‘Shadow’ assessment of a plan or project under regulation 63 of the Conservation of Habitats and Species Regulations 2017 as amended (‘Habitats Regulations Assessment (HRA)’)

Case/application: The proposed 2023 re-issue of Defra’s General Licence 43 permitting the release of Common Pheasant and Red-legged Partridge within European Sites and within 500m of them

Assessment made by: Natural England for Defra

Date: This addendum dated January 2023

Sites considered: **All SPAs in England**

Assessment Contents:

Part A – Introduction and information about the plan or project

Part B – Information about the European Site(s) which could be affected

Part C – Screening of the plan or project for appropriate assessment

Part D – Shadow appropriate assessment and conclusions on site integrity

Appendices

References/Sources of evidence

PART A: Introduction and information about the plan or project and an initial assessment of credible risk to European Sites

A1. Introduction

This assessment forms an Addendum to Natural England's original Shadow HRA (Part 1 - SPAs) commissioned by Defra and dated January 2021. This is referred to as the 'Shadow HRA dated January 2021' hereafter.

A2. Details of the plan or project

Defra is proposing to reissue a General Licence GL43: licence to release common pheasants or red-legged partridges on European sites and within 500m of their boundary - GOV.UK (www.gov.uk) in spring 2023.

The current licence is valid until 30 May 2023. The proposed duration of the reissued GL43 on 31 May 2023 would be one year.

Subjects to its renewed HRA, Defra is proposing to re-issue GL43 for 2023 with the same Conditions that form an integral part of the GL43 issued for 2022.

The project under assessment is hereby referred to as 'GL43'.

A.3 Initial assessment of risks to Special Protection Areas (SPAs)

As per Natural England's original Shadow HRA dated January 2021.

PART B: Information about the Special Protection Areas (SPAs) and Ramsar sites which could be affected

B1. Brief description of the SPAs and their Qualifying Features

As per Natural England's original Shadow HRA dated January 2021.

B2. European Site Conservation Objectives

As per Natural England's original Shadow HRA dated January 2021.

PART C: Screening of the plan or project for appropriate assessment

To check whether a more detailed appropriate assessment is necessary, there are two screening tests required by the assessment provisions of the Habitats Regulations:

C1. Is the plan or project directly connected with or necessary to the (conservation) management (of the European Site's qualifying features)?

As per Natural England's original Shadow HRA dated January 2021.

C2. Is there a likelihood or a risk of significant adverse effects ('LSE')?

This section forms an addendum to Part C2 of Natural England's original shadow HRA dated January 2021 as commissioned by Defra as competent authority for the project and should therefore be read in conjunction with it.

C2.1 Risk of Significant Effects Alone

Risk-pathway sub-heading - Disease, parasite and environmental contamination

In this context, a risk-pathway is generally defined as a link or a causal connection between the constituent elements of a proposed project, and the ecological requirements of the designated features of the protected site. These represent the potential ways in which the project might credibly affect the designated features of European Sites. Consideration of these pathways has informed this initial screening assessment of risk, along with the likely location, proximity, type, scale, extent, duration, frequency and timing of each aspect of the project, if permitted.

This addendum is concerned with the assessment of the following additional risk-pathway identified during 2022 prior to any re-issue of GL43 in spring 2023:

> *The risk that a flock of kept pheasants or red-legged partridges released (under GL43) within or near to a SPA which are, or soon become, infected with High Pathogenicity Avian Influenza H5N1 (herein referred to as 'bird flu' or 'HPAIV') at the point of, or shortly after, their release during 2023 go on to*

directly or indirectly transmit HPAIV to wild birds which form part of a classified SPA population.

Contamination of the natural environment occupied by wild birds with pathogens, parasites, foreign compounds could lead to chronic effects on wild birds including direct viral transmission and secondary poisoning, which could lead to their reduced survival.

It is important to note this shadow HRA addendum is only concerned with examining the overall risk of gamebird releasing into SPAs and within a zone of 500 metres around them (the legislative scope of GL43), and not any wider risks to wild birds more generally from the releasing of gamebirds in other parts of the wider countryside. This addendum does not consider any consequential risks associated with the recreational shooting of released pheasants and red-legged partridges following their initial release and which may take place either within SPAs or around them.

The main evidence sources used to explore the existence of this risk pathway and the credibility or likelihood of an effect by the proposed activities and their consequential outcomes are identified in the References section at the end of this assessment.

C2.1.1 Risk of mortality to SPA birds caused by disease: pathways of transmission of HPAIV from released non-native gamebirds into SPA populations

Context

The reason for the consideration of this additional risk-pathway is because 2022 has been an unprecedented year for the sustained transmission of HPAIV within wild birds across Great Britain. Commercial flocks of poultry were also put at high risk from the disease, with infections prompting a number of restrictive Orders requiring indoor housing of poultry and strict biosecurity measures.

High Pathogenicity Avian Influenza ('bird flu') is a disease that can affect many bird species. Wild waterbirds of the orders Anseriformes (e.g., ducks, geese, and swans) and Charadriiformes (e.g., gulls, terns, and shorebirds) are considered the natural reservoir of avian influenza viruses, and their inter-continental migratory patterns and interactions with each other, with poultry and other captive birds has underpinned previous avian influenza outbreaks worldwide.

Avian influenza can spread by the movement of infected birds, from bird-to-bird by contact with contaminated body fluids and faeces, either directly or through contaminated objects and surfaces, or ingestion of infectious material. Transmission occurs directly via viral particles in body fluids, typically where birds congregate at high density, or indirectly via faecal contamination of the environment. The virus can persist for prolonged periods in the environment at low temperatures (up to 55 days at 4˚C) and can also be spread by humans on equipment, clothing and vehicles.

In Britain, the risk of avian influenza outbreaks typically increases in autumn and winter as migratory waterbirds arrive and then decreases during the summer as environmental conditions (warm, dry, high sunlight exposure) reduce virus survival and as migratory waterbirds leave. During 2022 however, the virus persisted in the UK throughout the summer months, causing significant breeding bird mortality in some populations.

In previous years, the national risk of HPAIV infection in wild birds has been considered low and has not been considered as a credible risk-pathway in previous HRAs of GL43. The risk of HPAIV in wild birds in Great Britain is currently assessed by Defra/APHA (January 2023) as being 'very high' (i.e., the event will occur almost certainly). At the time of writing, there have been 162 confirmed cases of highly pathogenic avian influenza (HPAI) H5N1 in the UK since 1 October 2022. There have been 278 cases of (HPAI) H5N1 in England since the H5N1 outbreak started in October 2021. Bird flu (avian influenza): latest situation in England - GOV.UK (www.gov.uk).

The 2022 outbreak caused the mass mortality of breeding seabirds at multiple coastal sites (including some UK SPAs). For example, high levels of mortality of Roseate Terns were recorded during 2022 at the UK's only breeding colony of this species on Coquet Island in Northumberland, and there were high levels of mortality reported at Sandwich Tern breeding colonies in Northumberland and Norfolk.

Mortalities in over 60 species of wild bird have been recorded, including resident populations of geese, swans and mallard. Birds of prey which typically scavenge on sick or dead prey items have also been affected; at the time of writing, there have been positive HPAI-H5N1 reports from APHA in a number of species during 2022/23, including common buzzard, sparrowhawk, kestrel, red kite and peregrine (an Annex I species on 1 SPA in England). During 2021, there were also several reported cases affecting hen harriers and white-tailed eagles. These figures will be a

substantial underestimate as they will only reflect those birds found dead, officially reported and selected for submission.

Previous HRAs of GL43 have been directly informed by the Evidence Review undertaken for Natural England and the British Association for Shooting and Conservation by Madden and Sage (2020). This concluded overall that there was, at that time, weak or ambiguous evidence that released game birds spread disease to non-game species (p6). It stated that whilst gamebirds were susceptible to notifiable diseases such as HPAIV (this being confirmed in pheasants in England in 2017), they appeared less susceptible to clinical effects than poultry. At that time, Madden and Sage went on to state that '*although there is the potential for gamebirds to spread these diseases to native fauna, including after release, in practical terms the likelihood of spread from infected gamebirds in the UK is low once an outbreak has been confirmed and game managers take appropriate remedial action'*.

Natural England's review of the Defra QRA 2022

This addendum to Natural England's shadow assessment of risk to SPAs has been informed by the recent Qualitative Risk Assessment (QRA) undertaken and published on the likely spread of High Pathogenicity Avian Influenza H5N1 (HPAIV) to wild birds from released, formerly captive pheasants during autumn 2022 (Defra, 2022). This qualitative risk assessment reviewed and evaluated the likely risks from HPAIV to 10 taxonomic groups of wild birds associated with 11 different habitat types as a result of pheasant releases during July and August 2022.

Whilst time-limited, the scope of the Defra QRA was broad and not limited to Protected Sites such as SPAs. It is however reasonable to consider SPA populations as a subset of the general wild bird population so the findings of the QRA are potentially of direct relevance and interest to this HRA.

According to the Defra QRA, it is now known that pheasants are susceptible to infection with HPAIV, this having been determined through experimental infection studies, the investigation of reported cases concerning pheasants and the testing of wild pheasants submitted via the APHA wild bird surveillance scheme. Several large die-off events in pheasants were reported in 2022 (Defra, 2022, p13).

Recognising the high background levels of HPAIV prevalence in wild birds during 2022, and the known susceptibility of pheasants to infection with HPAIV, the QRA

concluded that the likelihood of increased risk of HPAIV transmission to wild birds from pheasants infected after their release in July and August 2022 was:

Very high for Anseriformes (ducks, geese, swans), birds of prey, corvids, waders, gulls, wild pheasants
High for owls, passerines
Medium for pigeons
Negligible for seabirds (excluding gulls)

The Defra assessment defined these risk levels as:

Negligible - Event is so rare that it does not merit consideration
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

The QRA also concluded that there was a high to very high likelihood of wild bird infections as a result of pheasant releases in all habitat types apart from coastal, mountainous and rocky habitats.

The increased risk to wild birds associated with the release of pheasants infected prior to release was considered to be slightly lower due to the probable low numbers of pheasants infected but not displaying clinical signs of avian influenza at the point of release.

The conclusion reached by Defra in its QRA was that the consequence to wild birds of pheasant releases which had taken place during July and August of 2022 was 'MAJOR', with moderate uncertainty. The QRA defined a 'major consequence' as a '*Major impact for small population; systems significantly compromised and abnormal operation, if at all; high level of monitoring required'.*

In addition, the large numbers of pheasants that were released, and the available data on pheasant survival following their release, led the QRA authors to conclude that pheasants could constitute a reservoir of HPAIV during summer and autumn months, and act as hosts for viral reassortment when exposed to new HPAIV strains in the autumn.

On reviewing Defra's QRA and noting its general scope, Natural England noted a number of omissions which Natural England also considers to be relevant as to the more specific question of whether the proposed re-issue of GL43 during 2023 would be likely to have significant effects on SPAs. These omissions are addressed below.

(a) The anticipated risks to wild birds (including SPA populations) associated with pheasant releases during summer 2023

The likelihood that HPAIV H5N1 will continue to circulate in wild birds in July/August 2023

The 2021/22 outbreak of avian influenza was unprecedented in its scale and duration. During the year, 158 cases of HPAIV were confirmed in the UK in captive bird units for example. In 2021/22 HPAIV transmission continued into summer months despite higher temperatures and UV light levels, both of which are usually associated with rapid inactivation of influenza viruses. As a result, and unlike previous years, the risk of HPAIV in wild birds remained at MEDIUM during the summer months when pheasants were most likely released.

It has been proposed that the current strain of HPAIV - H5N1 - is more transmissible than previous strains (APHA, *pers. comm*.). The mechanism for this increased transmissibility is poorly understood at present but is likely to be due to:

i) the potential for H5N1 viruses to persist in wet faeces with no detectable loss of infectivity after 40 days at 4˚C (Shortridge *et al,* 1998)
ii) the survival of H5N1 for up to seven months in freshwater at 0˚C or two months at 10˚C (Nazir *et al*, 2010) and
iii) the infective potential of the currently circulating strain of H5N1 at extremely low viral concentrations (Ahren *et al*, 2022).

Influenza viruses are considered to be prone to antigenic drift and shift resulting in changes in pathogenicity. However, Shortridge *et al* (1998) demonstrated limited antigenic drift through antigenic analysis of H5 viruses isolated between 1979 and 1997 from domestic poultry in Hong Kong and this may be true of the current strain of HPAI in circulation: as of November 2022, the predominant HPAI strain of H5N1 isolated from the most recent wild bird cases submitted to APHA is largely unchanged from the strain circulating in the summer of 2022 (APHA, *pers. comm*).

