Gamebird Releasing and Management in the UK

A review of ecological considerations, best practice management and delivering net biodiversity gain

Game & Wildlife CONSERVATION TRUST

www.gwct.org.uk

Contents

Foreword 5

Summary 6

Introduction 9

- Not native, but naturalised 9
- Trends in released gamebirds 10
- Rearing and releasing today 10
- Husbandry of released game 10
- Scientific review methodology 12

Ecological consequences 14

- To what extent are woodlands planted and retained for pheasants? 14
- How woodland management for pheasants affects other wildlife 16
- Do pheasants affect soils and ground flora in and around release pens? 18
- Do released pheasants affect invertebrate communities in woodlands or elsewhere? 20
- The effect of released pheasants on woodland bryophytes and lichens 22
- Do hedgerows and other edge habitats on farmland benefit from released gamebird management? 23
- The effect of gamebirds on hedgerows near to release sites 24
- How songbirds use game crops on farmland 25
- Supplementary feeding for gamebirds 27
- Do released red-legged partridges affect invertebrates in sensitive open habitats? 28
- Possible effect of released pheasants on reptiles 29
- Red-legged partridge releasing and over-shooting wild partridges 30
- The effect of predation control 31
- The impact of releasing gamebirds on predators 32
- Illegal killing of raptors 35
- Parasites of pheasants and partridges 36
- Diseases of gamebirds and wildlife 36

Dispersal 38

Conclusions 42

References 44

Appendix 1 50

Citation:

Sage, R.B., Brewin, J., Stevens, D.C. and Draycott, R.A.H. 2021. *Gamebird Releasing and Management in the UK. A review of ecological considerations, best practice management and delivering net biodiversity gain.* Game & Wildlife Conservation Trust, Fordingbridge.

Game & Wildlife CONSERVATION TRUST

Foreword

By Rt Hon Sir James Paice
Chairman of Trustees
Game & Wildlife Conservation Trust

Rt Hon Sir James Paice

The debate on releasing pheasants and partridges for shooting in the lowlands is now high on the political agenda. For the first time, the impacts of gamebird management are being questioned, other conservation organisations are reviewing their attitudes to gamebird management and shooting, and in some cases are challenging government about the legalities of such management. We have never witnessed such scrutiny of what happens on shooting estates since releasing began. The GWCT, as providers of research, will respond to these events and we will focus on potential ecological effects of gamebird management, especially releasing. This topic has already been well served recently by the production of several reviews involving GWCT scientists and the dissemination of our research, but we need to do more.

This report is our assessment of the impacts of managing for gamebirds, both positive and negative, a review of the science, and of the gaps in our knowledge that still remain. The GWCT is determined to improve the balance between positive and negative effects through more research, advice and an increasing take up of best practice.

The ecological balance identified by this work can be tipped either way. Where shoots over-stock pens and site them directly onto very sensitive locations, more negatives will be felt, but where shoots keep to appropriate stocking densities in well-sited pens and support their birds well, the positives will outweigh the negatives and the shoot will be environmentally beneficial overall. Increased awareness of the potential ecological effects, along with education around best practice guidelines, can help shoot owners improve their ecological profile with relative ease. GWCT offers courses and publications to help shoot operators tip the balance. Advances in technology or an overhaul of the industry is not required; we already know much about what makes a well-run shoot, and how these can be good for the countryside.

But adherence to best practice guidelines and the GWCT's Principles of Sustainable Game Management (see page 50) will be crucial if we are to demonstrate that well-run shoots create and maintain habitats that benefit gamebirds and other wildlife alike and that game management, when conducted properly, contributes a net gain to biodiversity.

Summary

History

Pheasants and red-legged partridges were successfully introduced as wild breeding birds from Asia in around the 12th century, and southern Europe in the 18th century respectively. Wild populations managed both for the table and for shooting began to decline in the early 20th century. Initially to replace the decline, releasing for shooting has steadily increased over the last few decades. Today, releasing of gamebirds is undertaken in woodland and farmland throughout the UK to support driven game shooting. It is estimated that between 35–48 million pheasants and 7–14 million partridges are released each year.

Releasing

Pheasants are usually released into large woodland-based open-topped pens when they are around two months old in late summer, to provide shooting from October to 1 February. Partridges are usually released into smaller, initially closed pens located in game crops on farmland at a similar age and time of year, although shooting can start a month earlier. The basic aim of gamebird management in and around release sites is to keep the birds healthy, protect them from predation and provide attractive habitat that holds birds in the right areas to facilitate driving and shooting.

Reviewing the science

These released gamebirds and their management have a range of potential effects on lowland habitats and other wildlife, many of which have been studied scientifically by the GWCT and others. GWCT scientists systematically searched and reviewed the literature on this topic recently, producing two review documents in 2020. The first, jointly carried out with the University of Exeter, is a comprehensive report commissioned by Natural England (NE) and The British Association for Shooting and Conservation (BASC). The second is a peer-reviewed paper published in the scientific journal *Wildlife Biology* that provides a summary overview. This report uses those reviews to provide an insight into the ecological effects of releasing, identifies factors which may influence these effects such as the size and location of releases, and gives information on how management for released game can deliver net biodiversity gain. This summary is illustrated in **FIGURE 3** in the Conclusions on page 42.

The impacts – positive and negative

In general, negative effects are caused by the birds themselves while positive effects are a consequence of management activities to support them. Some of the negative effects such as damage to woodland floras or insects are localised, usually at the release site or feed point while others, in particular disease issues and the effect of releasing on generalist predators, may occur across a wider area – known as the landscape scale. Many of the positive effects of woodland management, hedgerow management or of game crops occur at the scale of a whole woodland or across an estate or farm.

Soils, ground flora, bryophytes and lichens

Released pheasants can affect soils and ground floras in release pens and in other places where they congregate, for example at feed points located in rides or along woodland edges. Away from these places within the release woodlands there is no evidence that released birds affect soils and ground floras. There is, however, some evidence that sensitive plant groups like lichens and bryophytes growing on trees in certain woodlands can be affected away from release sites – possibly because of atmospheric enrichment and/or changes in microclimate.

Outside of woodlands, when pheasants congregate at feed points and in game crops on farmland, the soil and flora might be changed to an extent. However, on areas that are already utilised for farming, and therefore heavily altered from their natural state such as improved grasslands or cultivated arable ground, this is of little consequence. Near to release points in woodland or on farmland, the base of hedges can be degraded by congregations of released birds. More generally hedgerows on farmland are often managed and retained for game management purposes.

Woodland and hedgerow retention, planting and management

Woodlands are in an exceptional position as the most widespread semi-natural habitat remaining in lowland Britain. This review identifies a range of benefits in and around woodlands of the habitat management carried out for pheasants. These arguably outweigh any negative impacts, which mainly occur at release points. Much of our older woodland has been retained and managed at least partly for its sporting value, and estates with a shooting interest tend to have better hedgerow networks.

Invertebrates

There are several studies into the potentially negative effect of released pheasants and partridges on insect communities away from release sites, but these find very little evidence. Pheasants and partridges become very thinly distributed away from the release pen. They will peck at insects but they have a mainly seed/plant-based diet as adults. Within release pens, when pheasant densities are at their highest, evidence suggests that there is a direct effect on some insect groups but not all. Specifically, for butterflies, there has been a study of woodland species and pheasants and another of a grassland species and partridges. Neither found evidence of damage.

Supplementary feeding

Good practice today demands that supplementary feeding of released gamebirds uses feeders designed to prevent grain accumulating on the ground. These feeders have been shown to be used by a wide range of birds and some mammal species, which can have real benefits for local bird populations. Where unwanted mammals such as rats are a problem, GWCT guidelines give advice on how to tackle that.

Game cover

There is clear evidence that game crops are widely planted on shoots and that they are attractive to a wide range of farmland and wood edge bird species. Larger plots have more benefit to birds than smaller ones, and best practice guidelines encourage shoots to plant large plots of the better seed-bearing crop types such as kale or quinoa. Some research also suggests that game crops may play a significant role in maintaining overwintering bird populations in the wider farmed landscape. This may be especially true in improved grassland areas where alternative food supplies are more limited.

Parasites and disease

There is evidence that some parasites and certain diseases of gamebirds are also found in other wildlife, especially birds. It may be that released gamebirds cause local infections in other wildlife, but more research is required.

Predation control

Legal predator control is often controversial, but it is widely accepted that wildlife populations can be negatively affected by predators. In particular, there is good evidence that a wide range of wild bird populations can be suppressed by foxes and crows. In the wider context of extensive habitat loss in recent decades, there is good evidence that effective predator control alongside game management is good for biodiversity and wildlife conservation. Whether all release-based shoots undertake effective predator control is less clear, but we know that some/many do.

Generalist predator responses to gamebird releases

How releases influence the local population density and behaviour of generalist predators is a key issue for many conservationists and researchers. Some work suggests predators are attracted to release sites but there is no evidence that they then cause problems for other wildlife. The possibility is entirely plausible, but there is a clear need to look at the issue thoroughly and avoid jumping to conclusions. In particular, research needs to be undertaken in the context of other modern land uses that also affect populations and the behaviours of generalist predators.

Dispersal

The dispersal of released pheasants and partridges away from release sites and into areas further away from the shooting grounds is a key factor when considering their wider effects. GWCT radio-tracking work indicates that even on large shoots where released birds can access different game-managed areas, at least 90% of surviving pheasants and partridges remain within 1km of the release point. These data and other evidence we have, for example about effects on insects, strongly suggest that the potential for released gamebirds to have any direct effects on habitats and wildlife away from the release site becomes very small. However, there are cases where released pheasants or partridges congregate in sensitive designated conservation sites. These need to be dealt with on a case-by-case basis and there is a mechanism for doing so via the statutory conservation agencies, for example Natural England and NatureScot.

Delivering net biodiversity gain

Some negative effects have relatively straightforward management solutions. Within the normal range of release densities, studies indicate that most negative impacts decrease with decreasing densities at release sites. There is also scope for shoots to reduce or eliminate local negative effects by identifying sensitive sites and avoiding conflicts with vulnerable species, for example reptile colonies or woodland areas with valuable ground floras. In contrast, many of the positive effects from woodland management, hedgerow management, game crops or the provision of supplementary food occur at the scale of a whole woodland or across an estate or farm. If sustainable releasing guidelines (Guidelines for Sustainable Gamebird Releasing, 2021) and the GWCT's Principles of Sustainable Game Management (**APPENDIX 1**) are followed then a net biodiversity gain is a likely outcome.

Introduction

The aims of this report are to:

1. Provide practitioners, advisors and policymakers with a clear account of the available scientific evidence relating to the effects of releasing pheasants and red-legged partridges into woodlands and on farmland on habitats and wildlife in the UK.
2. Look at the factors which may influence these effects such as the size and location of releases and the way their dispersal is managed.
3. Provide information on how game managers can actively limit or avoid negative effects and maximise positive ones.
4. Illustrate how management for released game can deliver net biodiversity gain.

Not native, but naturalised

The ancestors of the pheasants and red-legged partridges released and shot in Britain are not native to the UK. Common pheasants *Phasianus colchicus* are found in much of China and then west possibly as far as parts of Greece and Turkey (Madge and McGowan 2002). They have been introduced to North America and most European countries and other places such as the West Indies and New Zealand. Red-legged partridges *Alectoris rufa* are less exotic, being native to south west Europe from Portugal, across Spain, the lower half of France, and into Northern Italy. They have been widely introduced into Britain, especially England, and there are birds in New Zealand, but numerous other introduction attempts, in particular to North America, have failed. In Britain today both species now have mixed origins through breeding with other pheasant and partridge sub-species or species.

While associations between pheasants and the Romans in Britain exist, for example in mosaics and paintings, they were probably not a wild breeding species at that time. By the 12th century, however, it is clear that the species was feral in Britain and was hunted for food. Lever (1977) suggests that the bird was probably successfully introduced for the first time by the Normans. Red-legged partridges were successfully introduced to the UK for shooting in the late 18th century, although earlier attempts had been made (Lever 1977).

Wild pheasants were probably common by the 16th century and increasingly became an important quarry species for sport and the table alongside the native grey partridge in the following centuries. In the late 19th and early 20th century very high densities of wild pheasant, greys and then red-legged partridges were being maintained by intensive management of habitats and predator control. A rearing and releasing system was also operational at this time, with pheasants being raised by farmyard hens using eggs collected from laying pens or from the wild. These released birds contributed a relatively small portion of the shooting bag, usually just a top-up to wild production on and off until the late 1950s when new methods of using incubators, hatchers and other developments were introduced.

The common pheasant is native in Asia and elsewhere east of Greece but has been naturalised in parts of Western Europe for many centuries.

Trends in released gamebirds

Alongside the enormous declines in wild birds in the lowlands, releasing has steadily increased in recent decades (**FIGURE 1**). Before about 1960 more pheasants were shot than released but since then the reverse has been true. By the early 1980s, releasing had increased about threefold since 1961. This increase has maintained a similar trajectory since then so that by the late 2010s, the index of release density for pheasants was around nine times higher than in 1961 (Robertson *et al.* 2017). A much steeper increase is seen for red-legged partridges since 1961, with around 200 times more birds released now than then. This is because releasing of this species was in its infancy at that time, while pheasant releasing had already become a widespread practice (Aebischer 2019). Releasing for shooting is now widespread in the UK lowlands but is particularly common in the south, west and north-east of England (Madden and Sage 2020).

Looking at the shorter timescale of the last 25 years or so, releasing trends of the two species have been more similar. In the most comprehensive paper on this topic, Aebischer (2019), noted that bag sizes have kept pace with the releasing trend for red-legged partridges over this period. The same is not true for pheasants, where the increase in the shooting bag has been half the increase of the release. This means the "return rate" (proportion of those released that are shot) has been declining for pheasants but not partridges. A key difference between the two species in terms of shooting is the open season which starts on 1 September for partridges and 1 October for pheasants. Both species are released two or three months before the shooting season begins and numbers are not added to at a later stage. Partly as a consequence of this, there is a widespread tendency for partridge shooting to occupy the first part of the season and pheasants the second, even though for both the season finishes on 1 February. Pheasant shooting was traditionally at its peak in December but in recent years, with increasing demand, there has been a tendency for this peak to be maintained throughout January until the season, finishes. Pheasants released in late summer to supply a day in late January have significantly higher non-shooting mortality rates than pheasants or partridges supplying the earlier season shooting because there is more time for them to die of other causes (Robertson *et al.* 2017). It is likely this trend towards later-season shooting has caused the overall reduction in released pheasant return rates.

Rearing and releasing today

The most widely used published estimate is that in 2016, 47 million (95% CI: 39–57 million) pheasant and 10 million (95% CI: 8–13 million) red-legged partridges were released in the UK (Aebischer 2019). At the time of writing, a new analysis provides a range of estimates that suggest between 32–57 million pheasants and partridges combined are released (Madden 2021). The APHA Poultry Register, which ought to provide good estimates of releasing, probably currently underestimates it by half due to non-compliance (Madden and Sage 2020). In other countries, the numbers of gamebirds released is smaller but still substantial. In France more than 10 million pheasants and 2.5 million red-legged partridges are released each year (ONCFS 2013). In the United States an estimated 10 million pheasants and 37 million bobwhite quail are released each year (Burden 2013). Pheasant and red-legged partridge releasing is undertaken in woodland and on farmland throughout the UK but especially in the south and north-east of England, usually to support driven game shooting (Tapper 1992; Madden and Sage 2020). On average a release-based shoot will release around 10 birds per hectare of land, while in some extreme situations in excess of 100 birds per hectare are released (Sage unpublished).

The modern system of rearing and releasing pheasants and partridges continues to be refined and developed by practitioners, but the principles were well established by the 1980s. Typically, after hatching chicks are kept in heated huts and then allowed into netted outdoor pens. Pheasants are then released into large open-topped pens based in small woodlands or at the edge of larger woodland blocks when they are about 7–10 weeks old in June to August. These release pens are basically a 2m high fenced area designed to protect poults from (primarily) foxes in the weeks after release, while they get used to roosting in trees. This might take three weeks or so, after which the young pheasants, now approaching adult size, are encouraged to make daily movements from the pens, usually out onto the surrounding farmland then back again at night.

Partridges are released at around 13 weeks old into closed movable netted pens at least four weeks before the shooting season. The pens are placed on harvested fields, usually alongside game crops or in game crop plantings. The pens are designed to allow the birds to see out and get used to their new environment before they are opened up, often after only two or three days, and are eventually removed. Pheasants can also be released using closed-topped pens on open farmland.

