Not all pigeons will fly to the SPA given 500 m distance.
Probability target bird contacts rare bird	Low	Hen harrier would scavenge carcase of pigeon if it died on the SPA. There is only a low probability that the infected pigeon will die from

species given bird is on site		HPAI on the SPA on the day of the shoot. However, the infected pigeon may infect some of the other bird species on the SPA which will die and be scavenged by the Hen Harrier. This could include pheasants and waterbirds such as herons, coots and moorhens depending on the habitat of the roost (moorland, bog). This risk is lower than at wetland sites and is lower for pigeons than for Canada geese. Hence risk is low through multiple bridging species at the wetland site. Prey species such as pipits could also be infected by the Canada goose although there is no information on this, other than a reed warbler case.
Probability rare bird is infected given exposure	High	Cases of HPAI reported in raptor species, including related hen harrier in GB
Overall probability	Very low*	Medium

*Assumes three lows and medium equal very low.

Aggregated risk of infection of at least one wintering hen harrier er shoot day being infected on SPA based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 25) is **low** from Figure 1 with medium uncertainty.

Table 28: Woodpigeon to stone curlew - summer: Probability (per target bird) that dispersed bird infects the rare bird. Assumes no shooting within 500 m of stone curlew nest.

Step	Probability	Uncertainty and notes

Probability HPAI is in wild birds	Medium	Low
Probability an individual target bird has been exposed to virus at the time of the shoot	Low	Pigeons would have relatively low exposures to other infected birds
Probability target bird is infected and sheds virus given exposure	Medium	Medium – pigeons are known to get infected and shed virus
Probability target bird seeks sanctuary on the SPA on shooting	Medium	Dispersion of 500 m in Table 11 relative to 500 m safe working distance of nesting stone curlew (Table 12).
Reduction in overflying by aerial dispersion of the target birds	Low	Not all pigeons will fly to the SPA given 500 m distance.
Probability target bird contacts rare bird species given bird is on site	Medium	The probability a woodpigeon lands near a Stone Curlew is medium as both could forage on the Breckland habitat.
Probability rare bird is infected given exposure	High	High – no data
Overall probability	Very low*	Medium, although no data on susceptibility, exposure is very low with medium uncertainty

*Assumes two lows and four mediums equal very low.

Aggregated risk of infection of at least one nesting stone curlew per shoot day being infected on SPA based on n = 500 woodpigeons (Table 11) with very low per bird risk (Table 25) is **low** from Figure 1 with medium uncertainty.

Results

The results are summarised for various wild bird species for Canada geese in Table 29. The wild bird species considered here are chosen on the basis of being representative species. Other wild species also listed as SPA features include merlin, short-eared owl, goshawk, honey buzzard, sand martin, and grey heron. These have not yet been considered here.

Table 29: Summary of probabilities of infecting rare/vulnerable species by an individual Canada goose and aggregated probabilities based on 100 Canada geese being dispersed per day with a shoot.

Rare or vulnerable wild bird species	Probability (p) per individual Canada goose dispersed by shooting	Aggregated probability of infection of one or more wild birds for n = 100 Canada geese per day with a shoot	Uncertainty
Nesting terns summer	**Low**	**High**	**Low**
Waterfowl winter assemblage	**Medium**	**Very high**	**Low**
Wader winter assemblage	**Medium**	**Very high**	**Low**
Nesting avocets	**Very low/Low**	**Medium**	**High**
Bittern winter	**Very low**	**Low**	**Medium**
Marsh Harrier nesting	**Low**	**High**	**Medium**
Hen harrier roosting	**Low/Medium**	**High**	**Medium**

Stone curlew nesting	**Very low**	**Very low**	**Medium**

The results are summarised for each wild bird species for woodpigeons in Table 30.

Table 30: Summary of probabilities of infecting rare/vulnerable species by an individual woodpigeon and aggregated probabilities based on 500 woodpigeons being dispersed per day with a shoot.

Rare or vulnerable wild bird species	Probability (p) per individual woodpigeon dispersed by shooting	Aggregated probability of infection of one or more wild birds for n = 500 woodpigeons per day with a shoot	Uncertainty
Nesting terns summer	**Very low**	**Low**	**Medium**
Waterfowl winter assemblage	**Very low/Low**	**Medium**	**Medium**
Wader winter assemblage	**Very low/Low**	**Medium**	**Medium**
Nesting avocets	**Very low**	**Low**	**High**
Bittern winter	**Negligible**	**Very low**	**Medium**
Marsh Harrier nesting	**Very low**	**Low**	**Medium**
Hen harrier roosting	**Very low**	**Low**	**Medium**
Stone curlew nesting	**Very low**	**Low**	**Medium**

The aggregated probabilities are separated out according to season with winter in Table 31 and summer in Table 32.