Experimental studies in chickens demonstrated that, unlike other HPAIV strains, faeco-oral rather than aerosol is the main transmission route for the H5N1 strain (Shortridge *et al*, 1998). Wild birds in close proximity to released gamebirds are therefore most likely to be exposed to H5N1 via faecal contamination of food (vegetation, invertebrates, seeds etc.) which is then ingested, or, in the case of predatory and scavenging wild birds, via ingestion of the carcass.

Due to the prolonged environmental persistence and low infective dose reported for this strain of HPAIV, Natural England considers it likely that there will still be a widespread prevalence of HPAIV infection in wild birds in summer 2023 (with medium confidence).

The potential for pheasants to be infected with HPAIV H5N1 in summer 2023

Defra's QRA reports that pheasants are susceptible to infection with the H5N1 strain and that several large die-offs attributed to avian influenza were reported in pheasants in 2022. If the strain of HPAIV circulating in 2023 is very similar to the strain evaluated for the QRA, pheasants are likely to continue to be infected with HPAIV H5N1 if exposed in 2023 (high certainty).

The potential for contact between released pheasants and wild birds

In general, between 39 and 57 million pheasants (Madden and Sage, 2020) are released into the wider countryside from the end of June onwards in preparation for the start of permitted shooting on October 1. During this time, it is estimated that mortalities due to predation and starvation are high but that 60 - 80% of released pheasants will survive to the start of shooting (Defra, 2022 from Turner and Sage, 2003). These data therefore suggest that, in a typical year, between 23.4 and 45.6 million pheasants are added to the wild pheasant population. This compares to a total estimated UK population of 83 million breeding pairs of wild birds. Backburn and Gaston (2021) estimate that each year common pheasants and red-legged partridges make up around 25% of the total British bird biomass, and during the peak of releasing in August estimated that this could rise to nearly 50%.

The releases of pheasants and red-legged partridges regulated under GL43 (and the focus of this shadow assessment) represents a small fraction (<1%) of the total released annually, without restriction, into the wider countryside. According to the data reported by GL43 licence users to Defra and Natural England as a condition of GL43 during the 2021 and 2022 releasing season, a total of just over 550, 000 game

birds were released under General and Individual Licence (combined) during 2021, falling to a combined total of 279, 173 birds during 2022.

At individual release sites, and despite the current limits placed by GL43 on releases taking place within or close to European Sites (SACs and SPAs), the number of pheasants and red-legged partridges may be in excess of local wild bird and SPA populations. The average total number of pheasants released per individual release was approximately 1018 individual birds, and 1334 for red-legged partridge. The size and overall biomass of these flocks may therefore be high relative to the typically low population size and density of wild birds which can be present on some SPAs. However, the paucity of directly comparable data on local wild bird abundance was recognised in Defra's QRA.

Releases were reduced during 2022 and the QRA reports anecdotal evidence of substantially fewer releases than normal. This is further supported by data directly reported to Natural England by GL43 licence users during 2022 under Condition 3 of GL43. Reasons for this are likely to be include a lower availability of poults during 2022, especially those imported from the EU, and the voluntary relocation of release pens to locations away from European Sites where no licence-based restrictions operate (a survey of industry stakeholders carried out in 2021 found that 25% of respondents stated they would re-locate pens to avoid requiring a licence). It is not currently known if this downward trend will continue into 2023. In some parts of the country, statutory restrictions prohibiting releasing within the 3km HPAIV disease control zones may also have been a factor.

Defra's QRA assessment of the likely exposure of wild birds (which would also apply to SPA birds) to released pheasants is based on an estimated number of effective contacts between them (Defra, 2022, p19). An effective contact is defined as a direct or indirect contact that results in infection of a wild bird through close contact, contact with a contaminated gamebird environment or through scavenging of infected pheasant carcass. The assumption made is that the number of wild bird contacts with pheasants and/or their release environs (directly or indirectly) will be directly related to the number of wild birds of a given species present within or close to a release area.

The peak time for releasing of pheasants and red-legged partridge is generally July – August when the number and density of released game birds will be highest. This period can coincide with the latter part of the wild bird breeding season, being as this can generally extend from February – September each year (with April – July being the peak time for breeding activity) depending on the species and the prevailing environmental conditions. The breeding season will start with territory/nest building

and end with the fledging of chicks. There will be some inter-annual variability in timings and some extremes of variability.

Where there may be no direct overlap between a breeding bird season and a gamebird release in late summer, there may be residual impacts left behind by kept game birds in terms of ground surface contamination that could still present a contact-pathway of transmission to local wild birds. Resident species of wild birds infected during the autumn/winter months may not survive to return to their breeding sites the following spring.

Interaction between released but kept gamebirds and SPA birds could generally occur in a variety of ways, exposing both sets of birds to disease risk. The risk to those SPA feature species which are unlikely to leave their SPAs during their relevant season will be largely dictated by the location of release sites, the dispersal of released game birds and their movement into their SPAs. Some more mobile SPA feature species which do not directly interact with gamebirds may utilise 'functionally linked land'[1] (e.g., wetland, farmland, grassland etc.) around their SPAs which may also be utilised by foraging or roosting gamebirds. Other SPA feature species likely to utilise functionally linked land around the SPA may also directly interact with gamebirds (most significantly though predation of sick individual birds and scavenging of carcasses. SPA species may be at risk from both bridging species and the more direct exposure pathways outlined above.

Natural England therefore considers that the number of potential contacts between released pheasants and wild birds during 2023 will be generally unchanged from those considered by Defra's QRA and could be potentially higher if pheasant release numbers are restored to previous levels (high certainty).

The potential for wild birds to be infected by released pheasants

In 2021/22 APHA reported mortality associated with HPAIV infection in 59 species of wild bird across all the taxa under consideration in the Defra QRA. Serology testing to assess previous exposure to, and recovery from, HPAI has not been undertaken at scale to date. There have been anecdotal reports of birds of some species recovering from apparent infection with HPAIV, but it is widely believed that all taxa, other than Anseriformes, become acutely ill and die rapidly after the onset of clinical signs. It is therefore very unlikely that generally there will be significant numbers of wild birds with immunity to HPAIV in summer 2023.

[1] The term 'functionally-linked land' intends to describe areas of land or sea occurring outside of a designated site, but which nonetheless are critical to or necessary for the successful ecological or behavioural functioning in a relevant season of a qualifying feature for which that site has been designated.

Wild birds (including SPA birds) are likely to remain susceptible to severe disease and mortality following infection with HPAI H5N1 resulting from contact with infected pheasants (medium certainty).

Conclusion

Natural England believes that the conclusions of the QRA (Defra, 2022) relating to pheasants will be generally applicable to the anticipated situation in summer 2023. Considering the potential for common pheasants to become infected with HPAIV and the potential for their direct and indirect contact with wild birds such as designated SPA populations, pheasant releases are likely to be associated with an increased risk of exposure and infection of wild birds with HPAIV, including those forming part of classified SPA populations.

(b) The anticipated risks to wild birds associated with red-legged partridge releases during summer 2023

Given the likelihood of HPAIV prevalence in wild birds (the primary source of infection to gamebirds) will continue throughout 2023 and that wild birds across many taxa will continue to suffer from severe morbidity and mortality associated with HPAIV infection, this section considers the additional risks that may be posed by the release of red-legged partridges in 2023.

The potential for partridges to be infected with HPAIV

There are no published studies demonstrating HPAIV susceptibility in red-legged partridges as far as the authors are aware. Experimental trials by the APHA suggest that red-legged partridges may be less susceptible to infection following exposure to HPAIV than domestic chickens and pheasants, with partridges only becoming infected following direct inoculation with high viral loads (Seekings *et al,* in press). One case of HPAIV infection in a red-legged partridge collected on 07/11/2022 in Stowmarket, Suffolk has recently been reported by APHA.

HPAI H5N1 has been demonstrated experimentally to infect the taxonomically related Chukar partridge (*Alectoris chukar*) leading to HPAI-associated clinical signs and 75% mortality (n=9); Perkins and Swayne, 2001). However, the onset of clinical signs and mortality reported by Perkins and Swayne (2001) was less rapid in Chukar partridges when compared to domestic chickens which may indicate that H5N1 is of lower pathogenicity in this species. Similarly, Humberd *et al* (2006) found that

Chukar partridges were less susceptible to infection than Chinese ring-necked pheasants when experimentally inoculated with ten influenza HA subtypes (HPAI and LPAIV) and exhibited no clinical signs of associated disease following infection.

Red-legged partridges may also be kept at high densities within their release pens, typically 250 birds in a pen 10x10 metres (Madden and Sage, 2020). High stocking densities may increase the likelihood that red-legged partridges will be exposed to HPAIV and also increase the viral load that birds are exposed to. It is therefore possible that partridges will be infected with H5N1 even if they are not particularly susceptible to infection.

Therefore, it is likely that red-legged partridges kept at high densities may be infected with HPAIV (low certainty).

The potential for contact between released partridges and wild birds

Madden (2020) reports that the APHA Poultry Register recorded 1371 sites within the UK holding a total number of 3,807,263 partridges for release in 2019. However, this may underestimate the total number of birds reared for release as not all shoots will register with compliance believed to be as low as 40% (Madden and Sage 2020). Madden (2020) reviewed several other datasets and estimated that the true number of red-legged partridges reared for release was likely to be 9.1 million per annum (range 5.6-12.5 million). For comparison, Madden (2020) reports that 3441 sites holding pheasants were recorded on the 2019 Poultry Register and estimated a total release population of 31.5 million pheasants (range 29.8 - 33.7 million). These data suggest that pheasant abundance and the number of pheasant shoots is roughly three times higher than for partridges. As 95.7% of all sites listed on the Poultry Register release pheasants (Madden, 2020), it is likely that many red-legged partridges are reared and released on sites that also release pheasants.

Releasing of red-legged partridges is typically associated with open country, usually arable farmland but also lowland grassland and amongst bracken stands on moorland fringes. GL43 specifies that partridge release pens should only be sited in cover crops in arable farmland or improved grassland (habitats which would normally be excluded from Protected Sites) whereas pheasant release pens are usually placed in woodland or woodland margins. Opportunities for direct contact between red-legged partridges and SPA birds would seem to be limited as a result. Nevertheless, camera trapping has shown that both pheasants and red-legged partridges will visit the same supplementary feeding stations post-release (Sánchez-

García *et al,* 2015) and so it is likely that, on farms where both species are reared, there will be overlap in the range occupied by both which could increase the overall density of gamebirds gathering around feeding stations.

Partridges are usually 'trickle-released' with a successively smaller number of birds retained in the pen which call to released birds (Madden and Sage, 2020). This management, combined with supplementary feeding and cover crop planting, helps to discourage partridges from dispersing widely with 90-95% of released partridges remaining within about 1km of the release point (Sage *et al*, 2020). A small number of partridges may disperse slightly further from release sites than pheasants, with 5% of released partridges being found over 1.5km from the release site (Madden and Sage, 2020) but it is likely that partridge densities around release sites remain high following release.

Post-release feeding of partridges is widely practised with an estimated 85% of pheasant and partridge shoots providing supplementary food between August and January (Mason et al, 2020). Supplementary feeding has been associated with higher abundances of raptors and ground-nesting birds in Spain (Sage et al, 2020). In England, camera-trapping by Sánchez-García *et a*l (2015) recorded the presence of 33 bird species, including15 species of songbird, including dunnock, Eurasian blackbird, yellowhammer, house sparrow, common linnet, song thrush, common starling, robin and common chaffinch at 259 bird feeders on three farms with both pheasants and red-legged partridges between 2011 and 2013. Such birds can form part of the diet of a number of predatory wild bird species.

Higher incidence of trichomoniasis has been reported in pigeons and doves on farms providing food for gamebirds (Mason et al, 2020) demonstrating that an increase in wild bird numbers and densities at gamebird release sites can be associated with an increase in disease transmission.

There is therefore potential for partridge releases to increase the abundance and density of game birds at release sites over the levels considered in the QRA and therefore increase the potential for contact between released gamebirds and wild birds of SPAs (medium certainty).

The potential for red-legged partridges to disseminate HPAIV

As noted above, there are very few studies examining HPAIV infection in red-legged partridges. However, unpublished data from experimental trials conducted by APHA

suggests that red-legged partridges may be less efficient at disseminating virus to conspecifics than other gallinaceous species such as chickens and pheasants, with onward transmission only occurring following inoculation with high viral loads (Seekings *et al,* in press). A small experimental study (n=11) in Chukar partridges detected viral antigen in both the respiratory and enteric tracts following inoculation with HPAI H5N1 (Perkins and Swayne, 2001). This would suggest that Chukar partridges infected with H5N1 have potential to transmit the virus in respiratory secretions and faeces and the same may be true of red-legged partridges. Similarly, in the study by Humberd *et al* (2006), Chukar partridges shed viable virus in their faeces for short durations, even in the absence of clinical signs of HPAI-associated disease. There is therefore a low likelihood that red-legged partridges could be a source of infection to other birds even if asymptomatic for avian influenza.