Husbandry of released game

While the initial aim of these pens is to protect new releases from predators and allow acclimatisation to life in the wild, the longer-term aim is that they occupy a home area that the birds like and are familiar with and to which birds will want to return. This enables birds to be fed and sometimes medicated, and for pheasants to maintain

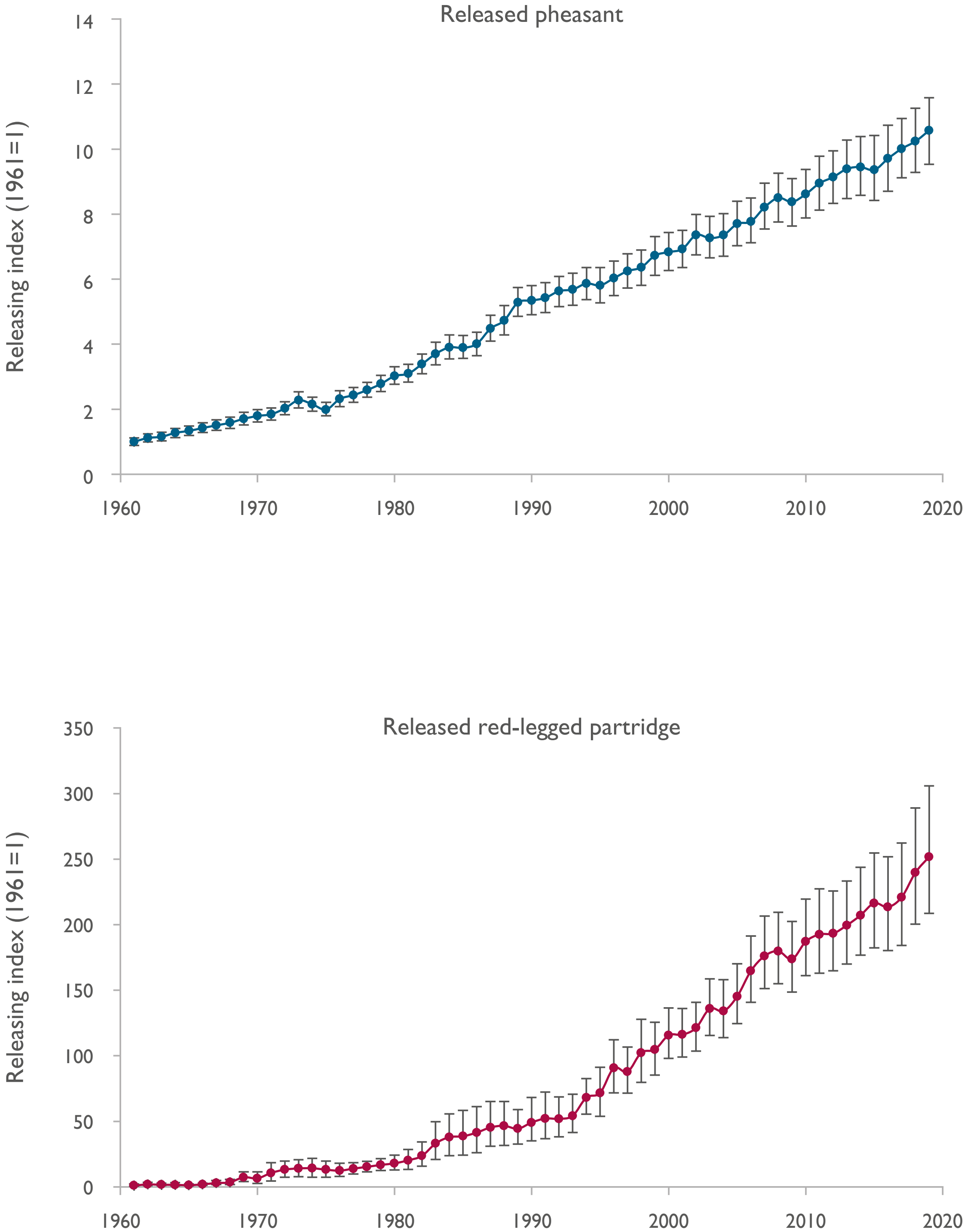


FIGURE 1

These graphs show how releasing for shooting in Britain has increased in recent decades. The horizontal axis is the year. The vertical axis indicates how many birds were released in a particular year compared to 1961. So for partridges the numbers released in recent years have been between 200 to 250 times the numbers released in 1961.

a level of protection at night. These home areas usually also form a key part of the process of shooting. There are many strategies for providing entertaining shooting by driving birds or by simply walking through areas and flushing birds. For pheasants, however, the basic model is to release birds into or alongside a woodland, then encourage the releases to make daily movements out onto adjacent farmland by feeding and planting game crops. On shoot days, birds can then be driven from those day-time places back to the release woodland and over the guns. For partridges, the releases are already out on the shooting grounds and the aim is to hold them in one of several release areas during the run-up to shooting or to allow them to fly from one release/game crop point to another on the shoot. A typical drive will then involve pushing the birds out of a game crop plot in a particular direction over the guns and on to another release point from which they can be driven another time.

The management of releases revolves around protecting the young birds from predation, providing good habitat and food resources to keep birds healthy, and to keep birds where the shoot requires them to be. If this is not done effectively and the releases move off the shooting grounds, the shoot will not work. The woodland and farmland habitat management methods that game managers employ to hold birds (and the effect these practices might have on other wildlife) are described elsewhere in this report.

This key principle of holding released but free-living birds in places on farmland and in woodland to provide shooting is a double-edge sword in relation to the ecological effects of those releases. On the one hand, it encourages released birds to congregate in some places, in particular release and feed points, which might have local negative effects. On the other hand, because the success of a shoot relies entirely on encouraging released birds to remain on the shooting grounds, this provides the incentive for habitat management work that may benefit other wildlife. It also provides the incentive to prevent birds dispersing and occupying unintended habitats off the shooting grounds. These and many other processes that affect the ecological consequences of releasing for shooting are explored more thoroughly in the following sections.

Scientific review methodology

Over the years, the GWCT research department has maintained a library of research documents looking at the ecological effects of releasing that includes both scientifically peer-reviewed and published literature, as well as grey literature sources from a wide variety of interested organisations. Grey literature describes "unpublished" studies such as student project reports from undergraduate to PhD level as well as other reports that are not peer-reviewed but contribute to our understanding, for example Natural England Research Reports. In 2020, GWCT scientists systematically accessed and reviewed both the peer-reviewed and grey literature base, incorporating the GWCT collection, using standard scientific procedures to provide an up to date, unbiased and comprehensive appraisal of the science on this topic. This review process resulted in two review documents in 2020. The first, carried out jointly with the University of Exeter, is a comprehensive report commissioned by Natural England (NE) and The British Association for Shooting and Conservation (BASC). The second is a recently published paper in the scientific journal *Wildlife Biology*, which has been peer-reviewed and conveys the main findings of the first report. A third review report was published by the RSPB in late 2020 (Mason *et al.* 2020).

In the NE report, Madden and Sage (2020) provide comprehensive and detailed factual information from the literature, factors that potentially affect how gamebird releases interact with the environment; for example the distribution of release sites in the UK and the way dispersal of gamebirds from release sites is limited. In the peer-reviewed paper, Sage *et al.* (2020) summarises key findings and uses them to define sub-topics. The evidence within these topics was then assessed and classified as finding a positive, neutral or negative effect, and combined to determine an overall direction of impact for that section. Taken together, these findings suggest an approximate overall balance of positive/neutral and negative effects.

The effect of releases on lowland habitats can be separated into two main areas: the impacts of the released birds themselves, which are called direct effects; and the associated management that accompanies releasing to support birds, or indirect effects. This report confines itself to ecological considerations. It does not look at social and economic consequences of releasing nor at the ethical or moral issues around gamebird shooting. A recent discussion of some of these aspects can be found in Feber *et al.* (2020), and Latham-Green *et al.* (2021) provides a detailed assessment of the social impact of participating in driven game shooting. Another factor we don't consider here is the use of lead ammunition. A recent review devoted to this issue has been published (Pain *et al.* 2019). In 2020, a consortium of organisations associated with shooting and game management announced the intention to oversee the phasing out of lead shot over the next five years (*https://basc.org.uk/lead/*).

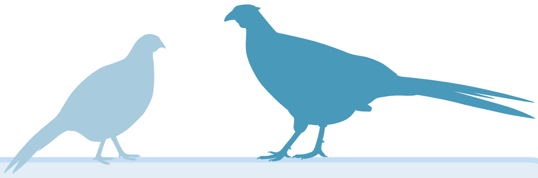
Pheasants are usually released into release pens in or alongside woodlands. Woodlands are in an exceptional position as probably the most common but certainly the most widespread semi-natural habitat remaining in Britain. As a consequence, any common management practice on woodland that might have an effect of habitat quality and wildlife needs to be scrutinised. Pheasant releasing is one of these. In contrast, the farmland around woodlands has in general become a poorer wildlife habitat compared with its natural or semi-natural state, because of modern farming. Red-legged partridge are usually released into improved farmland habitats so there is less potential for damaging effects. The structure of this report reflects this basic difference in potential impacts, focusing on pheasant releasing in woodlands in the first few discussion sections and partridge release onto farmland later.

A typical closed partridge release pen in a game crop. © Alex Keeble.

An open-topped woodland pheasant release pen fence.

Ecological consequences

To what extent are woodlands planted and retained for pheasants?



WOODS PLANTED AND RETAINED FOR PHEASANTS

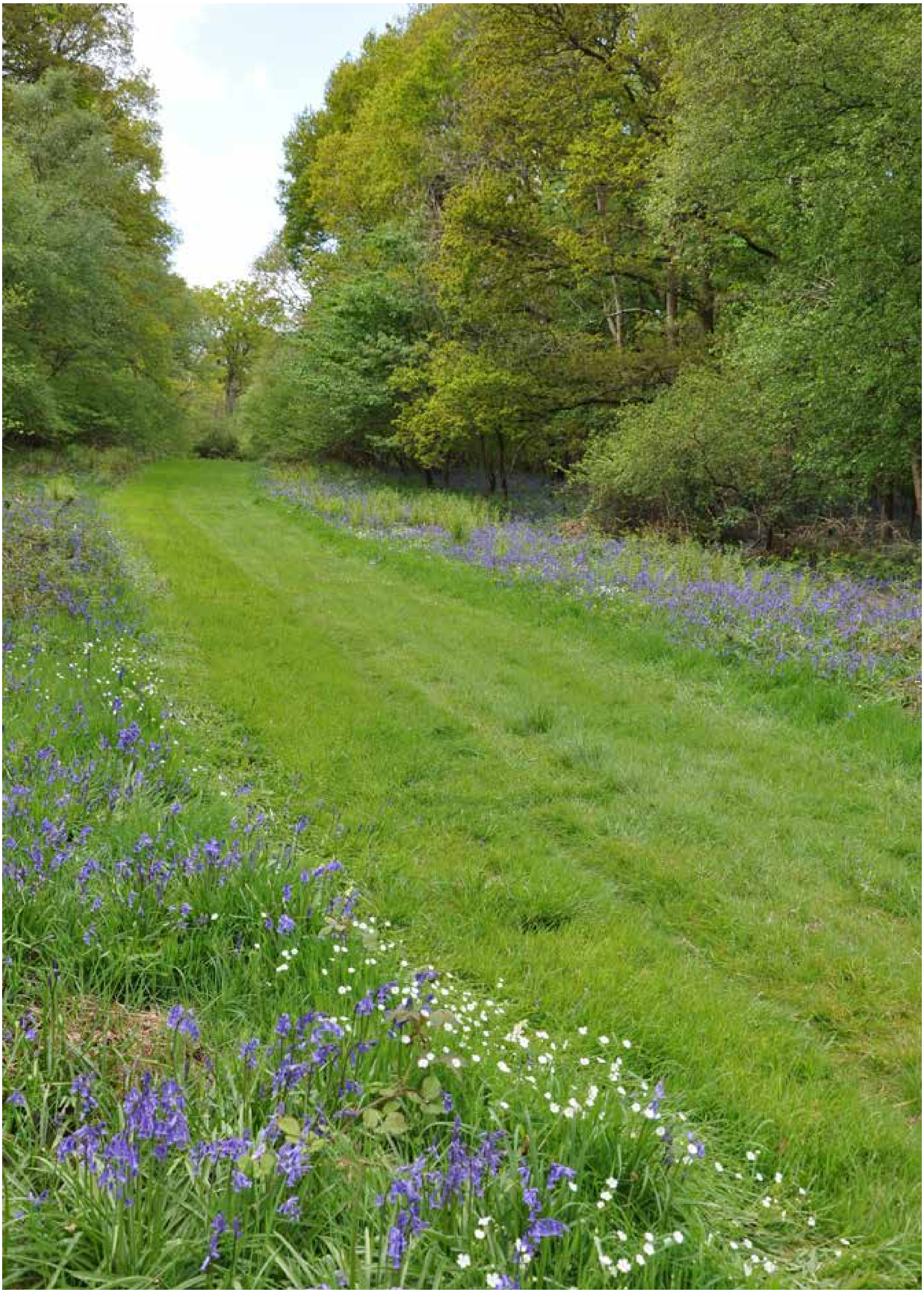
1. **Much of our older woodland has been retained and managed at least partly for its sporting value.**
2. **Use for pheasant shooting has been given as a main reason for planting new woods by a majority of landowners.**
3. **New woods should mirror the character of existing 'natural' woodland in the locality.**
4. **Some native wildlife need open treeless countryside, so planting new woods in the wrong place can be detrimental.**

Woodlands are in an exceptional position as probably the most common but certainly the most widespread semi-natural habitat remaining in lowland Britain. Most of our landscape is farmed, and the wildlife that existed on that farmland, prior to mid-20th century intensification (or on the unimproved habitat the farmland replaced) has been fundamentally changed.

Taking account of continued recent increases in the number of pheasants released each year, it is likely that at least 15–20% of all woodland in the UK is managed for gamebirds, primarily pheasants, to some extent. That is more than is managed for wildlife conservation (Aebischer 2019; Gilbert 2007; Firbank 1999). Questionnaire surveys undertaken in the 1980s and early 1990s showed that over half of landowners who released pheasants retained or planted new small woodlands with pheasants in mind (Cobham Resource Consultants 1983; Short 1994) and, at least partially as a consequence, release sites had more woodland. Using a more scientific approach by visiting several hundred $1km^2$ grid squares, Firbank (1999) also found that those with a game management interest had more and larger woods than non-game squares. In the eastern counties game squares were also more likely to have had a significant increase in woodland since the 1960s.

Based primarily on experience, the early *Game Conservancy Green Guide* booklet series (e.g. Game Conservancy Trust 1988) provided advice on how to plant or manage these woodlands for releasing and shooting. This included the design of sloping woodland edges, providing shrubby cover, and the creation of flushing and rising points. Robertson *et al.* (1993a; 1993b) and the Game Conservancy Annual Reviews (1987 to 1993) reported on a programme of work studying the characteristics of woodlands that made them good habitats for pheasants (see also Robertson 1992 for a summary). The work showed, for example, that pheasants spend the majority of their time within 20m of the woodland edge, so smaller deciduous woodlands hold higher densities of pheasants in winter and summer than larger ones. Woodland rides needed to be at least 30m wide to create a woodland edge suitable for pheasants (Robertson 1992) and woodlands with abundant shrubby cover between 0.3–2m in height were favoured by pheasants during the winter (Robertson *et al.* 1993a). A landscape that contained around a quarter or a third woodland was found to provide the optimum potential for pheasants to establish woodland-edge breeding territories (Robertson *et al.* 1993b). Woodland historians and other commentators observe that game estates are more likely to retain and manage existing woodlands and plant new ones (Rackham 2003; Oldfield *et al.* 2003). Planting new woodlands in open landscapes is not always a good thing and this is widely recognised by game managers.

Many of these studies on woodland planting for pheasants are over 20 years old, but the motivations for shoots to plant, retain and manage woodlands for pheasant remain the same. Releasing numbers have increased substantially in recent decades so the need for woodlands to hold pheasants and facilitate shooting has also increased. Woodlands continue to be planted and retained for shooting. Later sections of this report look at how woodland areas inside and next to release pens are affected by the presence of large numbers of pheasants in late summer and over the winter. The next section considers how woodland management for pheasants outlined above might affect other wildlife, especially birds.



Lowland game management for released pheasants has encouraged landowners to retain and manage woodlands. © Rufus Sage

How woodland management for pheasants affects other wildlife

Many of the techniques suggested in the early GWCT guides to improve woodlands for pheasants, for example keeping rides open, coppicing and skylighting (reducing canopy cover by removing select trees) are beneficial to other wildlife, particularly birds (Amar *et al.* 2006; Fuller *et al.* 2005; Fuller and Henderson 1992; Ludolf *et al.* 1989). Early questionnaire or small-scale studies indicated that these techniques were being used in game woods (Short 1994; Robertson *et al.* 1988; Woodburn and Robertson 1990; Robertson 1992).