Table 31 Results for winter. Probability of infection of one or more of those rare/vulnerable species per SPA site per day with a target bird shooting event. Based on disturbance of 100 Canada geese and 500 woodpigeons per bird shooting event.

	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Wader assemblage	Terns
Canada goose (n = 100)	Low	High	N/A	N/A	Very high	Very high	N/A
Woodpigeon (n = 500)	Very low	Low	N/A	N/A	Medium	Medium	N/A

Table 32 Results for summer. Probability of infection of one or more of those rare/vulnerable species per SPA site per day with a target bird shooting event. Based on disturbance of 100 Canada geese and 500 woodpigeons per bird shooting event.

	Bittern	Hen harrier	Stone curlew	Marsh Harrier	Wildfowl assemblage	Breeding waders (Avocets)	Terns
Canada goose (n = 100)	N/A	N/A	Very low	High	N/A	Medium	High
Woodpigeon (n = 500)	N/A	N/A	Low	Low	N/A	Low	Low

Route 2 General dispersion of non-target wild bird species within the site

Route 2 considers the implications of dispersion of non-target wild birds which could serve as bridging species to the rare or vulnerable birds on the sites. These non-target species could include other waterbird species such as ducks, geese and swans, larger species such raptors and also the many smaller passerine species such as starlings,

sparrows, tits and finches. Dispersion of ducks, geese and swans can be considered under the Canada goose model in Route 1.

Raptors are generally present in very small numbers at low densities and their disturbance would make little impact on the HPAI risk although they may fly long distances if disturbed. Their contribution to the increase in risk would be lower than that for the pigeons/corvids considered in Route 1, and it should be noted that raptors cover large distances anyway when hunting.

Passerines being small do not tend to fly long distances when disturbed but more head for cover. Disturbance dispersal of starlings is likely to be less and pose less of a risk than their normal feeding-roost commuting (Bart Donato pers comm) which occurs in winter. Reedbeds roosts of starlings start to form in early September and are augmented as the autumn goes on and birds from East Europe arrive.

Large starling roosts continue through the winter into early Spring when the birds disperse to breeding sites. In winter the starlings fly long distances in small groups from their night roost sites in the reedbeds to their chosen feeding areas and then return late afternoon. Other groups of wintering passerines which could be dispersed by shooting include the winter thrushes (fieldfares and redwings). They also cover large distances and disturbance by shooting would not increase this.

Perhaps the most important group of birds to consider is other ducks and geese which are disturbed. The risk from these may be much higher than for the Canada geese considered here because of their larger flock sizes. Without data for numbers of non-target ducks at geese at protected sites, a risk assessment is not attempted here for this route. Thus, for example, the disturbance of a flock of 1,000 pink-footed geese would present a ten-fold higher risk than that from the 100 Canada geese considered here for each of the rare/vulnerable species in Table 1 and Table 2. This assumes the two geese species are equivalent in HPAI transmission and shedding.

Likelihood of disturbance of non-target wild bird species by shooting of target bird species

In Denmark, the mean flight initiation distance (FID) for a flock of 400-600 pink-footed geese birds was 500m, but this decreased to 300-400m in spring outside the shooting season. Similarly, in a German wintering area, flocks of 500-1000 white-fronted geese and bean geese reduced their FID from 500m to 200m following the end of the shooting season (Gerdes & Reepmayer 1983 cited in Fox and Madsen 1997).

In autumn-staging Brent geese feeding on mudflats, the FID of flocks of 200-500 birds increased in the course of the autumn season, from an average of 211m in late September (before intensive hunting started) to 367m in late October, after a period with intensive shooting (Madsen 1988).

Route 3 Scavenging of carcasses of shot/injured bird species

Shot corvid and pigeon carcases are generally left and could be scavenged by certain avian species in Table 7 including harriers, peregrines and merlins. Some target birds infected with HPAI would have died from the virus anyway and therefore could have been scavenged. The increased risk from shot birds therefore only applies to those infected target bird individuals which survive the virus or would have survived the virus if they'd not been shot. Peregrines can be ignored because they hunt live species anyway (Table 7) and catch them in flight although it is noted that disturbance by shooting could result in a target bird being caught in the air by a patrolling peregrine.

References

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