Bertran *et al* (2011) demonstrated high loads of HPAI H7N1 viral RNA in feather pulp over a week after experimental infection of red-legged partridges, indicating that partridge feathers and carcasses could be a source of environmental contamination and infection to other animals.

Red-legged partridges could disseminate HPAIV even if asymptomatically infected and their carcasses could be a source of infection to predators and scavengers even if the birds do not appear to have died from avian influenza (low certainty).

The potential for wild birds to be infected by released red-legged partridges

As noted above for pheasants, it is very unlikely that there will be significant numbers of wild birds, including SPA birds, with immunity to H5N1 in summer 2023. It is therefore very likely that susceptible wild birds will be infected with H5N1 if exposed to virus shed by red-legged partridges.

Wild birds are likely to be susceptible to severe disease and mortality following infection with H5N1 resulting from contact with infected partridges (medium certainty).

Conclusion

Considering the potential for red-legged partridges to be infected with HPAIV and the potential for contact with wild birds, Natural England's view is that releases are likely to be associated with an increased risk of exposure and infection of wild birds including those forming part of classified SPA populations with HPAIV H5N1.

(c) The potential of 'bridging species' to disseminate HPAIV beyond the release area during summer 2023

The Defra QRA did not consider the role of bridging species, such as gulls that may travel considerable distances in their foraging activities, to act as vectors to disseminate HPAIV beyond a gamebird release site. Natural England considers that this is relevant to the assessment of likely significant effects on SPAs and to both pheasant and partridge releases as this could increase the potential for transmission to susceptible SPA species.

The likelihood that bridging species will visit pheasant/partridge release sites

Natural England is not aware of documented evidence of gull presence at gamebird release sites. However, these species are known to be regular visitors to farmland in general (Shriner and Root, 2020), as are starlings, lapwing and golden plover and are therefore very likely to be present on farms and estates releasing gamebirds. In addition, as omnivorous species, there is a high likelihood that gulls, particularly herring, lesser black-backed, black-headed and common gulls, and starlings would be attracted to grain feeders. Buzzards have been reported at higher densities around pheasant release sites (Swan *et al,* 2020; Pringle *et al,* 2019). Corvids are also likely to be attracted to gamebird release sites: crows, rooks and jackdaws were camera-trapped at gamebird feeding stations by Sánchez-García *et al* (2015) and crow and jay abundance has been positively associated with gamebird presence (Pringle *et al*, 2019).

Natural England considers that there is potential for bridging species to visit gamebird release sites (high certainty)

The potential for bridging species to be exposed to HPAIV H5N1

Infected gamebirds are very likely to contaminate soil, feeders and water sources with virus in their faeces. In addition, grain feeders may be contaminated by virus in respiratory secretions while gamebirds are eating. Where birds are at high density, there is likely to be a high level of environmental faecal contamination. Viral survival during summer, when environmental temperatures and UV light levels increase, would be expected to be shorter than during winter months. Nevertheless, it has been experimentally demonstrated that HPAI H5N1 may remain viable in wet and dry poultry faeces for four days at 24˚C (Kurmi *et al*, 2013) and for 19 days at 20˚C in freshwater (Nazir *et al,* 2010), typical temperatures during late summer and early

autumn. Foraging birds are likely to stand in gamebird faeces on the ground which may adhere to the under-surface of their feet. In addition, gulls, birds of prey and corvids would also be expected to opportunistically predate or scavenge sick, dying and dead gamebirds.

Bridging species at gamebird release sites are likely to be exposed to HPAIV H5N1 if kept gamebirds are or become infected (high certainty)

The potential for bridging species to disseminate HPAIV beyond gamebird release sites

Faeces adhered to bird feet could be transported some distance from a gamebird release site as birds fly between foraging sites, and subsequently transferred into the environment – soil or water – when the bird lands. As HPAIV H5N1 has been demonstrated to remain infective for at least 4 days in both wet and dried faeces and more than two weeks in water at summer temperatures (Kumar *et al*, 2013; Nazir *et al,* 2010) there is a high likelihood that viable virus shed in faeces by infected gamebirds could be moved to a new location.

The potential for bridging species to disseminate HPAI H5N1 will vary according to the species' ecology and time of year. The most extensive risk zones are likely to be associated with starlings which will commute 10's of kilometres to winter reedbed roosts, and gulls which have large foraging ranges in both summer (from breeding colonies) and winter (to roost waterbodies). Woodward *et al* (2019) identify mean maximum foraging ranges for gull species as:

- Herring Gull: 58.8(+/- 26.8) km
- Lesser black-backed Gull: 127(+/- 109) km
- Black-headed Gull: 18.5 km
- Common Gull: 50 km

During the non-breeding season, gull home ranges are generally smaller but may be locally significant. For example, O'Hanlon et al (2022) report a median range of 30.5 km for herring gulls originating from five different breeding colonies and GPS tracked in winter. For starling, Whitehead (1994) cites the report by Wynne-Edwards (1929) that starlings travelled 38 km between a feeding area and roost site, while a North American study observed starling ranging distances of up to 80 km (Hamilton & Gilbert, 1969). Hen harriers – a UK SPA species - are likely to range approximately 10km while hunting (Arroyo *et al*, 2014).

Corvids, pigeons, and other small passerines are potential bridging species but are less likely to commute from farmland to SPA sites on anything more than a local (<5km) scale. In addition to acting as mechanical vectors for H5N1 dissemination, bridging species that become infected and viraemic themselves could spread H5N1 in faeces and respiratory secretions at new sites some distance from gamebird releases. For example, starlings have been shown experimentally to shed H5N1 without signs of clinical disease (Boon *et al*, 2007). The QRA (Defra, 2022) estimated that the likelihood of HPAIV infection in gulls was very high in farmlands and wetlands and, overall, this likelihood was estimated as very high.

Natural England considers that the extended ranging distances of bridging bird species and prolonged virus survival could result in HPAIV being spread to SPAs at some distance from gamebird release sites, many of which will be outside the scope of GL43 due to their distance from SPAs (medium certainty)

The potential for wild birds including SPA birds outside the expected contact zones to be infected with HPAI H5N1

Susceptible wild birds could be exposed to HPAI H5N1 by eating food or drinking water that has been contaminated via faeces on birds' feet or excreted by infected bridging birds. The likelihood of this occurring is increased by the potential for prolonged HPAIV persistence, particularly in water, but will vary from species to species and site to site depending on the density and behaviours of birds present. H5N1 in freshwater has been shown to be infective to susceptible bird species even at very low viral concentrations (Ahrens *et a*l, 2022).

In addition, predatory or scavenging birds such as raptors, corvids and gulls could be exposed to HPAIV by ingesting the carcasses of infected bridging birds. If exposed, birds of most species are likely to become infected because the infective dose of HPAIV is believed to be low.

Natural England considers that wild birds (including those designated populations on SPAs) present beyond normal gamebird contact zones could be exposed to and infected with HPAIV disseminated by bridging species (medium certainty)

The potential for HPAIV infections in birds to be increased above the background level due to bridging species

Although birds considered to be bridging species, in particular gulls, have potential to disseminate HPAIV from gamebird release sites to more distant areas including SPAs, the gregarious and wide-ranging nature of these species means that they are likely to be foraging in multiple environments and birds within a group may therefore be exposed to HPAIV through many routes.

Nevertheless, in late summer when gamebirds are typically released, gulls may still be at their breeding sites and foraging trips may be biased towards locations where food resources are readily available. It is therefore possible that central point foragers will preferentially visit farms where supplementary feed is regularly provided to gamebirds and thereby increase their potential for exposure to HPAIV and dissemination to the breeding site if gamebirds are infected.

Because of the scale at which bridging species move daily, and the potential for direct contact at both ends of these movements with either gamebirds or SPA features of interest, the risk associated with gamebird releases may extend a considerable distance (potentially up to 127km depending on the species involved) from release sites and may potentially put SPAs at risk.

The QRA (Defra, 2022) estimated the risks to seabirds associated with pheasant releases to be negligible. Natural England considers that bridging species have the potential to act as vectors between gamebird release sites and distantly located birds (e.g., those present on SPAs) which could become infected with HPAIV as a result. However, Natural England considers the increase in risk over and above the pre-existing background level of risk is likely to be low. Natural England estimates that consideration of this additional route to HPAIV dissemination by way of bridging species increases the QRA risk from 'negligible' to 'low' (i.e., a rare event but can occur).

C.2.1.2 Overall assessment of risk of likely significant effects on SPAs

Following the consideration and identification of the specific risk-pathways associated with the releasing of non-native gamebirds and the potential for infection of wild SPA birds above, this section considers the specific risks to SPA species.

The risk to SPA features is likely to be determined by the potential for contact and the spatial overlap between SPA features and gamebirds, or SPA features and bridging species. Three categories have been identified:

- SPA feature species unlikely to leave SPAs and for whom risk is dictated by gamebird dispersal
- SPA feature species likely to utilise functionally linked land around their SPA but do not directly interact with gamebirds
- SPA feature species likely to utilise functionally linked land around their SPA and may directly interact with gamebirds (most significantly though predation of sick individuals)

Of the SPA listed features, only those non-breeding features associated with the inshore marine environment (such as divers and sea ducks), species restricted to highly exposed rocky coasts (such as purple sandpiper), or those associated with heathland and scrub (such as Dartford warbler and woodlark) are likely to avoid coming into contact with bridging species.

Natural England consider all other features are likely to be at increased risk from HPAIV associated with gamebird releases.

A list of SPAs and SPA features Natural England considers to be potentially at significant risk is attached at Appendix I.

C2.2 Risk of significant effects in-combination with effects from other proposed plans and projects

As per Natural England's original Shadow HRA dated January 2021.

C3. Overall Screening Decision for the Plan/Project

Based on the details submitted about the proposed project, Natural England has made a 'shadow' assessment of whether it is likely to have significant effects on any SPA, either alone or in-combination with other plans and projects.

This addendum to Section C2 and C3 of Natural England's shadow HRA dated 2021 covers an additional risk-pathway of the direct or indirect transmission of HPAIV from released gamebirds causing significant adverse effects on wild birds forming part of classified SPA populations.

Natural England believes that the overall conclusions reached by the Defra QRA in light of 2022 are likely to be applicable to the anticipated situation relating to HPAIV in summer 2023. Given the known susceptibility of gamebirds to HPAIV and the

potential pathways of interaction and exposure considered above, Natural England believes that there is a significant additional or amplified risk of transmission of HPAIV to designated features of SPAs from HPAIV both local to release sites and - potentially - at sites remote from release sites via bridging species of bird. We have:

- High confidence of additional risk from pheasant releases
- Medium to low confidence of additional risk from red-legged partridge releases
- Low confidence of additional risk to remote sites from bridging species

In light of Part C of this assessment above, Natural England has concluded that since the plan or project is likely to have significant effects on some or all of the Qualifying Features of any SPA, a shadow appropriate assessment of the project is required.

PART D: Shadow Appropriate Assessment and Conclusions on Site Integrity

D1. Scope of Shadow Appropriate Assessment

In light of the screening decision above in section C, this section contains the shadow appropriate assessment of the implications of the plan or project in view of the Conservation Objectives for the European Site(s) at risk.

The Sites and the Qualifying Features for which significant effects have not been ruled out in section C2 above and which are relevant to this appropriate assessment are:

- All classified SPAs (excluding wholly marine SPAs)

Each of the 'likely significant effects' on bird features identified in Part C are examined under appropriate assessment through the two tables in Section D3 below.

D2. General statement on the current status, influences, management and condition of the European Sites and those Qualifying features as potentially relevant to the plan or project

As per Natural England's original Shadow HRA dated January 2021.

D2.2 Conservation Objectives

An appropriate assessment of the implications of the plan or project for a European site must be made in view of that site's conservation objectives (regulation 63(1) of the Habitats Regulations 2017).

Of the six overarching Conservation Objectives advised by Natural England for SPAs (see Conservation objectives for land-based protected sites in England: how to use the site advice - GOV.UK (www.gov.uk), the three attributes of most relevance to the likely effects of this project are –

- The supporting processes on which the habitats of their qualifying features rely,
- The population of each of their qualifying features, and

- The distribution of their qualifying features within the site.