In the early 2000s, however, a series of more robust studies of woodland habitat structure and bird use were undertaken in a sample of 160 sites in southern and eastern England. Draycott *et al.* (2008a) determined the impact of pheasant-management on vegetation structure and woodland composition away from release pens and on breeding songbird abundance. They found that, on average, pheasant managed woods had a more open tree canopy structure and greater ground cover of herbaceous plants. There were around one quarter more songbirds in the game woods than the non-game woods. In particular, there were more warblers, with on average two warbler breeding territories per four-hectare plot in game woods compared with 1.3 territories in non-game woods. Woodland warblers depend on the presence of a ground layer of vegetation for nesting, and these papers suggest that active woodland management for released pheasants can encourage this.

Woodburn and Sage (2005) reported that the edge zone of woods managed for pheasants had a more sloping profile, more shrub cover and fewer overhanging trees than non-game woods. In eastern England, butterfly numbers and species diversity was higher in the edge zone of game woods than non-game woods. Historically, forest fragmentation and woodland management techniques in the UK such as coppicing have favoured woodland edge species that are today of conservation importance (Ferris and Carter 2000).

Capstick *et al.* (2019a) reported that rides in game woods were not longer, but were wider (10.5m) than those in non-game woods (8.8m) and hence occupied a higher proportion of the woodland area that had a more open canopy. Woodland rides in game woods also had more shrub species and experienced more disturbance by vehicles, while in non-game woods this was by footfall and horses. The study did not find a difference in butterflies, which are looking for a combination of sun and shelter in these habitats (Warren and Fuller 1993). Robertson *et al.* (1988) found more butterflies in game-managed areas of woodland than other areas of the same woodland and suggested that the presence of rides and other open areas were the main reason. Rides are considered a priority in forest management for conservation (Ferris and Carter 2000). Game managers maintain rides for access, as open areas for pheasants, and on some shoots as places to locate a line of Guns. They are wider, more open, and it seems have a richer woodland ground flora compared to rides in non-game woodland. In the past, pheasant feed areas were commonly established along rides within woodlands, which were strawed to encourage foraging. This is now thought to smother woodland plants, enrich soils, and bring weeds into the woods (Robertson 1992) so best practice guidelines advise against this and the use of hoppers for feeding is much more common today.

Hoodless *et al.* (2006) documented higher numbers of wild birds in woods in winter where pheasants were released. In November and December, on average 13 species were recorded in game woods compared to 10.4 species in non-game woods. Bird communities of game woods contained higher numbers of finches, tits, shrub species such as blackcap and chiffchaff (as a group), and woodpigeons than those of non-game woods. Thrush and woodpecker numbers were not different. Bird numbers increased as tree canopy cover decreased, which suggested that tree-thinning or skylighting in the game-managed woods may have been benefitting birds. Feeding in pheasant woods in winter may also be a component (see page 27 for section on feeding). For most resident woodland birds, knowledge of their winter habitat use is poor compared to that of their breeding requirements but some work has shown that, in general, shelter and food availability are probably important factors (Fuller *et al.* 2005; Vanhinsbergh *et al.* 2002).

In other studies of game managed woods, Davey (2008) found that the abundance of four seed-eating or omnivorous birds (blue tit, robin, nuthatch, dunnock) and two primarily insectivorous species (blackbird and wren) were positively related to the density of feed hoppers, while two other insectivorous species (song thrush and willow warbler) showed negative relationships with feed hoppers. In a sample of 26 conifer woodlands in the Exmoor region, Sage (2018a; 2018b) measured the structure of woodland with and without game management. This indicated that the lower and upper tree canopy in conifer woods (which tend to be very dense) managed for game was about a quarter more open than in non-game ones. There was more bracken and a tendency towards more bramble and grasses but no difference in the abundance of herbaceous vegetation.

On average 18 birds were encountered per survey transect in the game conifer woods, significantly more than in the non-game woods, which had an average of 10 birds per survey. Conifer woods that already had some of these characteristics were probably selected for game-management purposes and then further improved through management for game. Many upland pheasant releases are located in conifer plantations.

Both pheasants and woodland warblers such as this blackcap prefer shrubby woodlands. © Chloe Stevens

Davey (2008) also studied small mammals in game woods in south-west England and reported that habitat variables were most important in explaining the number of mammals caught, but that game management also had an effect. In particular, higher numbers of bank voles and wood mice were caught at sites with feed hoppers all year, and the distribution of wood mice within woods was found to be positively related to feed hoppers and release pens in autumn. Bank voles were more common near to pens in spring. Common shrews were the only species that was less commonly caught near to release pens after the pheasants were released, with the suggestion that this was due to habitat disturbance. There are no other studies of small mammals and game woods, and the emphasis from this PhD study was that game management tended to be positive for woodland small mammals. The study found no evidence that the pheasants themselves affected the small mammals either directly or through habitat effects. Wood mice and, to a lesser extent, bank voles are robust common species found in a range of habitats. Common and pygmy shrews are adaptable but insectivorous (Harris and Yalden 2008) and it is possible that effects of pheasants on invertebrate communities in release pens may be detrimental to that group (e.g. Neumann *et al.* 2015, see section on page 20). Hazel dormice were not caught in the study but they need a diverse shrub layer so game management may benefit this species; although they may also be sensitive to other game-related activities in woods (Bright and Morris 1990).

Grey squirrels are sometimes reported as being more common in woodlands with pheasant feeders but there have been no dedicated studies on this. Draycott and Hoodless (2005) counted squirrels during other spring and summer surveys in their sample of game and non-game woods and found no difference in grey squirrel numbers.

Many of the positive effects of woodland management for pheasants on birds and other wildlife occur across a wider scale – either a whole woodland or a large area within an even larger woodland. Taking account also of woodland planting and retention, we would argue that the benefit of these positive management effects outweighs the negative impacts, which mainly occur across a small area at release points (see next section) or in other nearby places where birds might congregate (see section on page 24).

WOODLAND MANAGEMENT FOR PHEASANTS AND OTHER WILDLIFE

1. Thinning the canopy to allow light in and encourage undergrowth is good for pheasants, and helps a range of other woodland wildlife including butterflies and songbirds.
2. Creating and maintaining wide rides is also commonly undertaken for managing pheasants or locating Gun stands and is often good for a range of other woodland wildlife.
3. Rides in high wildlife value woodland can be damaged by vehicles.
4. Non-native woodland plantations, including those made up of conifers, can still be made into better game and wildlife habitats.
5. Gamebird feeding can help other woodland wildlife. While this can include pest species like grey squirrels and brown rats, feeding areas are often used to attract and subsequently control these species.

Do pheasants affect soils and ground flora in and around release pens?

Pheasants are usually released into woodland-based, fenced pens in late summer (Game Conservancy Trust 1996), which protect the releases from foxes until they get used to roosting in trees. The effects of these pens and the birds released into them is a key but usually locally confined impact of releasing. Sage *et al.* (2005a) looked at floras and soils inside and alongside release pens and in areas elsewhere, compared to ancient semi-natural woodland (ASNW) sites.

The release pens tended to have more bare ground, lower plant density and lower average species diversity of herbs and ferns than other parts of the same woodlands outside the pen. (Sage *et al.* 2005a; Sage 2018a). These studies also indicate, however, that release pens are not devoid of woodland plants, and changes in ground flora are often subtle. Shade-tolerant perennials such as wood avens, dog violet and wood speedwell are relatively uncommon in pens while annual species and some perennials preferring fertile or disturbed soil such as annual meadow grass or chickweed may be more common, especially when stocking densities rise above the recommended threshold. Similarly, perennials preferring shady habitats like wood millet or wood anemone decreased as stocking densities increased above about 1,000 birds per ha of pen (Sage *et al.* 2005a). Soil potassium and phosphate were higher in pens while acidity (pH) and magnesium levels were not detectably different in this small sample.

Common chickweed. © Will George

There are several mechanisms by which woodland ground floras might be changed where pheasants are released. Change to soil chemistry is one. Plants that are still present in late summer and autumn may also be damaged directly by pecking and trampling when birds are released. The woodland ground flora will also be affected by tree and shrub management in and around release pens. For example, where the tree canopy is thinned in a woodland pen, while certain plants and animals can benefit, plants that thrive in shade may be reduced.

The findings of Sage *et al.* (2005a) in particular provide the basis for the current recommendation that release pens should be stocked at around 1,000 birds per ha or less (Code of Good Shooting Practice). The number ties in with long-standing pen stocking recommendations based on good husbandry (Game Conservancy Trust 1996). The mean pen size in this study was 0.48 ha (data collected in 1988) stocked at 2,200 birds per ha of pen. In 2005, the authors looked at another sample of about 50 pens (GWCT, unpublished). Many pens were still overstocked but pens size had increased to 0.81 ha with a mean stocking density of 1,800 birds per ha.

Elements of degradation at release sites, in particular soil enrichment, probably accumulates over time although we do not really have an insight into this. There has, however, been some work on floral recovery. In a sample of 65 pens disused or abandoned for up to 14 years, Capstick *et al.* (2019b) found that soil phosphate and potassium remained around 50% higher than in non-game plots while nitrate levels, pH and soil organic matter were not different between game and non-game plots. There were a few more plant species that prefer high fertility in the abandoned pens than in the controls and about a third fewer winter green perennials, which were the group of plants most affected in Sage *et al.* (2005a). However, overall vegetative percentage cover had recovered and there were no longer differences in the proportion of grasses and annual herbs or species of disturbed ground. In the oldest pens in this study (14+ years) the sensitive ground flora community and soil chemistry showed significant signs of recovery. Long-term recovery was lower at sites where a higher density of pheasants (>1,000 per hectare) had previously been released. This further supports the recommendation that pen stocking should be limited to 1,000 birds per hectare (GWCT 2021). The paper recommends that, in general, release pen relocation should be minimised and not usually undertaken on conservation grounds. However, where a pen covers part or all of an important site and there are long-term conservation aims or strategies in place, pen relocation should be considered.

Ancient Semi Natural Woodlands (ASNW) are considered to be particularly valuable in terms of wildlife and cultural heritage and, as a consequence, have a high sensitivity to damaging activities (Rackham 2003; Peterken and Game 1984). As expected, these studies in ASNWs show that released pheasants degrade soils and ground floras in release pens. They probably do the same in other places where birds congregate, in particular at feed points in the woodland. Away from these places within the release woodlands there is no evidence that releases are affecting soils and flora (but see section on woodland management on page 16). Outside of woodlands, when pheasants congregate on farmland feed points and in game crops, the soil and flora might also be changed, but on improved grasslands or cultivated arable areas this is of little consequence. However, damage can be done if congregations occur on other valuable semi-natural habitats.

SOILS AND GROUND FLORA IN AND AROUND PHEASANT PENS

1. The GWCT recommends a maximum stocking density of 1,000 pheasants per hectare of release pen, as described in our Sustainable Releasing Guidelines.
2. Exceeding GWCT stocking recommendations is likely to damage ground flora and soils within the pen, as well as potentially compromising pheasant health.
3. Even lightly stocked pens are likely to exhibit some changes to soils and flora within them.
4. Some floristic change in pens is likely to be a result of management, such as canopy thinning, rather than an effect of the birds themselves.
5. Pens generally should not be moved unless conservation gains are expected. Remaining below 1,000 birds per hectare of pen will speed recovery in abandoned pens.
6. If siting pens in ASNW, game managers are encouraged to identify and avoid sensitive areas and to reduce the maximum stocking density to 700 per hectare of pen.

Stocking pheasant release pens at or below recommended densities is key to minimising the impact on soils, insects and ground floras at release sites.

Do released pheasants affect invertebrate communities in woodlands or elsewhere?

Pheasants are omnivorous and in the wild they will take animal foods, generally insects, particularly when they are chicks (Beer 1988). However, wild adult birds do not need a high protein intake and their diet is primarily plant-based. In the rearing system the diet of young birds pre-release is usually grain-based with added protein. Despite this, it is thought that released birds probably retain an instinctive interest in insects and will opportunistically eat them if they see them and can catch them.

The evidence that this happens to the extent that insect populations are compromised is mixed. There is some good evidence from pitfall trapping work that invertebrate communities inside release pens are altered (Neumann *et al.* 2015). While the study found no difference in overall invertebrate abundance, or in ground beetle (carabid) and rove beetle (staphylinid) species richness between pens and non-release areas, the release pens had a different community of ground beetles with fewer large woodland species and more beetles characteristic of arable fields and grasslands. There were also more snails and some other detritivores in the pens.

They also found altered conditions for invertebrates inside the pens in terms of leaf litter and plant species composition (see previous section, page 18) with more disturbance-tolerant species than outside the pens. It is not clear whether the difference in beetle communities inside and away from release pens was due to changes in plant and soil conditions, to predation of beetles by pheasants, or a combination of these things. Release pens commonly have more sunlight due to tree canopy management, which may favour the ground beetles recorded.

Outside of release pens, Pressland (2009) used pitfall traps at 17 pairs of matched woodland sites (with or without releasing) in south-west England. There was no detectable difference in insect numbers at wood-edge plots with or without releasing and before or after releasing, and between any plot type after release. Some insect groups were caught more frequently in areas with releasing and some without, but these variations were not easily explained. There were fewer insects overall caught in pitfalls in grass fields outside of the releasing woods before releasing occurred (May/June sampling). Faecal analysis indicated that the proportion of invertebrates in the pheasant diet increased in spring when more insects were available. The pheasants themselves were, of course, much less common in the spring (typically under 10% of the total release) than in the early winter.

Corke (1989) found associations in different areas to suggest that predation of caterpillars by pheasants was affecting population size and the distribution of some woodland fritillary butterfly species. However, another paper on this by Warren (1989) described how the size, timings and behaviour of these butterfly larvae meant that they were at a low risk of predation and suggested that Corke's findings were probably just correlations, and not directly caused by the pheasants. Clarke and Robertson (1993) took a closer look at this potential conflict by exposing caterpillars on violets (their food plants) in woodland but found no evidence that released pheasants were predating them. They also showed that, of 50 woods surveyed for butterflies in 1970, the proportion that had fritillary species had declined by around 35% overall, but that the decline was the same in woods with pheasant releasing and those without. Although the survey found no evidence, Clarke and Robertson (1993) discussed the possibility that pheasants may have an indirect adverse effect on these specialist butterflies if the violet host plants themselves were affected by being in or very close to pheasant release pens.

There is a perception that away from the release sites, released pheasants are predating invertebrates and reducing populations across the wider countryside. In reality, there is no good evidence to support this idea, and there are other factors to remember. For example, the diet of released adult pheasants is primarily plant-based and most birds receive feed for life. Observations show that pheasants do peck at some insects such as crane flies but also that many insects move too fast to be caught and many others move too slowly or are too well hidden to be seen. There also seems to be poor understanding of how thinly distributed pheasants become away from release sites. In release pens, where they are at by far their highest densities, it has been shown that certain invertebrate communities can be affected. However, the range of invertebrates affected and the scale of these impacts are limited even at these highest pheasant densities. It is unclear to what extent those insect groups that are affected in the pens are altered by direct predation or by indirect changes to habitat. Either way, this is a negative impact of release pens. But, perhaps ironically, this evidence of only a limited effect with very high densities of pheasants also supports the idea that away from release sites, pheasants are not damaging insect communities.

Some woodland specialist insects such as large ground beetles like this Pterostichus niger *can be affected inside release pens but there is no evidence released gamebirds have an impact away from release sites.*

PHEASANTS AND INVERTEBRATE COMMUNITIES

1. While the main diet of adult pheasants is grains and seeds, they will eat small invertebrates.
2. Evidence shows that insect populations inside release pens can be affected, probably either by predation, by changes in soils and floras, or both.
3. There is also evidence to show that pheasants are unlikely to have a significant impact on invertebrates away from release sites.
4. Although suggested by an early correlative study, more recent work indicates it is very unlikely that pheasants eat significant numbers of fritillary (or probably any butterfly) caterpillars.

Silver-washed fritillary.

The effect of released pheasants on woodland bryophytes and lichens

Lichens and certain plant types such as mosses and liverworts (of the group called bryophytes) are usually found growing on trees or rocks, and are particularly sensitive to damage through enrichment of the soil or atmosphere. Because of this, they typically remain common in woodlands that are in relatively clean-air regions of the country (e.g. Mitchell *et al.* 2004). Some preliminary calculations from the Centre for Ecology and Hydrology on atmospheric nitrogen compounds caused by pheasant excrement suggested that some woodlands with large pheasant releases could have levels raised enough that it might cause these sensitive plants to decline.

In the only study of its kind, Sage (2018a; 2018b) undertook a survey of bryophytes (mosses and liverworts) and lichens on the ground and on tree trunks in pheasant releasing woods and control woods at seven large shooting estates in Devon, south-west England. The abundance and diversity of bryophytes and lichens on trees overall was not different between release pen plots and plots without pheasants. However, when analysed further, moss diversity was about 25% lower on trees in woods on the release sites compared to the estate woods without release pens, and liverwort species diversity was about 30% lower. There was no difference in lichen species diversity between plot types.

Moss growing on a tree in woodland.

An expert eye is required to properly study mosses, liverworts and lichens on trees.

For moss and lichen abundance, there was no difference between woods with and without released pheasants. Liverwort abundance was, however, about 50% lower in pheasant release woods. Some of the species encountered in the study are considered to be sensitive to atmospheric nitrogen enrichment, and the presence or abundance of these species is sometimes used as an indicator of this in woodlands (Mitchell *et al.* 2004). It is possible that the differences found arise from increased nitrogen in the air but other factors may also be involved. For example, management undertaken to create sunny areas in and around pens may reduce the suitability of the microclimate in those areas.

PHEASANTS AND WOODLAND BRYOPHYTES AND LICHENS

1. It is possible that increased levels of nitrates in the atmosphere of pheasant release pens might affect some bryophytes and lichens.
2. Not overstocking pens is likely to minimise any atmospheric enrichment, and therefore reduce the risk of damage.

Do hedgerows and other edge habitats on farmland benefit from released gamebird management?

Hedgerows are often used by game managers to connect woodland pheasant and partridge-releasing areas to holding cover, usually game crops, to facilitate shooting (Game Conservancy Trust 1988). It is likely that many hedgerows today were planted or retained for game interests in the past. Firbank (1999) reported more hedges, more complete hedgerow networks, and greater connectivity between hedges and woods on areas with an interest in game than on non-game areas. Common farmland or hedgerow birds and butterflies were 10% more abundant on areas with an interest in game than on non-game areas. Using satellite imagery of around 150 locations, Draycott *et al.* (2012) found that these so-called game estates had more hedgerows per square kilometre than farms with no releasing. Using ground surveys, the size of the hedges was similar on game and non-game areas but there were more grass margins or other uncropped strips alongside the game estate hedges.

Many release-based shoots are interested in maintaining the population of gamebirds left over from the shooting season so that they might breed and produce a few wild birds for the next season. They will use feeders and some may improve nesting cover and provide brood-rearing cover. However, it is uncommon for release-based shoots to use particular techniques such as conservation headlands or beetle banks unless they have particular interest in wild birds. Ewald *et al.* (2010) discovered this by looking at sites accessing agri-environmental schemes (AES) in the late 2000s.

Released game estates maintain and create hedgerows on farmland. They also create grass margins and other strips alongside them. A small number of released game estates go further and create dedicated nesting and brood-rearing cover, to encourage wild breeding in their surviving released birds.

This young female pheasant is using a grassy bank alongside a hedgerow to move between the release site and a game crop.

The effect of gamebirds on hedgerows near to release sites

Pheasants are often encouraged to make daily movements along hedgerows between release woods and holding cover, and partridges will use hedges as connecting cover where they are released nearby. Based on surveys at around 100 sites, Sage *et al.* (2009) found around twice as much bare ground on hedge-banks and inside hedges within 100m of release pens than in hedges further away from the release sites. The ground flora structure within hedges (but not on hedge-banks) near to release sites was also reduced. At sites with larger releases (over 1,500 – in the nearby pen) the low structure of the hedge itself was also affected and there were more perennial weed species inside hedges within around 100m of release pens. The overall abundance of songbirds in hedgerows was not affected by the proximity of a hedge to a release pen, but there were fewer songbirds in hedges close to release sites of more than 1,500 birds. In their study of hedgerow abundance and structure, Draycott *et al.* (2012) reported that hedgerow structure was similar on game and non-game sites and that woody species richness and woody cover was not depleted in hedges adjoining woodlands with pheasant release pens. Unlike Sage *et al.* (2009), this study did not take account of the distance to release pens along hedges.

The combined findings of these studies suggest that hedgerows can be affected close to woodland pheasant release pens, especially larger release pens. While Sage *et al.* (2009) only considered pheasant releasing, it is reasonable to suggest that similar impacts may occur where released partridges congregate in hedges close to their release points.

HEDGEROWS AND GAME MANAGEMENT

1. Estates with game management interests tend to have better hedgerow networks than those where there is no such interest.
2. Countryside Stewardship schemes can be used to plant wide margins that can enhance and protect hedgerows and increase their value for game and other wildlife.
3. Gamebird releasing provides a good incentive to retain and manage hedges.
4. Planting new hedges is a good way to link release sites and drives such as spinneys and cover crop plots.
5. Where large numbers of pheasant or partridge poults use hedges as a link or shelter habitat there is a risk of damage to their flora.

While game managers maintain and improve hedgerows for gamebirds, near to larger release sites, the basal ground flora and lower hedge structure can be damaged.

Goldfinch feeding on the seeds of a teasel plant.

How songbirds use game crops on farmland

Winter game crops are widely planted on released game estates to provide feed areas and to hold pheasants and red-legged partridge as part of a shoot (Game Conservancy Trust 1994). Ewald (2004) estimated that 80% of all shoots planted game crops covering 3% of their arable area. Several studies have shown that these crops attract and provide cover and food for a wide variety of farmland and wood-edge birds. For example, 30 winter game crop plots contained more than 10 songbirds per ha in most months between October and January, while the adjacent arable field plots contained less than one (Sage *et al.* 2005b). Kale and quinoa game crops were best for birds including tree sparrow, bullfinch, reed bunting, yellowhammer and grey partridge, which have all shown significant declines on UK farmland (see also Stoate *et al.* 2003; Parish and Sotherton 2004).

In a study of winter bird crops (i.e. game crops) at 192 farmland sites, Henderson *et al.* (2003) found 12 times as many birds per ha compared to conventional crops. The authors thought kale was especially good because of its seed-bearing and soil-moisture retention properties, which would benefit snails, worms and other invertebrates. They also found that kale and quinoa retained seed better as the winter progressed compared to most other crops they studied. For most of these crops, larger plots of one ha or more retained seeds for longer.

Winter and summer game crops are planted in relatively small plots and hence concentrate birds in and around them. Nevertheless, these patches of game crops lead to substantial increases in the abundance of wintering and breeding songbirds, which use those plots and the adjacent land. This applies to both generalist farmland/wood-edge species as well as some declining farmland birds. In regions of the UK where there is no arable cropping, game cover crops can be the only seed crops available to farmland birds, and the evidence suggests that those may be key in maintaining overwintering populations in those areas.

Larger shoots tend to plant more game crops and in larger individual plots. At three such estates in the Exmoor region totalling 60km^2, there were 143 separate game crop plots averaging just under 1.8 ha each (Sage 2018a; 2018b). One quarter was maize while the rest contained 15 other crop types, the commonest being kale, miscanthus, various root crops and a wild bird mix. Most of the farmed land in the region is grassland for livestock grazing. Comparisons with cropping maps from the late 1960s showed that the game interest on the Exmoor estates today contributes to a cropping pattern in the landscape that was more like that of the 1960s than that of modern farmland without a game interest. The number of breeding resident birds using the hedgerows near to game crops on Exmoor was 2.5 times higher compared to hedgerows in other places at other sites. In eastern Scotland, game crop plots in grassland landscapes had more birds in winter than similar game crops in arable areas (Parish and Sotherton 2008).

Game crops planted on farmland and elsewhere to manage released game are clearly attractive to a wide range of farmland and wood-edge bird species. The research suggests that larger plots have more benefit to birds probably because they retain their seed food supply better towards the end of the winter. Best practice encourages shoots to plant large plots of the best seed-bearing crop types. There is also some research to suggest that game crops may play a significant role in maintaining overwintering bird populations in the wider farmed landscape that then remain in the area to breed. This may be especially true in improved grassland areas where alternative food supplies are particularly limited.

SONGBIRDS AND GAME CROPS

1. Game crops planted by shoots add up to a very significant amount of habitat for farmland wildlife, especially songbirds.
2. Larger plots retain their value later into the winter.
3. Small-seeded crops like millet, quinoa and second-year kale are likely to be better than maize.
4. Biennial crops such as kale can provide good cover for two years, while offering valuable nesting and foraging habitat for game and farmland birds during the intervening spring and summer.
5. Diversity can be improved significantly by growing separate strips of different crops alongside each other as part of a larger block.
6. Game crops in improved grassland landscapes may be especially valuable to birds.

Seed bearing crops such as this sandoval quinoa are good for a wide range of farmland and wood edge bird species and are widely planted by released game managers on farmland. © Kings Crops

Supplementary feeding for gamebirds

Providing supplementary winter food for released gamebirds through feeders is practised on most release-based shoots. To find out which animals used these feeders, Sánchez-García *et al.* (2015) used trail cameras on 260 spiral dispenser drum feeders at three sites with modest pheasant releases plus wild grey and red-legged partridges. They found that birds and mammals used the feeders for about half the time each. The gamebirds used them plus a range of other birds, the commonest of which were wood pigeon, blackbird, dunnock and yellowhammer. Other UK BAP species recorded included house sparrow, linnet, song thrush and starling, while other farmland birds like corn and reed bunting have also been documented using feeders (Brickle 1997). The commonest mammal species were brown rat, common mouse and deer species, brown hare, rabbit, grey squirrel, stoat and hedgehog. The study provided management suggestions for minimising use of hoppers by pest or other non-target species. For example, the study found that rats use feeders along hedges or wood edges and take more time than birds to find feeders again when they are moved.

Siriwardena *et al.* (2007; 2008) looked at relationships between farmland birds and seed provided on the ground (i.e. not in feeders or as game crops) at 110 sites and found peak use in January and February for most farmland bird species. Local population declines for yellowhammer, robin and dunnock were reduced with seed provision, and numbers of several other species appeared to increase. Birds benefitted most if the food resources were widely distributed i.e. more than 1km apart. They conclude that current farming practices, including the agri-environment prescriptions of the time (without a game interest and associated game feeding) did not provide enough food in late winter for these birds. This suggests that if game estates maintain feed points following shooting, as required by the Code of Good Shooting Practice, overwinter survival and subsequent breeding numbers of seed-eating farmland birds on those estates may increase.

SUPPLEMENTARY FEEDING FOR GAMEBIRDS

1. Well-organised gamebird feeding can help a range of other wildlife species.
2. Scavengers such as rooks, rats and grey squirrels can take feed intended for game. Hoppers with spirals are especially prone to this.
3. Other designs of feeders can supply game and songbirds without supporting scavengers.
4. Shoots that comply with The Code of Good Shooting Practice and feed on into the spring are likely to see better productivity of wild breeding game and other farmland birds.
5. Feeders that are moved frequently, even short distances, help to minimise parasite build-up and to deter rats.

Most release-based shoots feed gamebirds using small hoppers. Many birds and some mammals also use and benefit from these hoppers.
© Christopher Wills

Do released red-legged partridges affect invertebrates in sensitive open habitats?

Partridges are usually released from small, closed pens on arable ground near game-crop or feed areas in the weeks before the shooting season begins in September (Game Conservancy Trust 1996). They are then normally driven between game crops to facilitate shooting. As they are not usually released into semi-natural areas like woodland, the potential for damaging habitats is reduced compared to pheasants. Partridges are, however, sometimes released into or alongside more sensitive habitats with valuable floras or rare insect communities.

One such habitat is chalk grassland, often found in hilly areas that are good for shooting. Callegari (2006a; 2016b) looked at the possible impacts on invertebrates of high-density releasing onto arable ground alongside sensitive chalk grassland habitats at six sites in central southern England, three with releasing and three without. Observational work established that a small proportion of the released birds used the grassland and individuals spent a considerable amount of time in feeding-related activity in September following release and initial dispersal, which then declined into the winter.

Using gamebird exclosures at the sites, however, found very little difference in insect communities with and without the gamebirds. Analysis of faecal samples showed that about half of the gamebirds had ingested invertebrate fragments in September, which dropped away to very small percentages by January. Most of the invertebrate community becomes inactive in winter so, although the gamebirds were eating invertebrates on the grassland following release in autumn, they did not appear to impact spring invertebrate densities. Part of this study focused on the Adonis blue butterfly, which occupied areas of the chalk grasslands, but again no reduction in spring emergence caused by gamebirds was detected (see also Callegari *et al.* 2014).

The findings of this work are similar to those for pheasants and woodland insects (see page 20), which suggest that away from release sites partridges are having little or no effect on invertebrate communities in nearby habitats. Like pheasants, the main diet of partridges is plant-based and partridge shooting on farmland usually involves driving groups of released birds from one game crop to another where the birds will find food.

RELEASED RED-LEGGED PARTRIDGES AND INVERTEBRATES

1. To minimise the risk of habitat damage, partridges are released where possible into game crops on farmland or other man-made habitats rather than semi-natural ones like permanent grassland.
2. Wherever possible release sites should not be close to potentially sensitive habitats like chalk grassland, and birds should be fed away.
3. There is little evidence that red-legged partridges harm wildlife on semi-natural habitats.

Adonis blue butterfly.

Possible effect of released pheasants on reptiles

The Amphibian and Reptile Conservation Trust (ARC) suggests that all six British reptile species could be vulnerable to predation by, in particular, pheasants (although partridges are not excluded) and that this could affect their conservation status locally. While adult released pheasants are not usually seeking protein in their diet, there is evidence that they will eat insects if they can easily find them (see page 20). According to ARC there are anecdotal observations of reptile predation by pheasants. Blanke and Fearnley (2015) cite earlier work, also often anecdotal, that suggests a range of predators of sand lizards including pheasants.

Although pheasants are released into woodlands, and reptiles usually tend to occupy more open habitats, certain reptiles (common lizard, slow worm and adder) will use open habitats at woodland edges, in woodland clearings and along woodland rides (e.g. Edgar *et al.* 2010) where pheasants can also be found in large numbers following release. While reptiles usually enter a dormant period for the winter (called brumation) and become unavailable for pheasants as food, there is an overlap in September and October when reptile activity will continue in warm weather (Beebee and Griffiths 2000; Edgar *et al.* 2010) and pheasants are moving around the release area. Reptiles have responses that minimise risk to predators (Blanke and Fearnley 2015), but they are more sluggish on colder days. Reptile hatchlings tend to live independently of adults.

Using DNA identification techniques to look at pheasant droppings, no reptile fragments were found in 50 samples collected from a grassland/heathland area that contained released pheasants and reptiles (Dimond *et al.* 2013). But sample sizes were very low for such a study to be conclusive. Berthon (2014) found that juvenile penned pheasants preferentially pecked at reptile-shaped plastic objects but adult pheasants did not peck at those objects. Berthon also recorded no reptiles under refugia (felt mats or boards on the ground) set out in a sample of pheasant-releasing woods at three sites in the New Forest area but did record a small number of grass snakes and slow worms in refugia in three non-release woods.

There is no clear evidence that pheasants impact reptiles, but it is plausible that there is a conflict, and there are management approaches that could usefully be employed as a precaution. In particular, it is good practice to limit the movement of released gamebirds onto sensitive reptile habitats in autumn. In the spring, numbers of remaining released gamebirds are typically less than 10% of the initial release size so the risk of conflict is lower. It has been suggested that concentrations of emerging adders in spring might be vulnerable.

The reptile management handbook (Edgar *et al.* 2010) mentions possible pheasant predation and refers to general GWCT advice on releasing good practice. Natural England has guidelines for developers that highlight the issues and the legal situation regarding reptiles when building work is proposed (*www.gov.uk/guidance/reptiles-protection-surveys-and-licences*). Ecological surveys are recommended and there is advice on mitigation measures. Surveys should be employed by shoots where there is a risk that a pheasant or partridge release encroaches on an area that has reptiles.

There is no clear evidence that pheasants impact reptiles but they may do near release sites. There are management approaches that could be employed as a precaution.

POSSIBLE EFFECT OF PHEASANTS ON REPTILES

1. While there is little evidence that pheasants are harmful to reptile populations, it is possible that a problem might exist, especially before hibernation in autumn and for young hatchlings.
2. It is best to avoid siting release pens on or near to known reptile colonies.
3. Choosing a later release date can reduce the period of time that reptiles are exposed to released pheasants before they hibernate.

Red-legged partridge releasing and over-shooting wild partridges

Releasing red-legged partridges facilitates shooting on farmland where wild partridges, either red-legged or grey, are absent or in low numbers. This can lead to a potential conflict where there is a low density of wild partridges, which need to be conserved and not shot. For the wild red-legged partridge, the release of reared birds is likely to lead to overshooting of any wild stocks but no work has been done to quantify this. For the native grey partridge the potential for over-shooting to reduce spring numbers has been quantified by Watson *et al.* (2007) who looked at the effect of raptor predation and shooting on winter mortality of grey partridge. Over a large area of his study site comprising numerous farms, a third of the wild grey partridge population was being accidentally shot on released-based shoots.

Watson *et al.* (2007) argued that removing grey partridges from the quarry list would be counter-productive, because most action to help support grey partridges is carried out by enthusiasts with shooting as the incentive. Instead, where shooting is based on releasing and shooting red-legged partridges at sustainable levels, training Guns to avoid greys and implementing a warning system that alerts them when greys are approaching could be effective. On one of the two farms in their study with a large partridge release, a policy of avoiding shooting greys was introduced after the main study using these voluntary measures and the proportion of the autumn grey partridge stock shot dropped to 16%. In another GWCT grey partridge recovery demonstration project, both grey and red-legged partridges responded to a programme of wild game management (Aebischer and Ewald 2010). A sustainable surplus of red-legged partridges were shot, with 5% loss of the autumn grey partridge stocks.