As regards this particular addendum, and this additional risk-pathway of accidental HPAIV transmission from released gamebirds into SPA populations, the relevant SPA Conservation Objective attributes being considered are -

- Non-breeding population: abundance
- Breeding population: abundance

D3. Assessment of potential adverse effects to SPAs, considering any incorporated and additional mitigation measures

This section considers the risks identified at the screening stage and set out in section C2. It further examines whether the risk of these potentially significant effects adversely affecting the integrity of SPAs can be generally ruled out in all aspects, having regard to the manner in which the plan or project described in section A2 would be carried out if a permission was granted. This section also takes into account restrictions and conditions that will be ordinarily imposed on the project's General Licences, irrespective of the presence of European sites.

Should it materialise, the additional risk of a significant adverse effect (i.e., a reduction in population abundance through mortality from HPAIV) through this risk-pathway may have a consequentially disproportionate and highly significant adverse impact on internationally important bird species/assemblages associated with SPAs. For example, if a single SPA bird was exposed to HPAIV through a direct or indirect contact with a released gamebird and then infected the wider SPA population, there is likely to be a significant population-level impact. Even a lesser HPAIV impact on a SPA population might also add to existing threats and pressures being felt by that population. Both impacts would be likely to undermine the achievement of conservation objectives to maintain or restore the abundance of the SPA population to the recommended level.

Population size and density of SPA populations can also vary from site to site. Species groups with particular apparent vulnerability, including seabirds and waterbirds, are frequently features of SPAs because of the aggregations they form in discrete and predictable locations. Introduction of HPAIV to these high-density bird areas directly, or more likely in intertidal areas via contact with bridging species, could present an elevated risk of adverse effects on integrity, especially given the rapid spread and severity of infection seen in the summer 2022 seabird colony

outbreak. Such transmission could lead to mortality-driven declines in abundance of SPA features, which could be sufficiently significant to undermine conservation objectives for the site. Other SPA populations may be present at lower density and in smaller numbers (e.g., raptors), and their conservation objective may well be to significantly restore and increase their abundance to a thriving, resilient and self-sustaining population. In these circumstances, spread of HPAIV following contact with released gamebirds may be less rapid due to its scattered nature of the SPA population but still be significant enough in view of an already fragile SPA population.

As outlined earlier, it is however recognised that there is an existing high background risk of HPAIV transmission to SPA birds from other wild birds which may be infected or acting as vectors for the virus. And although Natural England considers there to be a credible risk or possibility of significant adverse effects on SPAs arising from the direct or indirect transmission-pathways of HPAI from infected released gamebirds, it recognises that there is significant scientific uncertainty as to the nature of impacts on wild bird populations, including SPA features, and therefore site integrity. The authors of the Defra QRA acknowledged the high level of uncertainty underpinning their conclusions due to a number of knowledge gaps, including the precise number and location of pheasant releases and the likely contact rates between pheasants and wild birds.

It may also be debatable the extent to which many SPA species would come into direct contact with gamebird habitats and release pens which are set in woodland and farmland habitat, or red-legged partridge release areas with cover crops. It could be argued that very few SPA species would directly move into and forage immediately within or around gamebird release pens or release areas, particularly those located within closed woodland settings. However, it is equally possible that released gamebirds may disperse into and congregate within habitat that is also utilised by SPA species whilst they are feeding, foraging or roosting, or come into contact with bridging species that might 'connect' gamebirds to SPA species. It is also acknowledged that, at this stage of gamebird management, released but kept birds can disperse but likely to stay close to their release area whilst they remain dependent upon feed and water being supplied by a keeper.

Despite the identified risk-pathways being present throughout 2021 and 2022, and the data gathered during the unprecedented outbreak of 2022 and the high mortality of wild bird population associated with some coastal SPAs, Natural England is also not aware of confirmed evidence as yet that demonstrates actual cause-and-effect

transmission between released pheasants or red-legged partridge and wild birds (including SPA birds).

Nonetheless, whilst background levels of HPAIV are considered high, Defra's QRA concluded, with only moderate uncertainty, that there were potentially '*major consequences'* to wild birds from pheasant releases into the wider countryside during July and August 2022. It is Natural England's view that the prevalence of HPAIV is likely to occur again during 2023 (see section C2.1) and despite the reduction in the numbers of released gamebirds reported during 2022, a bounce-back in release numbers during 2023 to previous levels cannot be ruled out. It can be anticipated that there will be a significant ongoing demand from land managers to carry out or permit gamebird releasing under the terms of GL43 during 2023.

In light of the above, and mindful of the international importance of the bird populations associated with Special Protection Areas and the strict level of protection required to be given to them by the Habitats Regulations 2017, Natural England's advice is that, at this stage of assessment, an adverse effect on site integrity arising from the potential transmission of HPAIV from released and kept gamebirds to SPA populations cannot in principle be ruled out. Its advice is that it is therefore appropriate for Defra to consider further mitigating measures that would apply to protect SPAs where releasing of non-native gamebirds under GL43 takes place during 2023.

There is currently a general deficiency of data on the full effects of HPAIV. This also merits a precautionary approach to the issue, which can be proportionate to the level of risk.

D3.1 Possible risk-mitigation options to ascertain no adverse effects on site integrity

D3.1.1 Analysis of existing mitigating measures

As currently proposed, GL43 in 2023 would include the same conditions as 2022. These conditions currently comprise the following restrictions:

'Condition 1. Releases within European sites
For the release of common pheasants or red-legged partridges into the wild, the following conditions apply.

Common pheasants: release density

The density of common pheasants released within a European site must be no more than 700 birds per hectare of release pen, or lower if required by a site of special scientific interest (SSSI) consent. Any release, including single or trickle releases, must not exceed this limit. Where any common pheasants are shot or killed, you must not release further birds where this would exceed the allowed limit.

The density of red-legged partridges released within a European site must be no more than 700 birds per hectare of land they inhabit, or lower if required by a SSSI consent. Any release, including single or trickle releases, must not exceed this limit. Where any red-legged partridges are shot or killed, you must not release further birds where this would exceed the allowed limit. You must site red-legged partridge release pens in cover crops on arable land or on improved grassland within a European site. You must not site them in semi-natural or unimproved habitats.

Condition 2. Release of gamebirds within the 500m buffer zone of a European site boundary

For the release of common pheasants and red-legged partridges into the wild, the following conditions apply.

Common pheasants: release density

The density of common pheasants released within the 500m buffer zone of a European site must be no more than 1,000 birds per hectare of release pen. Any release, including single or trickle releases, must not exceed this limit. Where any common pheasants are shot or killed, you must not release further birds where this would exceed the allowed limit.

Red-legged partridges: release density

The density of red-legged partridges released within the 500m buffer zone of a European site must be no more than 1,000 birds per hectare of land they inhabit. Any release, including single or trickle releases, must not exceed this limit. Where any red-legged partridges are shot or killed, you must not release further birds where this would exceed the allowed limit.

Activity in the buffer zone
Any activity in the buffer zone must not encourage the released birds to inhabit or occupy an adjacent European site. This includes where you place pens and feed birds'.

There are several ways to implement mitigating measures to exclude or reduce the possibility of adverse effects on European sites. The most effective and secure route is through stipulating restrictive conditions on the General Licence. Conditions are enforceable and are therefore best to encourage and drive compliance, especially where the measures are critical to ascertaining no adverse effect on site integrity. Licence recommendations, sometimes alternatively termed 'important information' or 'notes', assist with interpretation of conditions and thus help clarify for licence users limits and parameters around the permitted activities to remain compliant.

These existing restrictions were originally put in place by Defra as licence conditions directly to avoid and minimise the risk of significant adverse effects on site integrity through excessive nutrient enrichment and ground disturbance causing significant deterioration in designated habitat structure and function (as previously assessed and examined by HRA (Defra, 2021) and informed by Madden and Sage, 2020).

These conditions, which, as proposed, are retained in 2023, might serve to indirectly ameliorate the additional risk of HPAI transmission into SPAs but this is to an unknown degree. What is known is that this additional risk-pathway was not considered in formulating these existing conditions and Natural England's view is that the current conditions cannot therefore be confidently relied upon to also satisfactorily mitigate this new risk to SPA features.

It is also relevant to note that where a case of HPAIV is confirmed amongst kept birds, one of the following statutory controls are put in place around the infected premises:

- a 3km protection zone and a 10km surveillance zone
- a 3km captive bird (monitoring) controlled zone

Information about the location and extent of these statutory zones is currently provided by the Animal and Plant Health Agency (APHA) interactive map.

The suite of Avian Influenza Regulations provides the necessary powers to compel or prohibit certain activity and set out what measures may be imposed by the

Secretary of State in outbreak circumstances. These measures can be imposed at a premises, local, regional or national level. Where Disease Control Zones are present around a known infected poultry premises and a 3km radius Protection Zone and 10km Surveillance Zone are declared, a range of restrictions on the movement of poultry (including gamebirds) and material associated with their keeping can apply. In these disease zones, it is already generally not permitted to release game birds.

These general measures are summarised in this Defra guidance on Bird flu: rules if you keep game birds - GOV.UK (www.gov.uk).

Natural England would therefore expect that these general control measures – applicable to any locality where there is a HPAIV outbreak amongst kept poultry and game birds – would also apply to situations within and close to SPAs. This already offers an existing measure specifically aimed at minimising the spread of HPAIV that can also help to minimise the risk to SPA populations should these be present in affected areas.

However, being triggered in response to a confirmed outbreak this general containment measure is not sufficiently anticipatory or wholly preventative to satisfy the requirements of the Habitats Regulations 2017. Natural England's advice is that Defra should consider the incorporation of additional mitigating measures into GL43 for 2023 to prevent and minimise the likelihood of HPAIV transmission to SPA birds in the first place and whilst gamebirds are still being kept and managed in their release areas. Natural England's opinion is that this will enable Defra to better ascertain whether adverse effects on the integrity of SPAs can be ruled out in accordance with regulation 63 of the Habitats Regulations 2017. This would be a precautionary step to reflect the acknowledged risk-pathways, the high degree of uncertainty as to the likelihood of HPAIV transmission and the nature conservation significance and strict protection afforded to SPA populations.

D3.1.2 Analysis of additional mitigation options

Defra's Mitigation Strategy for Avian Influenza in Wild Birds in England and Wales published in August 2022 provides limited specific guidance in terms of conservation or recovery responses for wild birds including SPA populations.

This shadow appropriate assessment therefore presents the following bespoke options for Defra to consider further in its HRA, noting that Defra as competent authority for GL43 may also wish to consider other options additional to those

identified above and specific to HPAIV considerations. The options have been presented in descending order of the likely certainty and confidence they offer, in Natural England's view, in mitigating the identified risks:

(A) No releasing within both SPAs and the current 500m SPA buffer zone or an expanded buffer zone

This general option would provide the clearest level of certainty that the risk of an adverse effect on SPAs would be significantly minimised. By not authorising releases within SPAs themselves and the adjoining 500m buffer zone through GL43, this option would provide further spatial separation and reduced overlap between released game birds and SPA birds.

Releasing of pheasants and red-legged partridges could continue beyond 500 metres without restriction or licence as this would be beyond the scope of GL43. However, given that released gamebirds and SPA birds will both be mobile and will disperse away from their release areas and SPAs respectively, to varying degrees, only preventing releases within 500m of SPAs may not sufficiently reduce the likelihood of contact.

A further possible option may therefore be to extend the geographical scope of GL43 by increasing the current width of the 500m buffer zone. This buffer zone was originally set to address the potential impacts on designated habitats within the boundaries of SACs and SPAs arising from high density gamebird releases around it, informed by the evidence relating to known dispersal patterns of the majority of released game birds from their release point. The purpose of this buffer zone was not only to place a limit on the numbers of pheasants and red-legged partridge that could be released in the immediate vicinity of a SAC or SPA but also that gamebird management activity within this zone discouraged released birds from congregating within the adjacent site (see Condition 2 of GL43 above). This set distance forms one of the statutory parameters of GL43 (Defra, 2021).

The distance of 500 metres set for the buffer zone was however not informed at that time by the potential risk of HPAIV transmission to SPA birds. As regards this risk, it could be considered that extending the width of the buffer zone in order to extend the control on gamebird releases that might take place beyond 500 metres could help to further reduce the likely spatial overlap and the likelihood of direct or indirect contact between released gamebirds and those SPA species (or bridging species) likely to

frequently leave their site to hunt, feed or roost on functionally linked land some distance away, land which could be subject to high density gamebird releases. The available evidence relating to the maximum foraging and dispersal distances of both SPA species and gamebirds shows that a considerable number of species will fly beyond 500 metres from their release area and/or their nesting/roosting sites as appropriate. There is moderate but consistent evidence from a series of tracking studies to indicate that the majority of released game birds do not generally disperse further than 500m from their point of release, inferring that game bird densities are typically higher closer to release pens and feeding stations (Madden & Sage, 2020). But some game birds will disperse further of course, with pheasants being recorded by some studies as moving up to 1000m from their release area (Madden & Sage, 2020).