PARTRIDGE RELEASING AND WILD PARTRIDGES

1. Where there are low populations of wild grey partridges, accidentally shooting them while driving red-legged partridges can have a damaging effect, possibly even leading to local extinction.
2. A system of warnings can help Guns avoid making mistakes. In particular, neighbouring Guns with a side-on view can often identify oncoming wild greys more easily and shout an alert.
3. A well-organised beating line can allow coveys of wild greys to escape to the side, rather than flying over the Guns.
4. Grey partridges tend to pair in mid or late winter so many shoots implement a rule against shooting at pairs from Christmas onwards.

Grey partridge.

The effect of predation control

The impact of predators on birds has been widely studied, but how effective predator control can be to limit this predation and benefit birds is less clear. In a comprehensive review Roos *et al.* (2018) found that for three of the four main groups of birds (seabirds, gamebirds, waders) there was good evidence that numbers were limited by predators. From those studies that looked at predator control scientifically, there was evidence that it could benefit all these groups and passerines too. Roos *et al.* (2018) concluded that predator management aimed at foxes and corvids simultaneously is likely to be effective for birds.

This seems fairly clear but the question that remains is: do release-based shoots undertake effective predator control? It has been thoroughly demonstrated that fox control by wild or released bird gamekeepers can reduce foxes locally (Porteus 2015; Reynolds *et al.* 1993; Tapper *et al.* 1996). In the 1980s good gamekeeper predator control on the Salisbury Plain was shown experimentally to improve wild partridge breeding by around three times (Tapper *et al.* 1996). The authors of that early work went on to describe and discuss how predator control undertaken for the benefit of small game has been practised in the UK for 200 years and has played a key role in shaping its fauna today (Reynolds and Tapper 1996). More recently, Aebischer *et al.* (2016) concluded that where predator densities were high, recovery of declining farmland birds including some passerines would require predator control as well as habitat management.

While released bird gamekeepers have the motivation to protect their releases during the winter, the resources allocated and the effectiveness of their fox and corvid control activities will vary widely from one site to another. It is likely that many release-based shoots undertake relatively little and sometimes no predator control but there is little quantification of this. Heydon and Reynolds (2000) showed that fox control in areas where there is relatively little interest in wild gamebird management resulted in no regional reduction in the fox population level below that predicted based on landscape. In his PhD thesis, Porteus (2015) suggested that larger release-based shoots in his study supported more foxes which were then ineffectively controlled.

At a local level, Sage *et al.* (2018b) combined the results of seven spring and summer pheasant radio-tracking studies. Two pheasant release sites classified as having high-level predator control had improved survival of adult birds during the spring compared to four release sites with low-level control. Draycott *et al.* (2008b) documented improved nest survival at one of those sites with high-level predator control. These two studies of pheasants suggest that at least some release-based shoots suppress predators sufficiently to have a positive impact on wild breeding birds.

Carrion crow.

In summary, there is some evidence that a significant minority of release-based shoots undertake effective predator control. In these circumstances the papers that Roos *et al.* (2018) review indicate that other wildlife can benefit.

THE EFFECT OF PREDATION CONTROL

1. **GWCT research has shown that predation control as practised by gamekeepers can have a significant beneficial impact on gamebirds and a number of non-game species.**
2. **Ground-nesting birds can be especially vulnerable to common predators and are therefore particular beneficiaries of good predation control.**
3. **On some shoots where game is released, predation control is focused on protecting release pens in the summer and autumn. Shoots that also control foxes and crows in spring will suppress predatory activity better and have wider benefits for wild breeding game and other wildlife.**

The impact of releasing gamebirds on predators

On average around 60% of pheasants and partridges released for shooting in the UK die of causes other than being shot. Most of these are predated but the corpses of any birds not picked up on shoot days will also be available to scavenging predators (Sage 2018b). The biomass of released gamebirds make a significant but seasonally very variable contribution to the total biomass of British birds (Blackburn and Gaston 2021; What The Science Says 2020).

In theory generalist predators like foxes, corvids and some raptors will respond numerically (i.e. increase in number) and/or functionally (switch to eating more pheasants) to an increase in abundance of a prey species such as released pheasants (Solomon 1949; Robertson and Dowell 1990). Bicknell *et al.* (2010) and others go on to discuss the idea that these predators are attracted to released game during the winter, remain on site and switch to other prey such as ground-nesting waders when the numbers of released birds decline in the following spring. This is a reasonable hypothesis but there is no evidence to support or refute it because the studies have not been done and there are no data available.

There is, however, information available relating to the first point, that predators may respond to releasing gamebirds in late summer. An increase in predator abundance with releasing could be regarded as a good or a bad thing depending on the species involved and the viewpoint. Conservationists would usually regard an increase in breeding range or abundance of buzzard or red kite as a good thing, but most would not suggest that an increase in crows or foxes was a conservation objective.

Robertson (1986) found four times as many fox droppings within 200m of a release pen after release than before, and that these droppings contained more pheasant fragments. Kenward (1977) and Kenward *et al.* (1981) found that 43 radio-tagged goshawks were the main cause of overwinter mortality of pheasants at a large release in Sweden. Goshawks were at a higher density, had smaller ranges and were heavier than goshawks elsewhere. These two studies suggest that some predators are attracted to locations where pheasants are released.

Taking a wider view, in their review of predation on birds, Roos *et al.* (2018) found that the overall density of foxes in England/UK was higher than in eight other European countries (but not Italy and Spain). They speculated (but provided no evidence) that this was because of habitat suitability factors, high farming production, lack of apex predators and the release of pheasants and partridges providing a food source throughout the winter. They also found that crow density was higher in the UK than in other European countries and suggested the same set of reasons.

There is a perceived problem of buzzards impacting recently released pheasants (Kenward *et al.* 2001; Lees *et al.* 2013; Parrott 2015) but most studies report little direct predation (Turner and Sage 2003; Lees *et al.* 2013). In his PhD, Swan (2017) found support for the idea that there are some buzzards that specialise in taking pheasant poults. The buzzard has increased substantially in population and range since the 1970s, in parallel with the widespread increase in pheasant releasing. Reductions in illegal killing, the banning of certain pesticides and an increase in the rabbit population (in previous decades) have been suggested as the most likely drivers of this (Parkin and Knox 2010) but it is possible that pheasant releasing has also contributed.

By studying their home ranges, Kenward *et al.* (2018) looked at habitat resources for buzzards, which indicated that rough ground, meadow and suburban land were most important. Coniferous and broadleaf woodland were not important, which by inference suggests that release sites were not either. Swan (2017) found that buzzards nested at greater density in areas with more pheasants and rabbits. Recently Pringle *et al.* (2019) reported a series of spatial correlations or associations between pheasants/partridges and the abundance of buzzards and some corvids. Some of the relationships suggest a possible straightforward response by the predators to the presence of gamebirds but others suggest different factors are probably involved. Correlations are where two measured variables appear to change in association with each other but provide no evidence of an actual effect or cause.

In one study looking at five pheasant release sites, both fox immigration rates (the number of foxes arriving from other areas) and the carrying capacities of foxes (the maximum number the area can support) appeared to be positively related to the estimated number of gamebirds released, the gamebird bag and the number of gamebirds not shot (Porteus 2015).

Most of these studies variously point to the idea that foxes and some corvids/raptors are attracted into areas containing recently released pheasants in late summer and autumn. This is a very plausible possibility. How local populations respond to predator control (see previous section) and as the pheasant population declines over the winter and into next spring is unclear. Further work on this, and the possibility of a link with increased predation of other wildlife, needs to be done in the context of other human activity, especially modern farming, which will also influence these predators.

THE IMPACT OF GAMEBIRD RELEASING ON PREDATORS

1. Gamebird releasing is likely to provide an extra food resource for some predator species, especially in late summer and winter.
2. There is some limited evidence that released gamebirds attract some generalist predators such as foxes, buzzards and crows.
3. It is suggested by some conservation organisations that predator populations supported by gamebird releasing may be having a detrimental effect on, for example, some ground-nesting birds, but there is currently no good evidence to support or refute this.

Foxes are common predators of most ground-nesting birds. It is possible foxes are attracted to gamebird releases at least for part of the year. On the other hand, if a release-based game shoot undertakes effective predation control, a gamekeepered shoot landscape might contain fewer foxes.


Common buzzard.

Illegal killing of raptors

In questionnaire surveys of release pheasant managers undertaken in the past, Lloyd (1976) and Harradine *et al.* (1997) both reported tawny owl, sparrowhawk and buzzard as the main 'problem' species at release sites. In a review FERA (2012) concluded that losses of released pheasant poults to raptor predation was less than 1% at the vast majority (more than 90%) of sites. Swan (2017) found support for the idea that there are some buzzards that specialise in taking pheasant poults. Some studies report little direct predation by raptors of released birds (Turner 2007; Lees *et al.* 2013) and Kenward (1977; 2001) suggests that only goshawk presents a serious threat to releases in Britain, but there remains a perceived problem of some other raptors impacting recently released pheasants (Kenward *et al.* 2001; Lees *et al.* 2013; Parrott 2015).

Kenward *et al.* (2001) is the main source of evidence for buzzards being killed in association with releasing. In this study, several radio-tagged individuals were found shot or poisoned near pheasant release pens. Similarly (but now over 40 years ago), Marquiss and Newton (1982) documented illegal killing of ringed goshawk in Britain at or near to pheasant release pens. In Portugal, kestrel were found to be less common on game estates and the abundance of most raptors varied inversely with gamekeeper density (Beja *et al.* 2009). The RSPB (2019 and previous years) has occasionally reported raptor killing alongside releasing in the UK. A Europe-wide review (Arroyo and Beja 2002; Manosa 2002) concluded that illegal killing of raptors was less common in association with releasing than with other forms of game management and that it had declined across Europe.

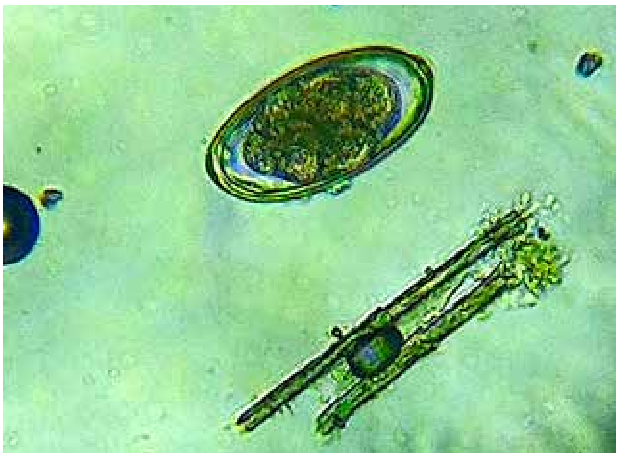
ILLEGAL KILLING OF RAPTORS

1. The GWCT condemns the illegal killing of any protected species.
2. There is a widespread perception that some released-bird gamekeepers break the law and kill protected species, especially birds of prey.
3. In recent times there is only limited evidence of this in isolated cases.

Parasites of pheasants and partridges

Released pheasants and red-legged partridges are prone to infection by a range of internal parasitic worm species (Clapham 1961; Draycott *et al.* 2000; Gethings *et al.* 2015). The worms are not necessarily particularly pathogenic to the gamebirds although gapeworm has been shown to reduce body condition in pheasants even at relatively low infection levels. Treating free-living pheasants for one very common worm *Hetarakis gallinarum* has also been shown to improve adult survival and aspects of breeding (Woodburn 1999).

The question here, however, is: are released gamebirds infecting other birds? There is little information on this. It is speculated that wild birds can cause gapeworm infections in poultry or released gamebirds and vice versa. Gethings *et al.* (2016a,b) showed that pheasants probably shared infections with carrion crows and both species showed reduced body condition.



Syngamus *egg.* © *Owen Gethings*

For *H. gallinarum* it has been suggested that released pheasants may act as a reservoir for this parasite while remaining unaffected but that it can be picked up by wild birds such as grey partridge, which are then negatively affected. Tompkins *et al.* (2000; 2001) experimentally infected a small number of grey partridge with *H. gallinarum* and found that at relatively low infections rates (i.e. at which pheasants would be unaffected) they lost condition. However, the results were not repeatable in a larger study by Sage *et al.* (2002).

Research at two large estates in south England (Ewald and Touyéras 2002) did not find any association between grey partridge productivity and proximity to pheasant release pens. Despite increasing numbers of released pheasants since the 1960s (Aebischer 2019), an analysis of 12,000 post-mortem reports found that the rate of infection of wild grey partridges by *H. gallinarum* fell by over 90% since 1951, suggested that free-ranging domestic fowls, now vanished from the British countryside, were responsible (Potts 2009; 2010).

Syngamus trachea or gapeworm is a particular problem for pheasant and partridge releases, and many game managers will treat birds for infections via their food or drink when released. However, birds will often re-infect themselves because the parasite eggs can survive in the soil from one season to the next (Gethings *et al.* 2015). There is little information on whether parasite control treatment for releases, which is frequently undertaken using anthelmintic-treated grain or water in pheasant feeders inside release pens, has any positive or negative effect on other wildlife (Mustin *et al.* 2018). Other animals especially birds are known to use pheasant and partridge feeders (see section on page 27).

Diseases of gamebirds and wildlife

The occurrence of diseases in released gamebirds on a particular site depends on factors such as the source of the gamebirds, contact with other wildlife, stocking density, management of the birds during rearing and prior to release, and also on external factors such as weather conditions.

In recent years respiratory diseases, especially *Mycoplasma gallisepticum* (*MG*) has become increasingly prevalent in reared gamebirds before and after release (Welchman *et al.* 2002). It has been detected in rooks (Pennycott *et al.* 2005) and is recognised in songbirds in North America, although this finding has not been replicated in the UK. It is thought that there are opportunities for transmission of *MG* from released gamebirds to wild birds in the UK and vice versa if, for example, gamebirds and corvids come into close contact when feeding.

Intestinal disease is common in young reared gamebirds but the same pathogens have not been recorded as causing clinical disease in wild gamebirds. Intestinal disease is commonly associated with bacterial infections, such as with *Salmonella* species and particular strains of *Escherichia coli*. Both of these bacteria are associated with disease in younger birds and therefore unlikely to spread to wild birds as a result of release. However, specific avian pathogenic strains and some bacteria are thought to have the potential to move from other species to humans (Díaz-Sánchez *et al.* 2012).

Antibiotics have been widely used in gamebird rearing to control a variety of disease conditions, and some bacteria may have developed resistance. *E. coli* isolated from a small percentage of wild partridges by Díaz-Sánchez *et al.* (2012) showed resistance to three selected antibiotics. The authors suggested that releasing treated birds was a potential means of disseminating antibiotic-resistant bacterial strains among wild birds. Resistant bacterial strains are also likely to spread to wild birds from all farmed livestock, and the reverse can occur as well. The use of antibiotics in the gamebird sector declined by 36% in 2017 compared with 2016 (Hammond and Tasker 2018) and routine use is no longer practised.

As with farmed poultry, gamebirds are susceptible to the notifiable diseases, avian influenza and Newcastle disease. Notifiable diseases in poultry and gamebirds are covered by UK legislation and there is a legal obligation to report them. Highly pathogenic avian influenza (HPAI) was confirmed in pheasants in England in 2017, and Newcastle disease was confirmed in pheasants in England in 1996 and 2005 (Aldous and Alexander 2008). These diseases are subject to an eradication policy. Although there is the potential for gamebirds to spread these diseases to wildlife (Bertran *et al.* 2014), in practical terms the likelihood of spread from infected gamebirds in the UK is low once an outbreak has been confirmed. Detailed advice on biosecurity in captive birds is available from Defra *www.gov.uk/guidance/avian-influenza-bird-flu*.

Lyme disease in humans, caused by *Borrelia* bacteria, is acquired through tick bites, predominantly from the sheep tick *Ixodes ricinus*. *Borrelia* bacteria are routinely found in several different species and can infect small mammals and ground-feeding birds as well as humans. The importance of different factors on the incidence of *Borrelia*-infected ticks and the effect of these ticks on wildlife is unknown (Ostfeld *et al.* 2018). Hoodless *et al.* (1998) confirmed ticks on released pheasants at a level comparable with small mammals, while Kurtenbach *et al.* (1998) showed that released pheasants can pass *Borrelia* bacteria back to ticks and are therefore a potential vector. Woodland managed for pheasants tend to have more shrubs and ground cover than other woods (see section on page 16) but these otherwise normally beneficial woodland conservation practices may promote ticks and tick-host interactions (Ehrmann *et al.* 2018). Whether there are particular tick-host communities involving pheasants that might increase the prevalence of *Borrelia* requires investigation.

PARASITES AND DISEASES OF PHEASANTS AND PARTRIDGES

1. Parasitic worms can cause considerable problems in released gamebirds.
2. There is some evidence that cross-infection from released game may affect some wildlife species.
3. Good husbandry, not overstocking pens, and prompt treatment of any disease outbreaks are likely to minimise any risk to wildlife, as well as reducing carry over in the ground from year to year.
4. Gamebird rearing and release has a history of using medication, including antibiotics, to control disease.
5. Routine use of antibiotics is no longer widely practised.

Close-up of a tick (Ixodes ricinus).

Dispersal

Dispersal of pheasants and partridges after release

Gamekeepers are motivated to prevent released gamebirds from dispersing away from their shoot areas and to manage their movements. A key tool is to provide good habitat and food, but managers will also frequently herd dispersing birds back towards shoot areas, often with dogs. Radio-tracking has been used at several sites to properly quantify the movement of released pheasants and partridges following release at a representative sample of professionally managed lowland release-based shoots in England over several years. Two studies in particular are the main source of information on this. Studies that document movements in gamebirds by observation alone are very likely to be biased because birds that move unpredictably are less likely to be included.

Hesford (2012) studied released red-legged partridges at six large sites over a three-year period (three in East Anglia and three in central southern England). All six sites had one or more full time gamekeepers and driven shooting took place. Birds were released into pens located in game crops on farmland. In total 274 individuals were radio tagged, between 41 and 56 per site. Tracking per site was undertaken for around five months following release. The overall fate of radio-tagged birds was 38% shot, 34% died of other causes (mainly predation by foxes), 13% unknown (usually radio tag failure), leaving 15% that survived beyond the end of the shooting season. Over this period the average final per-bird dispersal distance from the release pen was 408m. 68% of birds stayed within 500m of the release point. 32% of birds dispersed more than 500m, 5% more than 1km and 1% more than 1.5km.

In her PhD, Turner (2007) studied released pheasant at six large sites, over three years in southern England. Sites had one or more full-time gamekeepers and driven shooting with birds released into pens located in woodlands. Turner tagged and tracked 486 pheasants in total, between 24 and 30 for each site each year. Birds were radio-tracked for six months but dispersal was investigated using data from the first three months, up until shooting began, when tracking was sufficiently frequent.

Overall, taking account of lost birds, 36% were shot and 48% died for other reasons (mostly predation), leaving 16% still alive at the end of shooting. The overall average maximum distance moved was 913m. This is the average of the furthest distance each bird was recorded from the release point i.e. all other radio-tracking locations were closer (therefore this is not the same as Hesford's measure). Females moved further than males. Turner (2007) also estimated the home range area of individual radio-tagged birds for which there were sufficient data (at least 10 locations) and then calculated home range sizes for each release pen. Home ranges are routinely used in wildlife ecology to give an indication of the area of land used by an animal or group of animals. The mean pen home range size for male pheasants was 45ha and for female pheasants it was 97ha. A circle of 97ha has a radius of 550m. Overall just under 90% of these pheasants (males and females) had pen home ranges of around 280ha or less. A circle with an area of 280ha has a radius of about 940m.

These pen home range sizes and associated dispersal distance are small compared to the size of the estates in the study, which were on average 1,350ha, ranging from 730–1,700ha. Turner looked at habitat use by the radio-tracked pheasants and in summary showed that in order of preference released pheasants used game crops, field edges, wood edges and then woodland interiors and open habitats. This suggests that released pheasants that dispersed more than average were probably still using game habitats on the estates, in particular game crops. It is noteworthy that for all measures of home range size and dispersal, females moved further than males, very approximately twice as far, as predicted by the literature of pheasant ecology.

In a brief summary of pheasant radio-tracking data from other studies, mean dispersal distance from release pen to February catch-site in 24 reared and released hen pheasants on a shoot in Cambridgeshire was 266 ± 41m (Sage *et al.* 2001). There are a few studies from elsewhere in Europe where small numbers of released partridges or pheasants have been radio-tagged and dispersal reported, sometimes in habitats that differ to British shooting estates based around farmland and woodland. Duarte *et al.* (2011) tagged 20 red legs before release into a mountainous area, which showed poor survival (most died within one month) and a mean dispersal distance of 830m. Alonso *et al.* (2005) reported mean dispersal distances of 378m and similar poor survival for partridges released at six months old. A group of 20 or so captive-reared and radio-tracked pheasants stayed at the release site while a group of

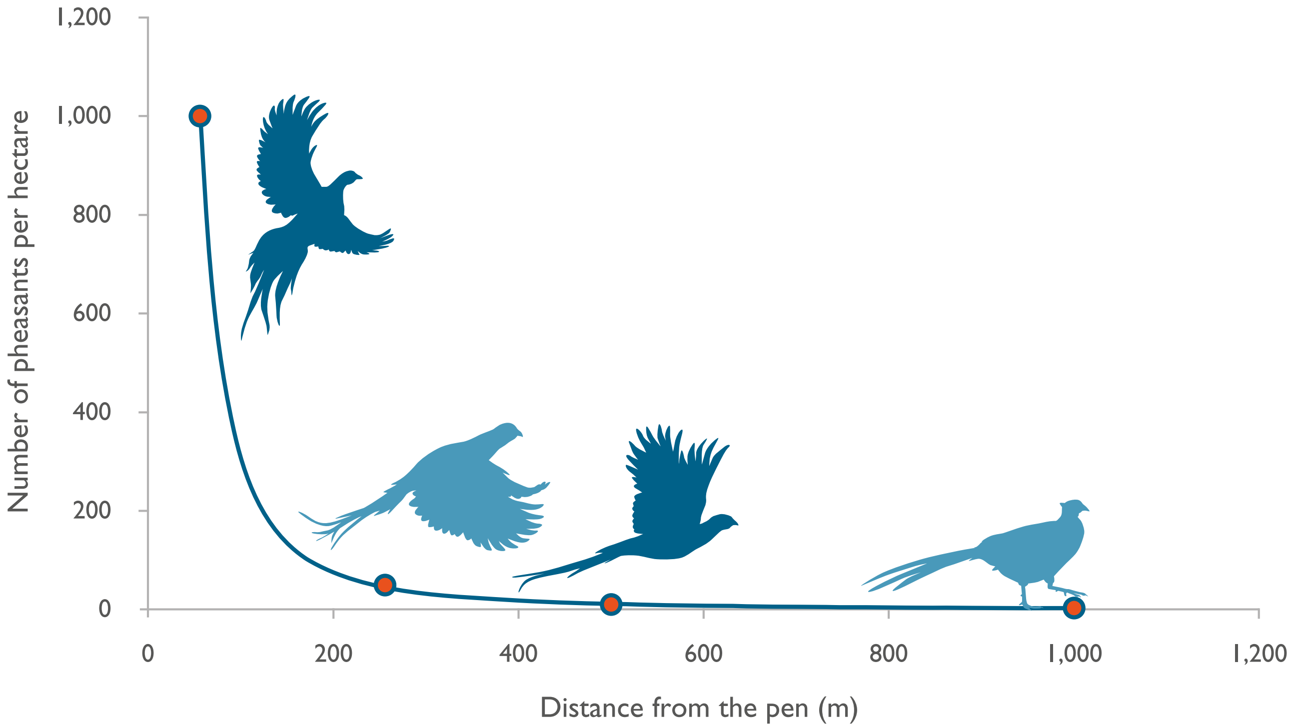


FIGURE 2

The density of released pheasants at varying distances from a release pen. In this graph we have assumed all birds are still alive and then distribute themselves evenly within circles of increasing radius from the pen. In reality densities will be lower than indicated at increasing distance from the pen and as the season progresses (see text for details).

10 caught wild pheasants moved around 1km between March and August (Bagliacca *et al.* 2008). Ferretti *et al.* (2012) released 40 radio-tagged pheasants into an agricultural and partially wooded area in central Italy with no hunting in September and tracked them until April. They reported a mean dispersal distance (average maximum distance from pen) of about 410 ± 47m and home ranges of about 12ha. Other studies that document movements in gamebirds by observation alone are not reported here because they are likely to be biased towards not including individuals moving less predictably.

Both Turner (2007) and Hesford (2012) found that on average around 15% of released pheasants and partridges on English shooting estates survive until the end of shooting. Other radio-tracking studies undertaken by the GWCT of hen pheasants during the spring in similar situations indicate that around 60% of these birds are then predated or scavenged between March and July (Sage *et al.* 2018c). The (largely unpublished) movement data from the studies included in Sage *et al.* (2018c) indicate that only a small proportion of these otherwise rapidly dwindling populations make any kind of further significant movements away from their release areas.

Spring dispersal distances were reported for a group of 24 released pheasants in one of those studies at a shoot in Cambridgeshire in Sage *et al.* (2001). Mean distance from release pen to nest sites was 503 ± 76 metres and from the February catch site to nest site was 350 ± 78m.

To fully appreciate the density of birds likely to occur as they disperse from the release pen and the effects released birds might have on the habitats surrounding the release points, it is useful to take a theoretical approach using some assumptions. The validity of these assumptions can be discussed in the context of what happens on real shoots. Using as a model a basic pheasant release pen of 1ha containing 1,000 pheasants, when birds are released into that pen each bird will have on average 10m^2 to itself.

For simplicity, let us assume first that the pheasant pen is a circle, second that birds disperse evenly from it and third that there is no mortality in the population. In reality the birds are more likely to congregate in areas where the gamekeeper wants them, for example in and around game crops on farmland as indicated by Hesford (2012) and Turner (2007). However if the birds disperse evenly into a circle 200m beyond the pen, they occupy an area of 20ha and each bird will have 200m^2 to itself. If the area occupied by the dispersing birds is 500m from the pen, then each bird has just under 1,000m^2 (0.1ha), or 10 birds per ha. If it is 1km then the density of pheasants is about three birds per ha and at 2km it is one bird per ha.

To arrive at these figures we have assumed no loss of birds. As the pre-shooting and shooting seasons progress, the actual number of birds occupying these areas will diminish through shooting and non-shooting losses. By the end of shooting and into the early spring, when wildlife and habitats will usually be more sensitive to any possible damage, on average around 10% of the original release will remain. If these 100 birds (from the 1,000-bird release) are contained evenly within 500m of the pen there will be around one bird per hectare. Within 1km of the release pen there will be three pheasant per 10ha. A similar approach can be taken for partridges noting that pens are usually smaller per bird and usually located in or near to game crops on farmland. In other words, for both pheasants and partridges, beyond 500 metres, the average released gamebird densities using this theoretical approach become very small.

In reality, as documented by Hesford (2012) and Turner (2007), in most situations densities distant from pens will be considerably less than these theoretical estimates. In some circumstances, however, it is possible that poorly managed pheasant releases will occupy adjacent or distant habitats at greater densities than this. This is more likely to happen at particularly large shoots, and to put it simply, when the habitat for pheasants on the shooting grounds is less good than the habitat in a nearby area. It is in the interest of the shoot owner and manager to ensure this does not happen – if it does the shoot will fail.

DISPERSAL OF PHEASANTS AND PARTRIDGES AFTER RELEASE

1. Providing good habitat for released game to keep birds on the shoot and to stop them dispersing onto other areas is a key aim of game managers.
2. Gamekeepers will also use feeding strategies and other techniques such as dogging in (where birds are pushed back from boundaries by dogs) to keep birds on the shooting grounds and away from protected or other sensitive sites.
3. While there is little evidence that dispersal onto protected sites causes harm, shoot managers avoid releasing close to such areas where possible.

Designated conservation sites such as SSSIs, SPAs and SACs that may be especially sensitive will not necessarily provide good habitat for released pheasants or partridges, but sometimes they will. On some sites Natural England or other designated site conservation managers provide consents for gamebird releasing and management within designated sites, often with restrictions. They have the opportunity to measure any effects of those releases on conservation interests and the ability to alter, limit or stop the releasing. Where pheasants are congregating on designated sites alongside, or distant from, shooting grounds then this can be addressed in the same way, on a site-by-site basis.

Conclusions

The ecological consequences of releasing gamebirds for shooting form a significant part of the debate about such practices in the UK, where more birds are released than in any other country.

Released gamebirds and the management undertaken to support them have a range of potential effects on lowland habitats and other wildlife, many of which have been studied by the GWCT and others. In 2020 GWCT research and the University of Exeter systematically accessed and reviewed this literature and produced two review documents.

This report describes the potential effects of releasing gamebirds on lowland habitats and other wildlife identified by the two reviews. Sage *et al.* (2020) in particular provides an overall summary using the literature to categorise possible effects, and identify them as either positive, neutral or negative (see **FIGURE 3**). That paper and this report suggest an approximate balance of positive/neutral effects to negative ones. They describe positive effects such as the provision of winter food and cover for songbirds in game cover crops planted to hold, shelter and feed released gamebirds, which are usually a consequence of gamebird management activities. Negative effects are usually caused by the released birds themselves, such as the impact on ground flora in semi-natural ancient woodland.

This report also describes how some of these negative effects have relatively straightforward management solutions. Working within the normal range of releases, observed in the majority of studies, most negative effects increase with the size of the release. Some negative effects involve very specific conflicts with nature conservation interests, which can be prevented if sensitive sites are identified and avoided.

The scale of the different effects also needs to be considered when interpreting the findings of this report. For example, some of the negative effects are locally confined, usually at the release site or feed points while others, in particular disease issues and the effect of releasing on generalist predators, may occur across a wider, landscape scale. Most of the positive effects of management for releases occur at the scale of a whole woodland or across an estate or farm.

The data we have on dispersal of released game indicate that a ban on releasing near to designated sites will have no benefit to the vast majority of those sites but will ruin all those shooting enterprises nearby. It had been suggested by some commentators that there should be a ban on releasing within 5km of any designated site but there is no justification for this idea at all.

The field-based research work used in the studies reported here were undertaken at many hundreds of different release-based shoots over several decades. Their findings should be interpreted as representing an average type of shoot in terms of size and adherence to good practice over that period, during which releasing numbers have steadily increased. By identifying damaging activities and practices the work done so far has increased the awareness of conflicts, the need for good practice and the tools to employ it. The overall balance of effects today and in the future will depend on the extent to which shoots engage in best practice and adhere to recommended stocking rates. The GWCT cannot stress too highly the importance of this.

There are still significant knowledge gaps throughout the range of topics covered in this report. To highlight a few key ones, more work looking at the impacts on reptiles is needed, and it would be useful to find out more about the landscape effects of crops planted for released game on shoots. More information on shared diseases is required. For predators, it is often suggested that large-scale late-summer releases in the UK enhance the abundance of generalist predators, which go on to have detrimental impacts on breeding farmland birds in the following spring, but there is currently no good evidence to support or refute this.

The GWCT will continue its work to identify negative impacts of gamebird releasing and find ways to eliminate or reduce them and to document the benefits to habitats and wildlife as a result of good management. From this science and application of good management will come more best practice guidelines, more advice and more awareness about the issues. No one releasing gamebirds should be ignorant of the consequences of their actions, good, neutral or bad.

The GWCT will encourage more shoots to seek advice and strive to be net contributors to biodiversity on the land they manage. Participants in shooting should be discerning about where they buy their shooting, and ask some key questions to shoots about how their shoot is run. All shoots are encouraged to follow best practice guidelines and the GWCT's Principles of Sustainable Gamebird Management.