The mean and maximum foraging distance of some SPA species out from their SPAs can be considerable and much further than 500 metres from a SPA boundary depending on the species, their ecological requirements, and the distribution of such supporting habitat (e.g., Scottish Natural Heritage, 2016) By way of example, foraging raptors and SPA species are known to travel much further than 500m to hunt and seek out sick and dead prey items. For example, during their breeding season hen harriers have a core hunting range of 2 km but may hunt over suitable habitat up to 10km from their nest sites (SNH, 2016; Arroyo *et al*, 2014). This range may not be fully encompassed by the designated SPA boundary. Similarly, non-breeding populations of wild swans and geese present as SPA features during the winter months can have an even greater core foraging range which may extend to suitable habitat 15 – 20 kms from their roosting sites within SPAs (SNH, 2016).

A buffer zone of 500 metres, even with controls placed on gamebird releasing within it, is therefore unlikely to significantly remove HPAI transmission risk-pathways and reduce the likelihood of interaction and contact between released gamebirds and SPA populations. An approach that would extend the current scope of GL43 (and its proposed scope for 2023) and would extend the geographical reach of the controls that could be placed on gamebird releasing close to SPAs may offer the greatest degree of certainty that risk would be sufficiently minimised.

The evidence to quantify the necessary extent of any standardised but wider SPA buffer zone in an attempt to spatially separate gamebird release areas from SPA birds and minimise HPAIV transmission risk is, however, limited. In addition, there is limited data for many SPAs as to the precise movements of SPA species beyond the site boundary and the location of important functionally linked supporting habitats.

As noted above, where a case of HPAIV is confirmed amongst kept birds, the statutory Avian Influenza Prevention Zones that are put in place around the infected premises extend to a radius of 3km. Gamebird releasing is then not permitted within that 3km zone. Whilst this may be an existing comparator, this distance does not appear to be set with the mitigation of ecological effects in mind.

A closer fit may be offered by Defra's current Avian Influenza 'Higher Risk Areas' which have been defined and mapped by Defra and APHA. These are areas close to substantial inland or coastal bodies of water where significant numbers of wild birds, and in particular, gulls and wild waterfowl, gather, such as lakes, marshes or estuaries, and forage. These areas have been established to highlight that the presence of these aggregations of wild birds in these localities are considered to pose a greater HPAI transmission risk to poultry farms and premises (and other kept birds) in their vicinity. Mandatory avian influenza prevention measures are not in force within these non-statutory Higher Risk Areas.

Of potential relevance to this shadow assessment is that these Higher Risk Areas have been informed not only by the density of wild over-wintering migratory waterfowl but also the typical foraging distances of those wild ducks, geese, and swans. These areas therefore incorporate a standardised buffer zone set at a 2 km radius intended to take the foraging movements of these wild birds into account. This distance, whilst greater than 500m, does not seem to reflect some of the available evidence cited above, however.

The current 500m buffer zone would seem to be an ineffective and limiting factor in fully mitigating this new particular risk of HPAIV transmission. However Natural England recognises that there may be practical constraints to pursuing this option to inform the GL43 for 2023. The Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England) (No. 2) Order 2021 formally defines the scope of GL43 as including a zone of 500 metres around a boundary of a European Site. This legislative underpinning of the 500metre buffer zone would appear to Natural England to make it difficult (but not impossible) to adjust without a further legislative amendment to address new and different risks such as HPAIV transmission. In other words, an option to extend the width of a buffer zone to extend the range of GL43 conditions and recommendation for 2023 would be dependent on Defra being able to deliver a legislative change to the 2021 Variation Order in time, and potentially subject to a prior regulatory impact assessment. We therefore recommend Defra

consider this option in further detail to assess its likely feasibility as a viable mitigation option.

(B) No releasing within SPAs - releasing within 500m buffer zones only.

Compared to option A above this option would provide less certainty that the risk of an adverse effect on SPAs would be wholly minimised. But by not authorising releases within SPAs themselves through GL43, this option would provide further spatial separation and reduced overlap between released game birds and SPA birds.

Based on the logic that reducing the number of gamebirds released within or immediately adjoining a SPA would reduce the chances of direct contact with wild SPA birds, this option would provide Defra with a degree of certainty that the risk to SPA birds from potential HPAI transmission linked to released gamebirds (additional to the background risk) could be significantly reduced. This option would best minimise the risk to those SPA species which are unlikely to leave their SPAs and for whom risk is strongly related to their direct proximity of gamebird releases and local gamebird dispersal.

Under this approach, GL43 would not however prevent releases occurring within the current 500m buffer zone around a SPA subject to the existing GL43 conditions of a restricted maximum density and restricted activity within the buffer zone. Given that the distance of 500m was not designed to minimise the risk of HPAIV transmission between released gamebirds and SPA birds, as explained above, such a residual risk may still remain under this approach.

If this option is pursued, further consideration could also be given to reducing the permitted release-density in the buffer zone as per option C below.

(C) Continue to permit releasing within SPAs and within 500m of a SPA but with reduced maximum release-density limits

The current release-densities in GL43 (no more than 700 birds per hectare of release pen within European sites and no more than 1000 birds per hectare of release area within 500m of European Sites), and which are proposed to apply during 2023, aim to ensure that where gamebird releasing does take place within or close to SACs and SPAs those releases take place at a low density which, based on a comprehensive evidence review, are unlikely to result in adverse ecological effects to designated habitats.

However, the effects of gamebird releasing which have informed the current release-densities have to date been limited to those associated with nutrient enrichment of the ground, changes in soil chemistry and subsequent impoverishment of the vegetation that forms part of designated habitats or supporting habitats (Natural England, 2020). The body of evidence that these adverse effects are likely to occur is strong and these negative effects tend to be spatially localised to and around the point of gamebird release (Madden & Sage, 2020). These generally sustainable release-densities which have been integral to GL43 during 2021 and 2022 do not take account of the risk of direct and indirect HPAIV transmission from kept gamebirds to wild SPA birds.

Defra's QRA (Defra, 2022) assumes and associates the level of transmission risk with numbers of released gamebirds, which may exceed local wild bird numbers at a release site. The more gamebirds that are released, the greater the risk of direct or indirect contact with wild birds. Reducing the overall potential for contact between aggregations of released gamebirds and local wild birds (including SPA species and bridging species) by reducing gamebird number and density would therefore seem a logical approach. Reducing the density and abundance of released gamebirds would also further reduce the magnitude of faecal contamination of the release area, which is considered to be a potentially significant pathway of HPAIV transmission to wild birds.

There is however currently scant evidence at this stage to identify a specific release density that would effectively minimise the risk of HPAIV transmission. Based on the logic above, and given the necessary generality of the licence, Natural England suggests that a 50% reduction in the currently permitted release density limit could provide a precautionary but also a simple, common-sense, and practical density which could be readily adopted into GL43. Such a reduction would mean a change from 700 birds per hectare of release pen within European sites to 350 birds as a maximum limit, and a change from 1000 birds per hectare of release area within 500m buffer zones to 500 birds.

A smaller reduction in release density maxima, for example by 25%, might provide a positive but more limited reduction in the potential exposure of SPA birds to infected game birds. Such a reduction could therefore be combined with mandatory biosecurity measures outlined above to provide Defra with greater confidence that the risk has been sufficiently mitigated.

A reduction – for 2023 only at this stage – would still enable releasing to take place where desirable but might provide Defra with sufficient certainty that the additional risk of HPAIV transmission, which is anticipated to remain high during 2023, into specially protected SPAs is to a degree being mitigated to further reduce the risk of any adverse effects including deterioration of designated habitats.

For the reasons outlined above, our confidence in the likely effectiveness of this mitigation measure in reducing HPAIV impacts to wild birds including SPA species is however currently moderate to low, as this will depend on the scale of the reduction. The larger the reduction, the more confidence there may be in its efficacy to minimise the risk.

(D) Continue to permit releasing within SPAs and 500m buffer zones at current release-density limits but with best-practice biosecurity measures (subject to further advice to Defra from APHA) as an additional mandatory requirement

Given the nature of this additional risk-pathway, biosecurity measures might play an important role in reducing the risk of introducing infected gamebirds into a release area and of them becoming infected shortly afterwards whilst being kept and then going on to infect local wild birds including SPA birds. Indeed, the implementation of such biosecurity measures to prevent the spread of HPAIV become mandatory within Avian Influenza Prevention Zones Bird flu: rules in disease control and prevention zones in England - GOV.UK (www.gov.uk).

Whilst they are being voluntarily encouraged to do so, including by their representative expert bodies such as GCWT (see this blog for example), gamebird keepers currently have no general statutory obligation to implement biosecurity measures outside of these statutory disease control zones. Defra's guidance on biosecurity and preventing welfare impacts in poultry and captive birds[2] sets out best practice measures applicable to 'poultry', which includes gamebirds, which are being reared or kept in captivity. Such best-practice measures are also widely endorsed by the gamebird releasing industry as standard good practice to deploy during gamebird shoots to protect the health of captive and kept game birds.

A number of these best practice measures are likely to be relevant to minimising risk to SPAs whilst pheasants and red-legged partridge are being introduced, actively

[2] Defra, Welsh Government & Scottish Government, 2022. *Biosecurity and preventing welfare impacts in poultry and captive birds - advice for all captive bird and poultry keepers (including game birds, waterfowl, and pet birds)*

managed and kept within their release areas and until they are no longer dependent on provisioning by a keeper. These measures might include:

- Reared game birds being checked by a vet on the day of release
- Released game birds being checked daily with sick birds trapped and humanely euthanised immediately
- Carcasses being actively searched for and removed immediately and disposed of appropriately, irrespective of confirmed HPAIV
- Increasing the number of feeding stations to reduce bird densities around each one with further consideration to location e.g., well away from habitats likely to be utilised by wild bird species of conservation importance.
- Feeding stations being regularly cleaned and placed on plastic sheeting that should be hosed down/disinfected regularly where possible
- Feeding stations for kept gamebirds being protected from local wild bird species
- Released game birds rounded up and rehoused immediately if an outbreak on site is suspected
- Grossly contaminated (with faeces) substrate being removed and disposed of appropriately
- Disinfection of vehicles, equipment, and boots used in gamebird management operations

If pursued, we would recommend Defra seek further advice from APHA as to the precise technical detail of the biosecurity measures likely to be most effective at disease control in these circumstances, and that such measures are agreed and endorsed by APHA.

Noting the strong advocacy by Defra and APHA of such measures, our confidence in the likely effectiveness of this mitigation measure in reducing HPAIV impacts to wild birds including SPA species is currently low. This is due to the absence of further detail about the biosecurity measures that might be considered relevant and be proposed. Natural England would be able to provide further advice in due course should Defra decide to pursue this mitigation option and provide further detail by way of its HRA.

Should GL43 be re-issued on this basis, Natural England would advise that, as a basic minimum standard, suitable biosecurity measures applicable to gamebird releasing and the risk of HPAIV transmission, should be formally set out and

incorporated into GL43 during 2023. To provide sufficient certainty as to the need to implement such biosecurity measures to help mitigate the risk of significant adverse effects, Natural England would suggest that an uplift in the implementation of the biosecurity measures suggested above would be necessary. This would be particularly necessary should Defra's HRA conclude that additional biosecurity is the only necessary mitigating measure required to ascertain no adverse effects on site integrity. In doing so, compliance with specific biosecurity measures would therefore become an additional formal condition of GL43. It would be a requirement for any person releasing gamebirds under GL43 to comply with and implement the biosecurity measures that would be listed.

We recognise that there may be uncertainty about such a measure and its enforceability. This may mean that such a biosecurity condition may not be reliable enough on its own to provide sufficient certainty that this risk of a significant adverse effect would be solely and reliably mitigated to reach a conclusion of no adverse effect on SPAs. As suggested above, the option may also be combined with Option C.

D3.1.3 Scope of proposed additional mitigation

Natural England has considered whether the suite of potential options suggested above could be spatially targeted to specific sites according to any differences in risk. In other words, whether some SPAs could be subject to more stringent measures than others.

Appendix 1 highlights that all terrestrial and coastal SPAs in England (bar one) have been classified for at least one vulnerable bird species and are exposed to at least one risk pathway. We therefore believe that a detailed segmentation exercise to identify SPA-specific mitigation is not necessary. In addition, our view is the overall transmission and spread of HPAIV and its outbreaks will be not restricted in terms of geography. Whilst there is good information about the location of past and current HPAIV outbreaks that have been reported, these may not provide a reliable indication of where future cases and outbreaks will arise during 2023 and in relation to SPAs.