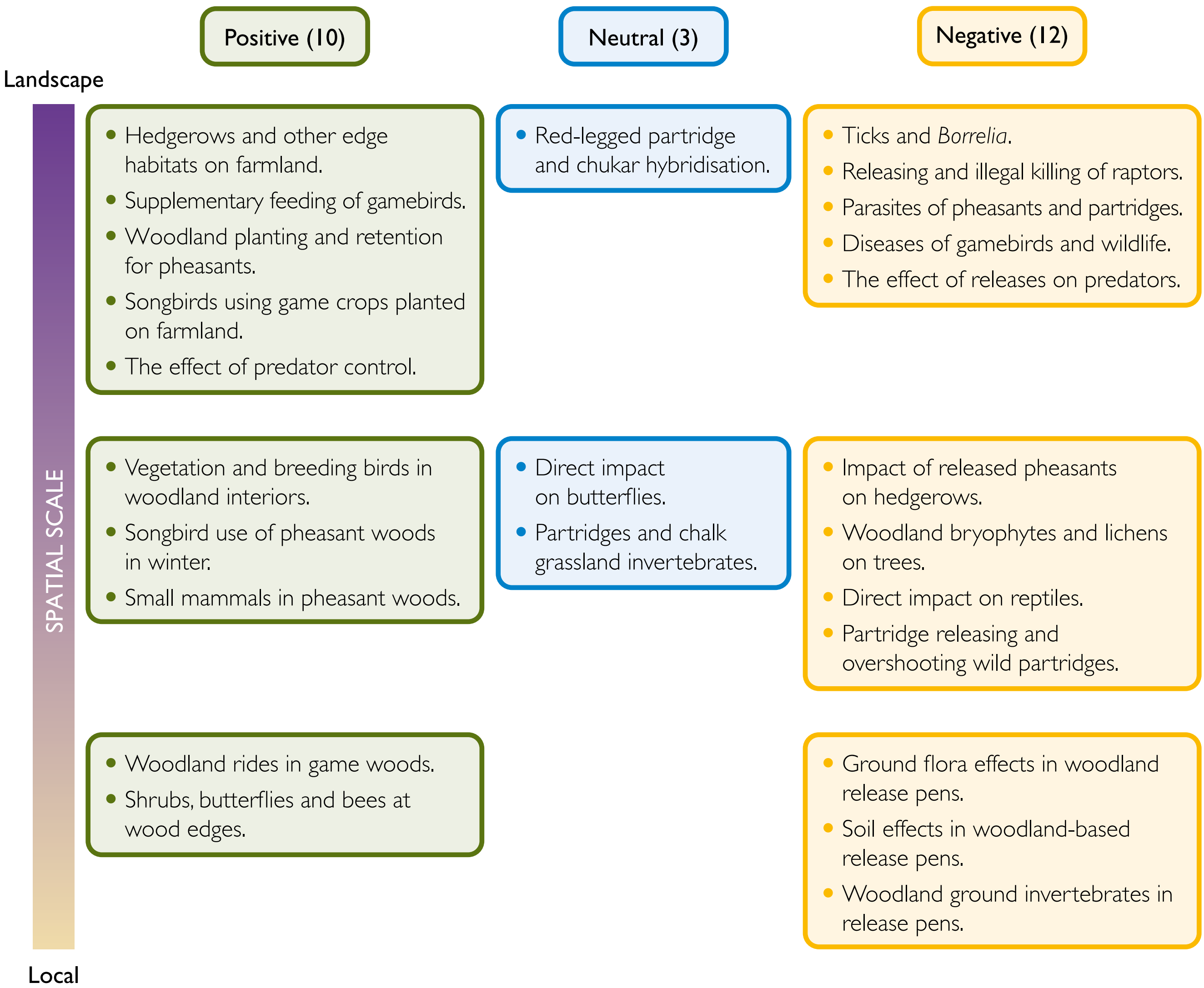


FIGURE 3

25 ecological consequences of gamebird releasing for shooting as identified by the review and synthesis in Sage *et al.* (2020). There is evidence that seven negative effects can be reduced or eliminated when fewer birds are released. There is scope for some local or patch related negatives to be avoided by identifying sensitive sites.

References

Aebischer, N.J. 2019. Fifty-year trends in hunting bags of birds and mammals and calibrated estimation of national bag size using GWCT's National Gamebag Census. *European Journal of Wildlife Research*, 65: 64–76.

Aebischer, N.J. and Ewald, J.A. 2010. Grey Partridge *Perdix perdix* in the UK: recovery status, set-aside and shooting. *Ibis*, 152: 530–542.

Aebischer, N.J., Bailey, C.M., Gibbons, D.W. *et al.* 2016. Twenty years of local farmland bird conservation: the effects of management on avian abundance at two UK demonstration sites. *Bird Study*, 63: 10–30.

Aldous, E.W. and Alexander, D.J. 2008. Newcastle disease in pheasants (*Phasianus colchicus*): a review. *The Veterinary Journal*, 175: 181–185.

Alonso, M.E., Pérez, J.A., Gaudioso, V.R. *et al.* 2005. Study of survival, dispersal and home range of autumn-released red-legged partridges (*Alectoris rufa*). *British Poultry Science*, 46: 401–406.

Amar, A., Hewson, C.M., Thewlis, R.M. *et al.* 2006. *What is happening to our woodland birds? Long-term changes in the populations of woodland birds*. RSPB Research Report Number 19, BTO Research Report Number 169.

Arroyo, B. and Beja, P. 2002. *Impact of hunting management practices on biodiversity*. Reconciling gamebird hunting and biodiversity (REGHAB) Report 78pp. Centre for Ecology and Hydrology.

Bagliacca, M., Falcini, F., Porrini, S. *et al.* 2008. Pheasant (*Phasianus colchicus*) hens of different origin. Dispersion and habitat use after release. *Italian Journal of Animal Science*, 7: 321–333.

Beebee, T.J.C. and Griffiths, R.A. 2000. *Amphibians and reptiles: A Natural History of the British Herpetofauna*. Harper Collins, London.

Beer, J.V. 1988. Nutrient requirements of gamebirds. *In:* Cole, D.J.A. and Haresign, W. (Eds), *Recent Advances in Animal Nutrition*. Butterworth, London. pp. 195–203.

Beja, P., Gordinho, L., Reino, L. *et al.* 2009. Predator abundance in relation to small game management in southern Portugal: conservation implications. *European Journal of Wildlife Research*, 55: 227–238.

Berthon, G. 2014. *Reptiles and pheasants*. Unpublished MSc project report. Game & Wildlife Conservation Trust.

Bertran, K., Dolz, R. and Majó, N. 2014. Pathobiology of avian influenza virus infection in minor gallinaceous species: a review. *Avian Pathology*, 43: 9–25.

Bicknell, J., Smart, J., Hoccom, D. *et al.* 2010. *Impact of non-native gamebird release in the UK: a review.* RSPB Research Report Number 40.

Blackburn, T.M. and Gaston, K.J. 2021. Contribution of non-native galliforms to annual variation in biomass of British birds. *Biological Invasions*, 23: 1549–1562.

Blanke, I. and Fearnley, H. 2015. *The Sand Lizard: Between light and shadow*. Laurenti Verlag, Bielefeld.

Brickle, N. 1997. The use of game cover and game feeders by songbirds in winter. *Proceedings of the 1997 Brighton Crop Protection Conference, BCPC,* 1185–1190.

Bright, P.W. and Morris, P.A. 1990. Habitat requirements of dormice *Muscardinus avellanarius* in relation to woodland management in southwest England. *Biological Conservation*, 54: 307–326.

Burden, D. 2013. *Game-Bird Preserve Business Development Guide*. Leopold Center Publications and Papers. Iowa State University Report 107.

Callegari, S.E. 2006a. *The Impact of Released Gamebirds on the Nature Conservation Value of Chalk Grassland in Central Southern England*. Unpublished Ph.D. thesis, University of Reading.

Callegari, S.E. 2006b. Impact of released gamebirds on chalk grassland. *Game Conservancy Trust Review of 2005*, 37: 42–43.

Callegari, S.E., Bonham, E., Hoodless, A.N. *et al.* 2014. Impact of game bird release on the Adonis blue butterfly *Polyommatus bellargus* (*Lepidoptera Lycaenidae*) on chalk grassland. *European Journal Wildlife Research*, 60: 781–787.

Capstick, L.A., Draycott, R.A.H., Wheelwright, C.M., *et al.* 2019a. The effect of game management on the conservation value of woodland rides. *Forest Ecology and Management*, 454: 1-11.

Capstick, L.A., Draycott, R.A.H., Wheelwright, C.M. *et al.* 2019b. Ground flora recovery in disused pheasant pens is limited and affected by pheasant release density. *Biological Conservation*, 231: 181–188.

Clapham, P. A. 1961. Recent observations on Helminthiasis in some British Game Birds. *Journal of Helminthology*, 35: 35–40.

Clarke, S.A. and Robertson, P.A. 1993. The relative effects of woodland management and pheasant *Phasianus colchicus* predation on the survival of pearl-bordered and small pearl bordered fritillaries *Boloria euphrosyne* and *B. selene* in the south of England. *Biological Conservation*, 65: 199–203.

Cobham Resource Consultants. 1983. *Countryside sports, their economic significance*. Standing Conference on Countryside Sports, University of Reading.

Corke, D. 1989. Of Pheasants and Fritillaries: Is predation by pheasants (*Phasianus colchicus*) a cause of the decline in some British butterfly species? *British Journal of Entomology and Natural History*, 2: 1–14.

Davey, C.M. 2008. *The impact of game management for pheasant* (Phasianus colchicus) *shooting on vertebrate biodiversity in British woodlands*. Unpublished Ph.D. thesis, University of Bristol.

Díaz-Sánchez, S., Sánchez, S., Ewers, C. *et al.* 2012. Occurrence of avian pathogenic *Escherichia coli* and antimicrobial-resistant *E. coli* in red-legged partridges (*Alectoris rufa*); sanitary concerns of farming. *Avian Pathology*, 41: 337–344.

Dimond, R., Warner, N., Wheeler, M.J. *et al.* 2013. *An investigation into the relationship between pheasants* (Phasianus colchicus) *and reptiles as prey*. Report, University of Worcester.

Draycott, R.A.H. and Hoodless, A.N. 2005. Effect of pheasant management on wildlife in woods. *Game Conservancy Trust Review of 2004*, 36: 38–39.

Draycott, R.A.H., Hoodless, A.N., Cooke, M. *et al.* 2012. The influence of pheasant releasing and associated management on farmland hedgerows and birds in England. *European Journal Wildlife Research*, 58: 227–234.

Draycott, R.A.H., Hoodless, A.N. and Sage, R.B. 2008a. Effects of pheasant management on vegetation and birds in lowland woodlands. *Journal of Applied Ecology*, 45: 334–341.

Draycott, R.A.H. Hoodless, A.N., Woodburn, M.I.A. *et al.* 2008b. Nest predation of common pheasant *Phasianus colchicus*. *Ibis*, 150: 37–44.

Draycott, R.A.H., Parish, D.M.B., Woodburn, M.I.A. *et al.* 2000. Survey of selected parasites of wild-living pheasants in Britain. *Veterinary Record*, 147: 245–246.

Duarte, J., Farfán, M.Á. and Vargas, J.M. 2011. New data on mortality, home range, and dispersal of red-legged partridges (*Alectoris rufa*) released in a mountain range. *European Journal of Wildlife Research*, 57: 675–678.

Edgar, P., Foster, J. and Baker, J. 2010. *Reptile Habitat Management Handbook*. Amphibian and Reptile Conservation, Bournemouth.

Ehrmann, S., Ruyts, S.C., Scherer-Lorenzen, M. *et al.* 2018. Habitat properties are key drivers of *Borrelia burgdorfeir* (*s.l.*) prevalence in *Ixodes ricinus* populations of deciduous forest fragments. *Parasites & Vectors*, 11: 23.

Ewald, J.A. 2004. Lowland Game Management Surveyed. *Game Conservancy Trust Review of 2003*, 35: 58–59.

Ewald, J. A., Aebischer, N.J., Richardson, S. *et al.* 2010. The effect of agri-environment schemes on grey partridges at the farm level in England. *Agriculture Ecosystems and the Environment*, 138: 55–63.

Ewald, J.A. and Touyéras, H. 2002. Examining the spatial relationship between pheasant (*Phasianus colchicus*) release pens and grey partridge (*Perdix perdix*) population parameters. *Zeitschrift für Jagdwissenschaft*, 48: 354–363.

Feber, R.E., Johnson, P.J. and Macdonald, D.W. 2020. Shooting pheasants for sport: What does the death of Cecil tell us? *People and Nature*, 2: 82–95.

FERA. 2012. *Reviews of selected wildlife conflicts and their management. Annex B: Approaches to mitigating bird of prey conflicts with pheasants at release pens, outdoor poultry and lambs*. The Food and Environment Research Agency Report No. WM0415. pp. 112.

Ferretti, M., Falcini, F., Paci, G. *et al.* 2012. Captive rearing technologies and survival of pheasants (*Phasianus colchicus L.*) after release. *Italian Journal of Animal Science*, 11: 29.

Ferris, R. and Carter, C. 2000. *Managing Rides, Roadsides and Edge habitats in Lowland Forests*. Forestry Commission Bulletin 123.

Firbank, L.G. 1999. *Lowland Game Shooting Study*. Institute of Terrestrial Ecology and Centre of Ecology and Hydrology, Grange over Sands, Cumbria.

Fuller, R.J. and Henderson, A.C.B. 1992. Distribution of breeding songbirds in Bradfield Woods, Suffolk, in relation to vegetation and coppice management. *Bird Study*, 39: 73–88.

Fuller, R.J., Noble, D.G., Smith, K.W. *et al.* 2005. Recent declines in populations of woodland birds in Britain: a review of possible causes. *British Birds*, 98: 116–143.

Game Conservancy Trust. 1988. W*oodlands for Pheasants*. Game Conservancy Ltd, Fordingbridge.

Game Conservancy Trust. 1994. *Game and Shooting Crops*. Game Conservancy Ltd, Fordingbridge.

Game Conservancy Trust. 1996. *Gamebird releasing.* Game Conservancy Ltd, Fordingbridge.

Game & Wildlife Conservation Trust 2021. *Guidelines for sustainable gamebird releasing.* Game & Wildlife Conservation Trust, Fordingbridge.

Gethings, O.J., Sage, R.B. and Leather, S.R. 2015. Spatio-temporal factors influencing the occurrence of *Syngamus trachea* within release pens in the South West of England. *Veterinary Parasitology*, 207: 64–71.

Gethings, O.J., Sage, R.B. and Leather, S.R. 2016a. Density-dependent regulation of fecundity in *Syngamus trachea* infrapopulations in semi-naturally occurring ring-necked pheasants (*Phasianus colchicus*) and wild Carrion Crows (*Corvus corone*). *Parasitology*, 143: 716–22.

Gethings, O.J., Sage, R.B., Morgan, E.R. *et al.* 2016b. Body condition is negatively associated with infection with *Syngamus trachea* in the Ring-necked Pheasant *Phasianus colchicus*. *Veterinary Parasitology*, 228: 1–5.

Gilbert, J. 2007. *National Inventory of Woodland and Trees 1995–1999: Analysis of Management and Biodiversity Data*. Forest Research, Edinburgh.

Hammond, P. and Tasker, J. 2018. Gamebird antibiotic use reduction. *The Veterinary Record*, 183: 197.

Harradine, J., Reynolds, N. and Laws, T. 1997. *Raptors and Gamebirds. A Survey of Game Managers Affected by Raptors*. British Association for Shooting and Conservation, Wrexham, UK.

Harris, S. and Yalden, D.W. 2008. *Mammals of the British Isles: Handbook*. Mammal Society, Southampton.

Henderson, I.G., Vickery, J.A. and Carter, N. 2003. The use of winter bird crops by farmland birds in lowland England. *Biological Conservation*, 118: 21–32.

Hesford, N.J. 2012. *Fate and survival of hand-reared red-legged partridges released for sport on farmland in the UK*. Unpublished MSc thesis. University of Cardiff.

Heydon, M.J. and Reynolds, J.C. 2000. Demography of rural foxes (*Vulpes vulpes*) in relation to cull intensity in three contrasting regions of Britain. *Journal of Zoology*, 251: 261–276.

Hoodless, A.N., Kurtenbach, K., Peacey, M. *et al.* 1998. The role of pheasants (*Phasianus colchicus*) as hosts for ticks (*Ixodes ricinus*) and Lyme disease spirochaetes (*Borrelia burgdorferi*) in Southern England. *Gibier Faune Sauvage*, 15: 477–489.

Hoodless, A.N., Lewis, R. and Palmer, J. 2006. Songbird use of pheasant woods in winter. *Game Conservancy Trust Review of 2005*, 28–29.

Kenward, R.E. 1977. Predation on released pheasants (*Phasianus colchicus*) by Goshawks (*Accipiter gentillis*) in central Sweden. *Swedish Game Research*, 10: 79–112.

Kenward, R.E., Arraut, E.M., Robertson, P.A., *et al.* 2018. Resource-Area-Dependence Analysis: Inferring animal resource needs from home-range and mapping data. *PLoS ONE*, 13(10): e0206354.

Kenward, R.E., Hall, D.G., Walls, S.S. *et al.* 2001. Factors affecting predation by buzzards *Buteo buteo* on released pheasants *Phasianus colchicus*. *Journal of Applied Ecology*, 38: 813–822.

Kenward, R.E., Marcström, V. and Karlbom, M. 1981. Goshawk winter ecology in Swedish pheasant habitats. *The Journal of Wildlife Management*, 45: 397–408.

Kurtenbach, K., Carey, D., Hoodless, A.N. *et al.* 1998. Competence of pheasants as reservoirs for Lyme disease spirochetes. *Journal of Medical Entomology*, 35: 77–81.

Latham-Green, T., Hazenberg, R. and Denny, S. 2021. Examining the role of driven-game shooting as a psycho-social resource for older adults in rural areas: A mixed-methods study. *Ageing and Society*, 1-27.

Lees, A.C., Newton. I. and Balmford, A. 2013. Pheasants, buzzards, and trophic cascades. *Conservation Letters*, 6: 141–144.

Lever, C. 1977. *The naturalized animals of the British Isles*. Hutchinson, London.

Lloyd, D.E.B. 1976. *Avian predation of reared pheasants*. Unpublished report for the British Field Sports Society, the Game Conservancy Trust, the RSPB and the Wildfowlers Association of GB and Ireland. pp. 84.

Ludolf, I.C., Robertson, P.A. and Woodburn, M.I.A. 1989. Changes in the ground flora and butterfly populations of woodlands managed to encourage pheasants. *In:* Buckley, PJ (Ed), *Biological Habitat Reconstruction*. Belhaven Press, London, pp. 312–327.

Madden, J.R. 2021. How many gamebirds are released in the UK each year? *European Journal of Wildlife Research*, 67: 72.

Madden, J.R. and Sage, R.B. 2020. *Ecological Consequences of Gamebird Releasing and Management on Lowland Shoots in England*. Natural England report.

Madge, S. and McGowan, P. 2002. *Pheasants, Partridges and Grouse*. A and C Black Ltd., London.

Manosa, S. 2002. *The conflict between gamebird hunting and raptors in Europe*. Reconciling gamebird hunting and biodiversity (REGHAB) report. pp. 79. University of Barcelona.

Marquiss, M. and Newton, I. 1982. The goshawk in Britain. *British Birds*, 75: 243–260.

Mason, L.R., Bicknell, J.E., Smart, J. *et al.* 2020. *The impacts of non-native gamebird release in the UK: an updated evidence review*. RSPB Research Report No. 66. RSPB Centre for Conservation Science, Sandy, UK.

Mitchell, R.J., Sutton, M.A., Truscott, A.M. *et al.* 2004. Growth and tissue nitrogen of epiphytic Atlantic bryophytes: effects of increased and decreased atmospheric N deposition. *Functional Ecology*, 18: 322–329.

Mustin, K., Arroyo, B., Beja, P. *et al.* 2018. Consequences of gamebird management for non-game species in Europe. *Journal of Applied Ecology*, 55: 2285–2295.

Neumann, J.L., Holloway, G.J., Sage, R.B. *et al.* 2015. Releasing of pheasants for shooting in the UK alters woodland invertebrate communities. *Biological Conservation*, 191: 50–59.

Oldfield, T.E.E., Smith, R.J., Harrop, S.R. *et al.* 2003. Field sports and conservation in the United Kingdom. *Nature*, 423: 531–533.

ONCFS. 2013. Le faisan commun. *http://www.oncfs.gouv.fr/Connaitre-les-especes-ru73/Le-Faisan-commun-ar1227*

Ostfeld, R.S., Levi, T., Keesing, F. *et al.* 2018. Tick-borne disease risk in a forest food web. *Ecology*, 99: 1562–1573.

Pain, D.J., Mateo, R., and Green, R.E. 2019. Effects of lead from ammunition on birds and other wildlife: A review and update. *Ambio*, 48: 935–953.

Parish, D.M.B. and Sotherton, N.W. 2004. Game crops and threatened farmland songbirds in Scotland: a step towards halting population declines. *Bird Study*, 51: 107–112.

Parish, D.M.B. and Sotherton, N.W. 2008. Landscape-dependent use of a seed-rich habitat by farmland passerines: relative importance of game cover crops in a grassland versus an arable region of Scotland. *Bird Study*, 55: 118–123.

Parkin, D.T. and Knox, A.G. 2010. *The Status of Birds in Britain and Ireland*. Christopher Helm, London.

Parrott, D. 2015. Impacts and management of common buzzards *Buteo buteo* at pheasant *Phasianus colchicus* release pens in the UK: a review. *European Journal of Wildlife Research*, 61: 181–197.

Pennycott, T.W., Dare, C.M., Yavari, C.A. *et al.* 2005. *Mycoplasma sturni* and *Mycoplasma gallisepticum* in wild birds in Scotland. *The Veterinary Record*, 156: 513–515.

Peterken, G.F. and Game, M. 1984. Historical factors affecting the number and distribution of vascular plant species in the woodlands of central Lincolnshire. *Journal of Ecology*, 72: 155–182.

Porteus, T.A. 2015. *Evaluation of restricted-area culling strategies to control local red fox density*. Unpublished Ph.D. thesis, University of British Columbia.

Potts, G.R. 2009. Long-term changes in the prevalences of caecal nematodes and histomonosis in gamebirds in the UK and the interaction with poultry. *The Veterinary Record*, 164: 715-718.

Potts, G.R. 2010. Pheasants, parasites and partridges. *British Birds*, 103: 123.

Pressland, C.L. 2009. *The impact of releasing pheasants for shooting on invertebrates in British woodlands*. Unpublished Ph.D. thesis, University of Bristol.

Pringle, H., Wilson, M., Calladine, J. *et al.* 2019. Associations between gamebird releases and generalist predators. *Journal of Applied Ecology*, 56: 2102–2113.

Rackham, O. 2003. *Ancient Woodland: Its history, vegetation and uses in England*. Castlepoint Press, UK.

Reynolds, J.C., Goddard, H.N. and Brockless, M.H. 1993. The impact of local fox (*Vulpes vulpes*) removal on fox populations at two sites in southern England. *Gibier Faune Sauvage*, 10: 319–334.

Reynolds, J.C. and Tapper, S.C. 1996. Control of mammalian predators in game management and conservation. *Mammal Review*, 26: 127–156.

Robertson, P.A. 1986. *The Ecology and Management of Hand-reared and Wild Pheasants* (Phasianus colchicus) *in Ireland*. Unpublished Ph.D. thesis, National University of Ireland, Dublin.

Robertson, P.A. 1992. *Woodland management for pheasants*. Forestry Commission Bulletin 106.

Robertson, P. A. and Dowell, S. D. 1990. The effects of hand-rearing on wild gamebird populations. *In:* Lumeij, J. T. and Hoogeveen, Y.R. (Eds). *The Future of Wild Galliformes in The Netherlands*. pp. 158–171.

Robertson, P.A., Mill, A.C., Rushton S.P. *et al.* 2017. Pheasant release in Great Britain: long-term and large-scale changes in the survival of a managed bird. *European Journal of Wildlife Research*, 63: 100.

Robertson, P.A., Woodburn, M.I.A. and Hill, D.A. 1988. The effects of woodland management for pheasants on the abundance of butterflies in Dorset, England. *Biological Conservation*, 45: 159–167.

Robertson, P.A., Woodburn, M.I.A. and Hill, D.A. 1993a. Factors affecting winter pheasant density in British woodlands. *Journal of Applied Ecology*, 30: 459–464.

Robertson, P.A., Woodburn, M.I.A., Neutel, W. *et al.* 1993b. Effects of land-use on breeding pheasant density. *Journal of Applied Ecology*, 30: 465–477.

Roos, S., Smart, J., Gibbons, D.W. *et al.* 2018. A review of predation as a limiting factor for bird populations in mesopredator-rich landscapes: a case study of the UK. *Biological Reviews*, 93: 1915–1937.

RSPB. 2019. Birdcrime 2018. *https://www.rspb.org.uk/birds-and-wildlife/advice/wildlife-and-the-law/wild-bird-crime/birdcrime-2018/.*

Sage, R.B. 2007. *Guidelines for sustainable gamebird releasing*. Game & Wildlife Conservation Trust, Fordingbridge.

Sage, R.B. 2018a. *Impacts of pheasant releasing for shooting on habitats and wildlife on the South Exmoor estates*. Game & Wildlife Conservation Trust, Fordingbridge.

Sage, R.B. 2018b. Ecological impact of releasing pheasants on Exmoor shoots. *Game & Wildlife Conservation Trust Review of 2017*, 49: 24–25.

Sage R.B., Hoodless A.N., Woodburn M.I.A. *et al.* 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*, 4: 1–12.

Sage, R.B., Ludolf, C. and Robertson, P.A. 2005a. The ground flora of ancient semi-natural woodlands in pheasant release pens in England. *Biological Conservation*, 122: 243–252.

Sage, R.B., Parish, D.M.B., Woodburn, M.I.A. *et al.* 2005b. Songbirds using crops planted on farmland as cover for gamebirds. *European Journal of Wildlife Research*, 51: 248–253.

Sage, R.B., Robertson, P.A. and Wise, D.R. 2001. Survival and breeding success of two pheasant (*Phasianus colchicus*) strains released into the wild. *Game and Wildlife Science*, 18: 331–340.

Sage, R.B., Woodburn, M.I.A., Davis, C. *et al.* 2002. The effect of an experimental infection of the nematode *Heterakis gallinarum* on hand-reared grey partridges *Perdix perdix*. *Parasitology*, 124: 529–535.

Sage, R.B., Woodburn, M.I.A., Draycott, R.A.H. *et al.* 2009. The flora and structure of farmland hedges and hedgebanks near to pheasant release pens compared with other hedges. *Biological Conservation*, 142: 1362–1369.

Sage, R.B., Woodburn, M.I.A., Hoodless, A.N. *et al.* 2018c. Fate of released common pheasants *Phasianus colchicus* on UK lowland farmland and the effect of predator control. *European Journal of Wildlife Research*, 64: 1–8.

Sánchez-García, C., Buner, F.D. and Aebischer, N.J. 2015. Supplementary Winter Food for Gamebirds Through Feeders: Which Species Actually Benefit? *Journal of Wildlife Management*, 79: 832–845.

Short, C. 1994. *Implications of game management for woodland management, landscape and conservation.* Centre for Rural Studies, Royal Agricultural College, Cirencester.

Siriwardena, G.M., Calbrade, N.A. and Vickery, J.A. 2007. The effect of supplementary winter seed food on breeding populations of farmland birds: Evidence from two large scale experiments. *Journal of Applied Ecology*, 44: 920–932.

Siriwardena, G.M., Calbrade, N.A., Vickery, J.A. *et al.* 2008. Farmland birds and late winter food: Does supply fail to meet demand? *Ibis*, 150: 585–595.

Solomon, M.E. 1949. The natural control of animal populations. *Journal of Animal Ecology*, 18: 1–35.

Stoate, C., Szczur, J. and Aebischer, N.J. 2003. Winter use of wild bird cover crops by passerines on farmland in northeast England. *Bird Study*, 50: 15–21.

Swan, G.J.F. 2017. *Understanding conservation conflicts surrounding predation and game shooting interests*. Unpublished Ph.D. thesis, University of Exeter.

Tapper, S.C. 1992. *Game Heritage: An Ecological Review from Shooting and Gamekeeping Records*. Game Conservancy Trust, Fordingbridge.

Tapper, S.C., Potts, G.R. and Brockless, M.H. 1996. The effect of an experimental reduction in predation pressure on the breeding success and population density of grey partridges *Perdix perdix*. *Journal of Applied Ecology*, 33: 965–978.

Tompkins, D.M., Greenman, J.V., Robertson, P.A. *et al.* 2000. The role of shared parasites in the exclusion of wildlife hosts: *Heterakis gallinarum* in the ring-necked pheasant and the grey partridge. *Journal of Animal Ecology*, 69: 829–840.

Tompkins, D.M., Parish, D.M.B. and Hudson, P.J. 2001. Differential impact of a shared nematode parasite on two gamebird hosts: implications for apparent competition. *Parasitology*, 122: 187–93.

Turner, C.V. 2007. *The fate and management of pheasants (Phasianus colchicus) released in the UK*. Unpublished Ph.D. thesis, University of London.

Turner, C.V. and Sage, R.B. 2003. Fate of released pheasants. *Game Conservancy Trust Review of 2002*, 74–75.

Vanhinsbergh, D., Gough, S., Fuller, R.J. *et al.* 2002. Summer and winter bird communities in recently established farm woodlands in lowland England. *Agriculture, Ecosystems and Environment*, 92: 123–136.

Warren, M. 1989. Pheasants and fritillaries: is there really any evidence that pheasant rearing may have caused butterfly declines? *British Journal of Entomology and Natural History*, 2: 169–175.

Warren, M.S. and Fuller, R.J. 1993. *Woodland Rides and Glades: their Management for Wildlife*. JNCC, Peterborough.

Watson, M., Aebischer, N.J., Potts, G.R. *et al.* 2007. The relative effects of raptor predation and shooting on overwinter mortality of grey partridges in the United Kingdom. *Journal of Applied Ecology*, 44: 972–982.

Welchman, D. de B., Ainsworth, H.L., Jensen, T.K. *et al.* 2002. Infectious agents associated with respiratory disease in pheasants. *Veterinary Record*, 150: 658–664.

What The Science Says. 2020. How many gamebirds are released in the UK per year? Available at: *https://www.whatthesciencesays.org/how-many-gamebirds-are-released-in-the-uk-per-year/*.

Woodburn, M.I.A. 1999. *Comparative Population Dynamics of Wild and Reared Pheasants* (Phasianus colchicus). Unpublished Ph.D. thesis. University of Southampton.

Woodburn, M.I.A. and Robertson, P.A. 1990. Woodland management for pheasants: economics and conservation effects. *In:* J.T. Lumeij and Y.R. Hoogeveen (Eds). *The Future of Wild Galliformes in the Netherlands*. Gegevens Koninklijke Bibliotheek, The Hague, 185–198.

Woodburn, M. and Sage, R. 2005. Effect of pheasant releasing on edge habitats. *Game Conservancy Trust Review of 2004*, 36–37.

Appendix I

The Principles of Sustainable Game Management

We reviewed internationally agreed guidelines on sustainable use and biodiversity. Many of the principles align closely with the Bern Convention European Charter on Hunting and Biodiversity. This charter has guidelines for game managers but also regulators so that they can help game managers to benefit conservation of biodiversity. The charter is based on two important agreements of the Convention on Biological Diversity. These are the Addis Ababa Principles and Guidelines for Sustainable use of biodiversity and the ecosystem approach to conservation (Malawi Principles). The Charter on Hunting and Biodiversity, and the Malawi and Addis Ababa Principles are supported by the International Union for Conservation of Nature (The IUCN is the global authority on the status of the natural world and the measures needed to safeguard it).

1. **BIODIVERSITY**
   All shoots, whether based on wild gamebirds, released gamebirds or a combination of both, should strive to achieve a net biodiversity gain on their land.

2. **LANDSCAPE**
   Through active management of the rural landscape, effective game management supports the growth of game populations, allowing a sustainable harvest with positive benefits for other species whilst avoiding population levels that could damage other land uses such as farming, forestry and nature conservation.

3. **DENSITIES**
   Gamebirds should only be released and managed at densities appropriate to the local circumstances, so that there is a net environmental gain from undertaking such activity.

4. **DIVERSITY**
   Appropriate habitat creation, management and sometimes restoration is needed for all gamebirds. Maintaining this critical and appropriate diversity of habitats is a feature of our advice and recommendations, based on our scientific research and observation. Habitats created, restored and managed to support gamebirds include woodland, hedgerows, field margins, game cover crops, wild bird seed mixes, moorlands and wetlands.

5. **TIMING**
   Releasing gamebirds in the summer increases the number of birds available to shoot in the autumn and winter. Shoot managers should only release gamebirds in habitats that enable them to acclimatise quickly to life in the wild, following the guidelines and recommendations outlined in the Code of Good Shooting Practice and British Game Alliance standards.

6. **DEVELOPMENT**
   Following release of gamebirds, habitats should be provided to encompass their year-round needs. All birds should be fully adapted to life in the wild before the first shoot day.

7. **RESPONSIBILITY**
   Shoots should ensure that all game that is fit for human consumption is eaten.

8. **SCIENCE**
   Grouse and wild partridge shoots should assess their proposed bag by calculating the sustainable yield based on annual game counts and follow GWCT recommendations for the sustainable harvest of wild game.

9. **SUSTAINABILITY**
   Game management provides an incentive to privately fund the creation, restoration and management of habitats across large areas of the countryside specifically for wildlife – something which is usually only incidental to other forms of land use such as forestry or farming.

10. **WILDLIFE**
    Habitats created and managed to support released gamebirds include woodland, hedgerows, field margins, game cover crops, wild bird seed mixes

and wetlands. Much other wildlife benefits from this habitat provision. Alongside the habitat provided and managed for gamebirds, predation control and supplementary feeding are often important aspects of game management. These activities can benefit a wide range of other wildlife.

11. BALANCE
Predation control is undertaken to reduce predation pressure. This is especially important in spring, to reduce levels of predation on nesting birds, nests and chicks and during summer to protect young birds. Many species, including several of conservation concern, benefit from predation control undertaken to conserve gamebirds.

12. LEGAL CONTROL
The predators targeted are common and successful generalists so a temporary reduction in their numbers locally will not jeopardise their population or conservation status. Predation control activities should be undertaken according to best practice guidelines to ensure they are legal, humane and effective. In no circumstances should any protected species ever be illegally killed to protect game, nor should any predation control activity risk negatively affecting the conservation status of a species.

Contact us

GAME & WILDLIFE CONSERVATION TRUST
Burgate Manor, Fordingbridge, Hampshire, SP6 1EF

Tel: 01425 652381
Email: research@gwct.org.uk

www.gwct.org.uk

Game & Wildlife
CONSERVATION TRUST