We therefore advise that the suite of potential mitigating measures, as suggested above, should be applied to all SPAs and all SPA buffer zones during 2023 should GL43 be re-issued.

D4. Assessment of potentially adverse effects considering the project 'in combination' with other proposed plans and projects

As per shadow HRA.

D5. Conclusions on Site Integrity

Because the project is not wholly directly connected with or necessary to the management of SPAs and is likely to have a significant effect on these, Natural England has carried out a 'shadow' appropriate assessment equivalent to that required by regulation 63 of the Habitats Regulations 2017.

This shadow assessment has been undertaken in view of Natural England's published advice as to the Conservation Objectives for SPAs, in particular the potential impacts on the abundance of those wild bird populations for which SPAs have been classified.

Natural England's advice, following this addendum to the shadow assessment dated January 2021, is that it may be ascertained that this project (the proposed re-issue of GL43 in 2023) will not have an adverse effect on the integrity of SPAs, either alone or in combination with other plans and projects, but subject to:

(a) its limited duration of 1 year, and,

(b) the adoption or incorporation of at least one of the mitigation options outlined in section D3.1.2 above as general restrictions and/or conditions to be attached to the project.

Based on the information about the proposed project currently available and the analysis provided in the shadow appropriate assessment, Natural England's advice is that Mitigation Option A is adopted.

Appendix 1

A Risk assessment of SPAs and their features

Species categorised according to risk of exposure to HPAIV transmission via bridging species (yes/no) and/or direct exposure pathway where:

- Category 1 - SPA feature species unlikely to leave SPAs and for whom risk is dictated by gamebird dispersal
- Category 2 - SPA feature species likely to utilise Functionally Linked Land around the SPA but do not directly interact with gamebirds
- Category 3 - SPA feature species likely to utilise Functionally Linked Land around the SPA and may directly interact with gamebirds (most significantly though predation of sick individuals)
- None – no direct pathway identified

Note that species may be at risk from **both** bridging species and direct exposure pathways; and other exposure-pathways may exist for SPA features (for example lateral transmission within species between sites).

Table A: By SPA Feature

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A001. Gavia stellata; Red-throated diver	N	Non-breeding	No	None	Outer Thames Estuary Liverpool Bay/ Bae Lerpwl
A002. Gavia arctica; Black-throated diver	N	non-breeding	No	None	Falmouth Bay to St Austell Bay
A003. Gavia immer; Great northern diver	N	non-breeding	No	None	Falmouth Bay to St Austell Bay
A005. Podiceps cristatus; Great crested grebe	N	Non-breeding	Yes	1	Rutland Water; Abberton reservoir

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A007. Podiceps auritus; Slavonian grebe	N	Non-breeding	No	None	Exe Estuary Falmouth Bay to St Austell Bay
A014. Hydrobates pelagicus; European storm-petrel	N	Breeding	Yes	None	Isles of Scilly
A016. Morus bassanus; Northern gannet	N	breeding	Yes	None	Flamborough and Filey Coast
A017. Phalacrocorax carbo; Great cormorant		Breeding	Yes	1	Abberton Reservoir SPA
A021. Botaurus stellaris; Great bittern		Non-breeding	Yes	1	Lee Valley Stodmarsh Marazion Marsh Upper Nene Valley Gravel Pits
A021. Botaurus stellaris; Great bittern		Breeding	Yes	1	Leighton Moss Broadland
A026. Egretta garzetta; Little egret		Non-breeding	Yes	1	Morecambe Bay & Duddon Estuary Poole Harbour Tamar Estuaries Complex
A034. Platalea leucorodia; Eurasian Spoonbill		Non-breeding	Yes	1	Poole Harbour
A036. Cygnus olor; Mute swan	VH	Breeding	Yes	1	Hornsea Mere
A036. Cygnus olor; Mute swan	VH	Non-breeding	Yes	2	Rutland Water Abberton Reservoir
A037. Cygnus columbianus bewickii; Bewick swan	VH	Non-breeding	Yes	2	Ribble and Alt Estuaries Martin Mere Lower Derwent Valley

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Walmore Common The Wash Nene Washes Ouse Washes Breydon Water Broadland Somerset Levels and Moors Avon Valley Dungeness, Romney Marsh and Rye Bay Severn Estuary Arun Valley
A038. Cygnus cygnus; Whooper swan	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Martin Mere Lindisfarne The Wash Ouse Washes Broadland
A040. Anser brachyrhynchus; Pink-footed goose	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Martin Mere The Wash North Norfolk Coast

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Broadland
A043a. Anser anser; Greylag goose	VH	Non-breeding	Yes	2	Lindisfarne Holburn Lake and Moss
A045b. Branta leucopsis; Barnacle goose	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes
A046a. Branta bernicla bernicla; Dark-bellied brent goose	VH	Non-breeding	Yes	2	The Wash North Norfolk Coast Stour and Orwell Estuaries Hamford Water Benfleet and Southend Marshes Dengie (Mid-Essex Coast Phase 1) Colne Estuary (Mid-Essex Coast Phase 2) Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5) Deben Estuary Exe Estuary Chesil Beach and The Fleet Chichester and Langstone Harbours Portsmouth Harbour Solent and Southampton Water The Swale Medway Estuary and Marshes Pagham Harbour
A046c. Branta bernicla hrota; Light-	VH	Non-breeding	Yes	2	Lindisfarne

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
bellied brent goose					
A048. Tadorna tadorna; Common shelduck	VH	Breeding	Yes	2	The Swale
A048. Tadorna tadorna; Common shelduck	VH	Non-breeding	Yes	1	Ribble and Alt Estuaries Mersey Estuary Lindisfarne Humber Estuary The Wash Hamford Water Poole Harbour Chichester and Langstone Harbours The Swale Medway Estuary and Marshes The Dee Estuary Severn Estuary
A050. Anas penelope; Eurasian wigeon	VH	Non-breeding	Yes	2	Ribble and Alt Estuaries Lindisfarne Lower Derwent Valley The Wash Nene Washes Ouse Washes Rutland Water North Norfolk Coast Abberton Reservoir Broadland

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Chichester and Langstone Harbours The Swale
A051. Anas strepera; Gadwall	VH	Breeding	Yes	1	Nene Washes Ouse Washes Minsmere–Walberswick Stodmarsh
A051. Anas strepera; Gadwall	VH	Non-breeding	Yes	2	Hornsea Mere The Wash Nene Washes Rutland Water Minsmere–Walberswick Abberton Reservoir Broadland Avon Valley Lee Valley Stodmarsh South-West London Waterbodies Severn Estuary Upper Nene Valley Gravel Pits
A052. Anas crecca; Eurasian teal	VH	Breeding	Yes	1	Minsmere–Walberswick
A052. Anas crecca; Eurasian teal	VH	Non-breeding	Yes	2	Ribble and Alt Estuaries Mersey Estuary Lower Derwent Valley Nene Washes Ouse Washes

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Rutland Water Hamford Water Abberton Reservoir Somerset Levels and Moors Chichester and Langstone Harbours Solent and Southampton Water The Swale The Dee Estuary
A053. Anas platyrhynchos; Mallard	VH	Breeding	Yes	2	Ouse Washes The Swale
A054. Anas acuta; Northern pintail	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Martin Mere Mersey Estuary The Wash Nene Washes Ouse Washes Stour and Orwell Estuaries Chichester and Langstone Harbours Medway Estuary and Marshes The Dee Estuary
A055. Anas querquedula; Garganey	VH	Breeding	Yes	1	Nene Washes Ouse Washes
A056. Anas clypeata; Northern shoveler	VH	Breeding	Yes	1	Lower Derwent Valley

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Nene Washes Ouse Washes Minsmere–Walberswick
A056. Anas clypeata; Northern shoveler	VH	Non-breeding	Yes	2	Nene Washes Ouse Washes Rutland Water Minsmere–Walberswick Abberton Reservoir Broadland Chew Valley Lake Chichester and Langstone Harbours Dungeness, Romney Marsh and Rye Bay Lee Valley Stodmarsh South West London Waterbodies
A059. Aythya ferina; Common pochard	VH	Breeding	Yes	1	Colne Estuary (Mid-Essex Coast Phase 2) Blackwater Estuary (Mid-Essex Coast Phase 4)
A059. Aythya ferina; Common pochard	VH	Non-breeding	Yes	2	Abberton Reservoir
A061. Aythya fuligula; Tufted duck	VH	Non-breeding	Yes	2	Rutland Water Abberton Reservoir
A062 Aythya marila; Scaup	VH	Non-breeding	No	1	Upper Solway Flats and Marshes
A063. Somateria mollissima; Common eider	VH	Non-breeding	Yes	None	Lindisfarne
A064. Clangula hyemalis; Long-tailed	VH	Non-breeding	No	None	Lindisfarne

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
duck					
A065. Melanitta nigra; Common scoter	VH	non-breeding	No	None	Liverpool Bay/ Bae Lerpwl
A067. Bucephala clangula; Common goldeneye	VH	Non-breeding	No	None	Upper Solway Flats and Marshes The Wash Rutland Water Abberton Reservoir
A069. Mergus serrator; Red-breasted merganser	VH	Non-breeding	Yes	None	Lindisfarne Chichester and Langstone Harbours Portsmouth Harbour
A070. Mergus merganser; Goosander	VH	Non-breeding	Yes	2	Rutland Water
A072. Pernis apivorus; European honey-buzzard		Breeding	Yes	2	New Forest
A081. Circus aeruginosus; Eurasian marsh harrier	H	Breeding	Yes	3	Humber Estuary North Norfolk Coast Minsmere–Walberswick Alde–Ore Estuary Broadland Benacre to Easton Bavents Dungeness, Romney Marsh and Rye Bay
A082. Circus cyaneus; Hen harrier	H	Breeding	Yes	3	Bowland Fells North Pennine Moors
A082. Circus cyaneus; Hen harrier	H	Non-breeding	Yes	3	Humber Estuary Ouse Washes Minsmere–Walberswick

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Dengie (Mid-Essex Coast Phase 1) Colne Estuary (Mid-Essex Coast Phase 2) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5) Broadland Dorset Heathlands New Forest Salisbury Plain Thames Estuary and Marshes Dungeness, Romney Marsh and Rye Bay Stodmarsh
A084. Circus pygargus; Montagu's harrier	H	Breeding	Yes	3	The Wash and North Norfolk Coast
A098. Falco columbarius; Merlin	H	Breeding	Yes	3	Bowland Fells North York Moors North Pennine Moors Peak District Moors (South Pennine Moors Phase 1) South Pennine Moors Phase 2
A098. Falco columbarius; Merlin	H	Non-breeding	Yes	3	Dorset Heathlands
A099. Falco subbuteo; Eurasian hobby	H	Breeding	Yes	1	New Forest Salisbury Plain
A103. Falco peregrinus; Peregrine falcon	H	Breeding	Yes	3	North Pennine Moors
A113. Coturnix coturnix; Common quail		Breeding	Yes	2	Salisbury Plain

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A123. Gallinula chloropus; Common moorhen		Breeding	Yes	2	The Swale
A125. Fulica atra; Common coot		Breeding	Yes	1	The Swale
A125. Fulica atra; Common coot		Non-breeding	Yes	2	Rutland Water Abberton Reservoir
A130. Haematopus ostralegus; Eurasian oystercatcher	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries The Wash Foulness (Mid-Essex Coast Phase 5) Exe Estuary The Swale The Dee Estuary
A132. Recurvirostra avosetta; Pied avocet	VH	Breeding	Yes	2	Humber Estuary North Norfolk Coast Minsmere–Walberswick Alde–Ore Estuary Stour and Orwell Estuaries Foulness (Mid-Essex Coast Phase 5) Medway Estuary and Marshes Dungeness, Romney Marsh and Rye Bay
A132. Recurvirostra avosetta; Pied avocet	VH	Non-breeding	Yes	2	Humber Estuary Alde–Ore Estuary Hamford Water Breydon Water

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Deben Estuary Exe Estuary Poole Harbour Tamar Estuaries Complex Thames Estuary and Marshes Medway Estuary and Marshes
A133. Burhinus oedicnemus; Stone-curlew	VH	Breeding	Yes	2	Breckland Porton Down Salisbury Plain
A137. Charadrius hiaticula; Ringed plover	VH	Breeding	Yes	1	Colne Estuary (Mid-Essex Coast Phase 2) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5)
A137. Charadrius hiaticula; Ringed plover	VH	Non-breeding	Yes	1	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Lindisfarne Hamford Water Benfleet and Southend Marshes Chichester and Langstone Harbours Solent and Southampton Water The Swale Thames Estuary and Marshes Medway Estuary and Marshes
A140. Pluvialis apricaria; European golden plover	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Mersey Estuary Lindisfarne Lower Derwent Valley Humber Estuary Breydon Water Somerset Levels and Moors Thanet Coast and Sandwich Bay Dungeness, Romney Marsh and Rye Bay Upper Nene Valley Gravel Pits
A140. Pluvialis apricaria ; European golden plover	VH	Breeding	Yes	2	North York Moors North Pennine Moors Peak District Moors (South Pennine Moors Phase 1) South Pennine Moors Phase 2
A141. Pluvialis squatarola; Grey plover	VH	Non-breeding	Yes	1	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Lindisfarne The Wash Gibraltar Point Stour and Orwell Estuaries Hamford Water Benfleet and Southend Marshes Dengie (Mid-Essex Coast Phase 1) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5) Exe Estuary

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Chichester and Langstone Harbours The Swale Thames Estuary and Marshes Medway Estuary and Marshes The Dee Estuary
A142. Vanellus vanellus; Northern lapwing	VH	Breeding	Yes	1	South Pennine Moors Phase 2 The Swale
A142. Vanellus vanellus; Northern lapwing	VH	Non-breeding	Yes	2	Breydon Water Somerset Levels and Moors
A143. Calidris canutus; Red knot	VH	Non-breeding	Yes	1	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Teesmouth and Cleveland Coast Humber Estuary The Wash North Norfolk Coast Stour and Orwell Estuaries Benfleet and Southend Marshes Dengie (Mid-Essex Coast Phase 1) Foulness (Mid-Essex Coast Phase 5) Thames Estuary and Marshes Medway Estuary and Marshes The Dee Estuary Mersey Narrows and North Wirral Foreshore
A144. Calidris alba; Sanderling	VH	Non-breeding	Yes	1	Morecambe Bay & Duddon Estuary

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Ribble and Alt Estuaries Lindisfarne The Wash Gibraltar Point Chichester and Langstone Harbours
A148. Calidris maritima; Purple sandpiper	VH	Non-breeding	No	None	Northumbria Coast
A149. Calidris alpina alpina; Dunlin	VH	Non-breeding	Yes	2	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Mersey Estuary Lindisfarne Humber Estuary The Wash Stour and Orwell Estuaries Benfleet and Southend Marshes Blackwater Estuary (Mid-Essex Coast Phase 4) Exe Estuary Chichester and Langstone Harbours Portsmouth Harbour The Swale Thames Estuary and Marshes Medway Estuary and Marshes The Dee Estuary Severn Estuary
A151. Philomachus pugnax; Ruff	VH	Breeding	Yes	1	Ribble and Alt Estuaries

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Ouse Washes
A156a. Limosa limosa islandica; Black-tailed godwit	VH	Non-breeding	Yes	2	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Mersey Estuary Humber Estuary The Wash Stour and Orwell Estuaries Hamford Water Blackwater Estuary (Mid-Essex Coast Phase 4) Exe Estuary Poole Harbour Portsmouth Harbour Solent and Southampton Water Thames Estuary and Marshes The Dee Estuary
A156a. Limosa limosa limosa; Black-tailed godwit	VH	Breeding	Yes	1	Nene Washes Ouse Washes
A157. Limosa lapponica; Bar-tailed godwit	VH	Non-breeding	Yes	1	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Lindisfarne Humber Estuary The Wash Gibraltar Point Foulness (Mid-Essex Coast Phase 5)

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Chichester and Langstone Harbours The Dee Estuary Mersey Narrows and North Wirral Foreshore
A160. Numenius arquata; Eurasian curlew	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary The Wash Chichester and Langstone Harbours The Swale The Dee Estuary
A162. Tringa totanus; Common redshank	VH	Breeding	Yes	1	The Swale
A162. Tringa totanus; Common redshank	VH	Non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Mersey Estuary Mersey Estuary Lindisfarne Teesmouth and Cleveland Coast Humber Estuary The Wash Alde–Ore Estuary Stour and Orwell Estuaries Hamford Water Colne Estuary (Mid-Essex Coast Phase 2) Foulness (Mid-Essex Coast Phase 5) Chichester and Langstone Harbours

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					The Swale Thames Estuary and Marshes Medway Estuary and Marshes The Dee Estuary Severn Estuary
A169. Arenaria interpres; Ruddy turnstone	VH	Non-breeding	Yes	None	Morecambe Bay & Duddon Estuary Northumbria Coast The Wash Chichester and Langstone Harbours Thanet Coast and Sandwich Bay
A176 Larus melanocephalus; Mediterranean gull	VH	Non-breeding	Yes	2	Morecambe Bay & Duddon Estuary
A176. Larus melanocephalus; Mediterranean gull	VH	Breeding	Yes	2	Poole Harbour Solent and Southampton Water Dungeness, Romney Marsh and Rye Bay
A177. Hydrocoloeus minutus; Little gull	VH	non-breeding	Yes	None	Mersey Narrows and North Wirral Foreshore Liverpool Bay/ Bae Lerpwl
A183. Larus fuscus; Lesser black-backed gull	VH	Breeding	Yes	3	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Bowland Fells pSPA Alde–Ore Estuary Isles of Scilly
A183. Larus fuscus; Lesser black-backed gull	VH	Non-Breeding	Yes	3	Morecambe Bay & Duddon Estuary

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A184. Larus argentatus; Herring gull	VH	Breeding	Yes	3	Morecambe Bay & Duddon Estuary
A187 Larus marinus; Great black-backed gull	VH	Breeding	Yes	3	Isles of Scilly
A188. Rissa tridactyla; Black-legged kittiwake	VH	breeding	Yes	None	Flamborough and Filey Coast
A191 Sterna sandvicensis; Sandwich tern	VH	Breeding	Yes	1	Morecambe Bay & Duddon Estuary Farne Islands Coquet Island North Norfolk Coast Alde–Ore Estuary Foulness (Mid-Essex Coast Phase 5) Poole Harbour Chichester and Langstone Harbours Solent and Southampton Water Dungeness, Romney Marsh and Rye Bay Solent and Dorset Coast Northumberland Marine
A191. Sterna sandvicensis; Sandwich tern	VH	Non-breeding	Yes	1	Teesmouth and Cleveland Coast The Dee Estuary
A192. Sterna dougallii; Roseate tern	VH	Breeding	Yes	None	Lindisfarne Farne Islands Coquet Island Solent and Southampton Water Northumberland Marine

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A193. Sterna hirundo; Common tern	VH	Breeding	Yes	1	Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Farne Islands Coquet Island The Wash North Norfolk Coast Breydon Water Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Farne Islands Coquet Island The Wash North Norfolk Coast Breydon Water Foulness (Mid-Essex Coast Phase 5) Poole Harbour Chichester and Langstone Harbours Solent and Southampton Water Pagham Harbour Dungeness, Romney Marsh and Rye Bay The Dee Estuary Mersey Narrows and North Wirral Foreshore Solent and Dorset Coast Northumberland Marine Outer Thames Estuary

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Liverpool Bay/ Bae Lerpwl
A193. Sterna hirundo; Common tern	VH	Non-Breeding	Yes	1	Mersey Narrows and North Wirral Foreshore
A194. Sterna paradisaea; Arctic tern	VH	Breeding	Yes	1	Farne Islands Coquet Island Northumberland Marine
A195 Sterna albifrons; Little tern	VH	Breeding	Yes	1	Morecambe Bay & Duddon Estuary Lindisfarne Teesmouth and Cleveland Coast Humber Estuary Northumbria Coast The Wash Gibraltar Point North Norfolk Coast Minsmere–Walberswick Alde–Ore Estuary Hamford Water Colne Estuary (Mid-Essex Coast Phase 2) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5) Great Yarmouth North Denes Benacre to Easton Bavents Chichester and Langstone Harbours Solent and Southampton Water Medway Estuary and Marshes Pagham Harbour

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Thanet Coast and Sandwich Bay Dungeness, Romney Marsh and Rye Bay The Dee Estuary Solent and Dorset Coast Northumberland Marine Outer Thames Estuary Liverpool Bay/ Bae Lerpwl
A199. Uria aalge; Common guillemot		Breeding	Yes	None	Farne Islands Flamborough and Filey Coast Northumberland Marine
A200. Alca torda; Razorbill		breeding	Yes	None	Flamborough and Filey Coast
A204. Fratercula arctica; Atlantic puffin		Breeding	Yes	None	Northumberland Marine
A222. Asio flammeus; Short-eared owl	H	Breeding	Yes	3	Peak District Moors (South Pennine Moors Phase 1)
A224. Caprimulgus europaeus; European nightjar		Breeding	No	1	Thorne and Hatfield Moors Minsmere–Walberswick Breckland Dorset Heathlands East Devon Heaths New Forest Thursley, Hankley and Frensham Commons (Wealden Heaths Phase 1) Wealden Heaths Phase 2 Thames Basin Heaths Ashdown Forest Sandlings

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
A246. Lullula arborea; Woodlark		Breeding	No	1	Breckland Dorset Heathlands New Forest Thursley, Hankley and Frensham Commons (Wealden Heaths Phase 1) Wealden Heaths Phase 2 Thames Basin Heaths Sandlings
A294. Acrocephalus paludicola; Aquatic warbler		Non-breeding	No	1	Dungeness, Romney Marsh and Rye Bay Marazion Marsh
A302. Sylvia undata; Dartford warbler		Breeding	No	1	Dorset Heathlands East Devon Heaths New Forest Thursley, Hankley and Frensham Commons (Wealden Heaths Phase 1) Wealden Heaths Phase 2 Thames Basin Heaths Ashdown Forest
A314. Phylloscopus sibilatrix; Wood warbler		Breeding	Yes	1	New Forest
A394. Anser albifrons albifrons; Greater white-fronted goose	VH	Non-breeding	Yes	2	Minsmere–Walberswick Severn Estuary
A684. Phalacrocorax aristotelis aristotelis; European shag		Breeding	Yes	None	Isles of Scilly

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
Inland bird assemblage	VH	Breeding	Yes	2	South Pennine Moors Phase 2 Ouse Washes The Swale Medway Estuary and Marshes Stodmarsh
seabird assemblage	VH	Breeding	Yes	2	Ribble and Alt Estuaries Farne Islands Coquet Island Isles of Scilly Flamborough and Filey Coast Northumberland Marine
waterbird assemblage	VH	non-breeding	Yes	2	Upper Solway Flats and Marshes Morecambe Bay & Duddon Estuary Ribble and Alt Estuaries Martin Mere Mersey Estuary Teesmouth and Cleveland Coast Lower Derwent Valley Humber Estuary The Wash Ouse Washes Rutland Water North Norfolk Coast Stour and Orwell Estuaries Abberton Reservoir

SPA designated feature	Defra QRA risk rating (where indicated)	Breeding or non-breeding feature	Considered at risk via bridging species	Categorisation of direct exposure risk pathway	Representation as qualifying features on SPAs
					Benfleet and Southend Marshes Breydon Water Dengie (Mid-Essex Coast Phase 1) Colne Estuary (Mid-Essex Coast Phase 2) Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Blackwater Estuary (Mid-Essex Coast Phase 4) Foulness (Mid-Essex Coast Phase 5) Somerset Levels and Moors Exe Estuary Poole Harbour Chichester and Langstone Harbours Solent and Southampton Water The Swale Thames Estuary and Marshes Medway Estuary and Marshes Dungeness, Romney Marsh and Rye Bay Stodmarsh The Dee Estuary Severn Estuary Arun Valley Mersey Narrows and North Wirral Foreshore Upper Nene Valley Gravel Pits Liverpool Bay/ Bae Lerpwl

Table B: By SPA

Terrestrial or coastal SPA	*Does SPA have at least 1 feature considered to be at risk of exposure via any pathway?*	*Is additional mitigation suggested?*
Abberton Reservoir	Yes	Yes
Alde–Ore Estuary	Yes	Yes
Arun Valley	Yes	Yes
Ashdown Forest	Yes	Yes
Avon Valley	Yes	Yes
Benacre to Easton Bavents	Yes	Yes
Benfleet and Southend Marshes	Yes	Yes
Blackwater Estuary (Mid-Essex Coast Phase 4)	Yes	Yes
Bowland Fells	Yes	Yes
Breckland	Yes	Yes
Breydon Water	Yes	Yes
Broadland	Yes	Yes
Chesil Beach and The Fleet	Yes	Yes
Chew Valley Lake	Yes	Yes
Chichester and Langstone Harbours	Yes	Yes
Colne Estuary (Mid-Essex Coast Phase 2)	Yes	Yes
Coquet Island	Yes	Yes
Crouch and Roach Estuaries (Mid-Essex Coast Phase 3)	Yes	Yes
Deben Estuary	Yes	Yes
Dengie (Mid-Essex Coast Phase 1)	Yes	Yes
Dorset Heathlands	Yes	Yes
Dungeness, Romney Marsh and Rye Bay	Yes	Yes
East Devon Heaths	Yes	Yes
Exe Estuary	Yes	Yes
Falmouth Bay to St Austell Bay	No	No
Farne Islands	Yes	Yes
Flamborough and Filey Coast	Yes	Yes
Foulness (Mid-Essex Coast Phase 5)	Yes	Yes
Gibraltar Point	Yes	Yes
Great Yarmouth North Denes	Yes	Yes
Hamford Water	Yes	Yes

Terrestrial or coastal SPA	*Does SPA have at least 1 feature considered to be at risk of exposure via any pathway?*	*Is additional mitigation suggested?*
Holburn Lake and Moss	Yes	Yes
Hornsea Mere	Yes	Yes
Humber Estuary	Yes	Yes
Isles of Scilly	Yes	Yes
Lee Valley	Yes	Yes
Leighton Moss	Yes	Yes
Lindisfarne	Yes	Yes
Liverpool Bay/ Bae Lerpwl	Yes	Yes
Lower Derwent Valley	Yes	Yes
Marazion Marsh	Yes	Yes
Martin Mere	Yes	Yes
Medway Estuary and Marshes	Yes	Yes
Mersey Estuary	Yes	Yes
Mersey Narrows and North Wirral Foreshore	Yes	Yes
Minsmere–Walberswick	Yes	Yes
Morecambe Bay & Duddon Estuary	Yes	Yes
Nene Washes	Yes	Yes
New Forest	Yes	Yes
North Norfolk Coast	Yes	Yes
North Pennine Moors	Yes	Yes
North York Moors	Yes	Yes
Northumberland Marine	Yes	Yes
Northumbria Coast	Yes	Yes
Ouse Washes	Yes	Yes
Outer Thames Estuary	Yes	Yes
Pagham Harbour	Yes	Yes
Peak District Moors (South Pennine Moors Phase 1)	Yes	Yes
Poole Harbour	Yes	Yes
Porton Down	Yes	Yes
Portsmouth Harbour	Yes	Yes
Ribble and Alt Estuaries	Yes	Yes
Rutland Water	Yes	Yes
Salisbury Plain	Yes	Yes
Sandlings	Yes	Yes

Terrestrial or coastal SPA	*Does SPA have at least 1 feature considered to be at risk of exposure via any pathway?*	*Is additional mitigation suggested?*
Severn Estuary	Yes	Yes
Solent and Dorset Coast	Yes	Yes
Solent and Southampton Water	Yes	Yes
Somerset Levels and Moors	Yes	Yes
South Pennine Moors Phase 2	Yes	Yes
South West London Waterbodies	Yes	Yes
Stodmarsh	Yes	Yes
Stour and Orwell Estuaries	Yes	Yes
Tamar Estuaries Complex	Yes	Yes
Teesmouth and Cleveland Coast	Yes	Yes
Thames Basin Heaths	Yes	Yes
Thames Estuary and Marshes	Yes	Yes
Thanet Coast and Sandwich Bay	Yes	Yes
The Dee Estuary	Yes	Yes
The Swale	Yes	Yes
The Wash	Yes	Yes
The Wash and North Norfolk Coast	Yes	Yes
Thorne and Hatfield Moors	Yes	Yes
Thursley, Hankley and Frensham Commons (Wealden Heaths Phase 1)	Yes	Yes
Upper Nene Valley Gravel Pits	Yes	Yes
Upper Solway Flats and Marshes	Yes	Yes
Walmore Common	Yes	Yes
Wealden Heaths Phase 2	Yes	Yes

References

Ahrens A, Selinka H-C, Mettenleiter T, Beer M & Harder T. 2022. Exploring surface water as a transmission medium of avian influenza viruses – systematic infection studies in mallards. *Emerging Microbes & Infections*. 11:1, 1250-1261, DOI: 10.1080/22221751.2022.2065937

Arroyo B, Leckie F, Amar A, McCluskie A & Redpath S. 2014. Ranging behaviour of hen harriers breeding in Special Protection Areas in Scotland. *Bird Study.* 61:1 48-55, DOI: 10.1080/00063657.2013.874976

Bertran K, Perez-Ramirez E, Busquets N, Dolz R, Ramis A, Darji A, Abad, F, Valle, R, Chaves A, Vergara-Alert J, Barral M, Hofle U & Majó N. 2011. Pathogenesis and transmissibility of highly (H7N1) and low (H7N9) pathogenic avian influenza virus infection in red-legged partridge (*Alectoris rufa*). *Veterinary Research*. 42, 24.

Boon A, Sandbulte M, Seiler P, Webby R, Songserm T & Webster R. 2007. Role of terrestrial wild birds in ecology of influenza A virus (H5N1). *Emerging Infectious Diseases*. 13:1720-1724.

Breithaupt A, Kalthoff, D, Dale J,Bairlein F, Beer M & and Teifke J. 2011. Neurotropism in blackcaps (*Sylvia atricapilla*) and red-billed queleas (*Quelea quelea*) after highly pathogenic avian influenza virus H5N1 infection. *Veterinary Pathology*. 48(5):924-932.

Brown J, Stallknect D & Swayne D. 2009. Infectious and lethal doses of H5N1 highly pathogenic avian influenza virus for house sparrows (*Passer domesticus*) and rock pigeons (*Columba livia*). *Journal of Veterinary Diagnostic Investigation*. 21:437-445.

Costa T, Chaves A, Valle R, Darji A, van Riel D, Kuiken T, Majó N & Ramis, A. 2012. Distribution patterns of influenza virus receptors and viral attachment patters in the respiratory and intestinal tracts of seven avian species. *Veterinary Research.* 43:28.

DEFRA, 2021. The Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England) (No. 2) Order 2021 (legislation.gov.uk).

DEFRA 2022. Risk Assessment on the spread of High Pathogenicity Avian Influenza (HPAI) H5N1 to wild birds from released, formerly captive gamebirds in Great Britain Pheasants (publishing.service.gov.uk).

DEFRA, Welsh Government & Scottish Government, 2022. *Biosecurity and preventing welfare impacts in poultry and captive birds - advice for all captive bird*

and poultry keepers (including game birds, waterfowl, and pet birds. Biosecurity and preventing disease in captive birds (gov.wales)

DEFRA, 2022 GL43 Habitats Regulation Assessment (HRA) (includes Annex A and B) - GOV.UK (www.gov.uk)

Fujimoto Y, Usui T, Ono E & Ito T. 2015. Susceptibility of wild passerines to subtype H5N1 highly pathogenic avian influenza viruses. *Avian Pathology*. 44(4):243-247.

Hamilton W & Gilbert W. 1969. Starling dispersal from a winter roost. *Ecology* 50: 886-898.

Humberd J, Guan Y & Webster R. 2006. Comparison of the replication of influenza A viruses in Chinese ring-necked pheasants and Chukar partridges. *Journal of Virology*. 80(5):2151-2161. DOI: doi:10.1128/JVI.80.5.2151–2161.2006

Kalthoff D, Breithaupt A, Helm B, Teifke J, Beer M. 2009. Migratory status is not related to the susceptibility to HPAI H5N1 in an insectivorous passerine species. *PLoS One* 4.7 (2009): e6170.

Kurmi B, Murugkar H, Nagarajan S, Tosh C, Dubey S & Kumar M. 2012. Survivability of avian influenza H5N1 virus in poultry faeces at different temperatures. Indian *Journal of Virology*. 24(2):272-277. DOI 10.1007/s13337-013-0135-2

Madden J. & Sage, R. 2020. The Ecological Consequences of Gamebird Releasing and Management on Lowland Shoots in England: a review by Rapid Evidence Assessment for Natural England and the British Association of Shooting and Conservation. *Natural England Evidence Review NEER016*. Peterborough: Natural England.

Mason L, Bicknell J, Smart J & Peach W. 2020. The impacts of non-native gamebird releases in the UK: an updated evidence review. *RSPB Research Report No. 66.* RSPB Centre for Conservation Science, Sandy, Beds.

Natural England, 2020. Summary of Findings and Conclusions on the Rapid Evidence Assessment (REA) "Ecological Consequences of Gamebird Releasing and Management on Lowland Shoots in England". Advice to Defra. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931396/defra-witness-statement-gamebird-release-exhibit3.pdf

Nazir J, Haumacher R, Ike A, Stumpf P, Böhm R & Marschang R. 2010. Long-term study on tenacity of avian influenza viruses in water (distilled water, normal saline, and surface water) at different temperatures. *Avian Diseases*. 54:720-724.

O'Hanlon N, Thaxter C, Burton N, Grant D, Clark N, Clewley G, Conway G, Barber L, McGill R & Nager R. 2022. Habitat Selection and Specialisation of Herring Gulls

During the Non-breeding Season. *Frontiers in Marine Science.* 9:816881. DOI: 10.3389/fmars.2022.816881

Perkins E & Swayne E. 2001. Pathobiology of A/Chicken/Hong Kong/220/97 (H5N1) Avian Influenza Virus in Seven Gallinaceous Species. *Veterinary Pathology.* 2001;38(2):149-164. DOI:10.1354/vp.38-2-149

Perkins E & Swayne E. 2003. Varied pathogenicity of a Hong Kong-origin H5N1 avian influenza virus in four passerine species and budgerigars. *Veterinary Pathology*. 40(1):14-24.

Pringle H, Wilson M, Calladine J & Siriwardena G. 2019. Associations between gamebird releases and generalist predators. *Journal of Applied Ecology*. 56:2102-2113. DOI: 10.1111/1365-2664.13451

Puryear W, Sawatzki K, Hill N, Foss A, Stone J, Doughty L, Walk D, Gilbert K, Murray M, Cox E, Patel P, Mertz Z, Ellis S, Taylor J, Fauquier D, Smith A, DiGiovanni R, van de Guchte A, Gonzalez-Reiche A, Khalil Z, van Bakel H, Torchetti M, Lenoch J, Lantz K & Runstadler J. 2022. *Outbreak of highly pathogenic avian influenza H5N1 in New England seals.* In press.

Rijks J, Hesselink H, Lollinga P, Wesselman R, Prins P, Weesendorp E, Engelsma M, Heutink R, Harders F, Kik M, Rozendaal H, van den Kerkhof H & Beerens N. 2021. Highly pathogenic avian influenza A (H5N1) virus in wild red foxes, the Netherlands, 2021. *Emerging Infectious Diseases*. 27(11):2960-2962. DOI:10.3201/eid2711.211281

Sage R, Hoodless A, Woodburn M, Draycott R, Madden J & Sotherton N. 2020. Summary review and synthesis - effects on habitats and wildlife of the release and management of pheasants and red-legged partridges on UK lowland shoots. *Wildlife Biology.* DOI: 10.2981/wlb.00766

Sánchez-García C, Buner, F & Aebischer N. 2015. Supplementary winter food for gamebirds through feeders: which species actually benefit? *Journal of Wildlife Management.* 79(5):832-845. DOI: 10.1002/jwmg.889

Scottish Natural Heritage, 2016. *Guidance on assessing connectivity with Special Protection Areas (SPAs)*.

Seekings A, Liang Y, Warren C, Hjulsager C, Thomas S, Lean F, Nuñez A, Skinner P, Selden D, Falchieri M, Simmons H, Brown I, Larsen L, Banyard A & Slomka M. In Press.

Shortridge K, Zhou N, Guan Y, Gao P, Ito T, Kawaoka Y, Kodihalli S, Krauss S, Markwell D, Murti K, Norwood M, Senne D, Sims L, Takada A & Webster R. 1998.

Characterization of avian H5N1 influenza viruses from poultry in Hong Kong. *Virology*. 252:331-342.

Swan G, Redpath S, Crowley S & McDonald R. 2020. Understanding diverse approaches to predator management among gamekeepers in England. *People and Nature*. 2:495-508. DOI: 10.1002/pan3.10091

Whitehead (1994) Foraging behaviour and habitat use in the European Starling, Sturnus vulgaris, in an agricultural environment. PhD dissertation. University of Oxford, Oxford.

Wobeser G. 2007. *Disease in Wild Animals*. Springer.

Woodward I, Thaxter C, Owen E & Cook A. 2019. Desk-based revision of seabird foraging ranges used for HRA screening, Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate. *BTO Research Report 724*. BTO, Thetford. ISBN 978-1-912642-12-0.

Wynne-Edwards V. 1929. The behaviour of Starlings in winter. *British Birds*. 23: 138-153 & 170-180.