

Gamekeepers: conservation and wildlife





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Gamekeepers: conservation & wildlife 2019 survey



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Front cover. © Paul Quagliana

Executive summary

Those surveyed manage more than **1,625,000**

hectares of land across England, Scotland and Wales which is about 65% of the area covered by the terrestrial protected areas.*

Provision of cover crops – supporting wildlife

90% of lowland gamekeepers plant game cover crops which has huge benefits for other wildlife.

81% of lowland shoots plant game cover that is not in a stewardship programme and **57%** of lowland shoots surveyed plant wild bird cover that was not in a stewardship scheme. These figures all show an increase since a similar conservation survey undertaken in 2011.*

Tree planting and woodland management

Woodland planting and management are common on shoots with

71% of respondents planting trees in the last 10 years, with **47.3ha (± 11.4)** planted on average. Of the 680 shoots that planted trees, **45%** reported shooting as a reason, a quarter reported conservation and nearly a fifth commercial forestry. Almost 30% of the respondents gave other reasons that did not fit into one of the categories – for example amenity, climate change, landscape etc.

*The total area surveyed was 1,625,216 hectares (ha), with 36 (3.8%) of respondents not specifying the area that they managed. To put this area into context, it is roughly 65% of the area covered by the terrestrial protected areas of England, Scotland and Wales as at 31 May 2019 (SSSI, MCZ, NCMPA, NNR, Ramsar, SAC and SPA site designations – a total of 2,489,000ha, Joint Nature Conservation Committee (JNCC) 2019 www.jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/).

Helping farmland birds

98% of gamekeepers provide supplementary food, providing grain for farmland birds during spring known as the 'hungry gap'. **23,426 tonnes** of supplementary food were supplied by respondents during the shooting season, with **4,309 tonnes** provided after the shooting season where there are fewer gamebirds on the ground.

Managing our uplands – rewetting

17% of those surveyed manage heather moorland, with more than four-fifths of those reporting some form of heather canopy management. Many gamekeepers are 'rewetting' moorland to counteract post-war drainage for grazing and other purposes. Within this survey, **over a third of those with heather moorland undertook moorland rewetting in the last five years.**



Foreword

by Liam Bell, Chairman, National Gamekeepers' Organisation and Alex Hogg, Chairman, Scottish Gamekeepers Association

965

gamekeepers took part in the survey – representing 52% full-time, 30% amateur and 18% part-time keepers.

Gamekeepers are bastions of our countryside. Their management of huge swathes of our natural environment by establishing and maintaining habitats, delivers great benefits for our songbirds, woodland plants, moorland wildlife and butterfly species. Sustainable shooting provides the incentive.

Research over the years has identified some of the effects – both positive and negative – of this activity, with properly conducted game management achieving a net positive impact on the environment.

The National Gamekeepers' Organisation, the Scottish Gamekeepers Association (SGA) and the Game & Wildlife Conservation Trust (GWCT) came together in 2019 to find out exactly what happens on the land managed by keepers.

This new report is a representative sample of the work carried out by gamekeepers across the UK and shows the sheer volume of conservation work that is undertaken. The investment in these habitats and the area of land managed by keepers is eye-opening to those who are unaware of their impact.

The joint projects involving gamekeepers, conservation charities and wildlife bodies highlighted in the report show how working together can make a real difference to our most precious habitats and species by increasing numbers of curlew and other red-listed birds, and keeping our woodland fauna at sustainable levels.

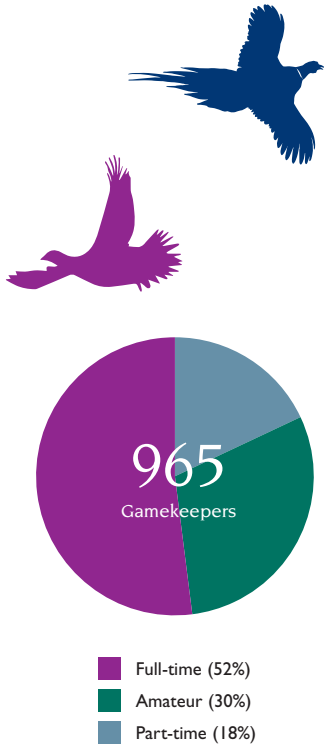
Gamekeepers add a richness to our countryside. They simply live and breathe the areas they look after and should be lauded for truly understanding the fine balance needed when juggling the management demands placed on our delicate countryside.

GAMEKEEPERS AND WILDLIFE SURVEY

This survey of gamekeepers is a repeat of one carried out in 2011 – *Gamekeepers and Wildlife: a new survey: 2011*.

In the spring of 2019, gamekeeper members of the National Gamekeepers' Organisation (NGO), Scottish Gamekeepers Association (SGA) and the Game & Wildlife Conservation Trust (GWCT) were surveyed via post and email.

Report highlights



1,625,216 hectares surveyed

60.3% of gamekeepers are in an environmental stewardship scheme

Over a third have environmental designations on land they manage

11ha the average area of wild bird cover planted for songbirds not in a Stewardship agreement



98% carry on providing supplementary food through the hungry gap after the shooting season

23,426 tonnes of supplementary food are provided during the shooting season across the survey area

4,309 tonnes of supplementary food are provided after the season across the survey area

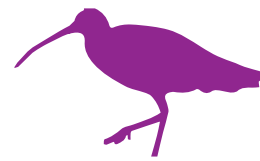
An average of **59** feeders per shoot

95.9% of gamekeepers manage their woodland

192,051 hectares of woodland are managed across the survey area

71% of gamekeepers have planted trees since the last conservation survey in 2011, with a quarter citing conservation as the reason for planting

45% reported shooting as a reason for planting trees



37.6% of gamekeepers managing moorland have undertaken rewetting in the last five years

90% report blocking grips as the method by which they are rewetting the moorland

© Tweed Media

p24



TREE PLANTING AND WOODLAND MANAGEMENT

More than 190,000 hectares of woodland are managed by gamekeepers and the benefits for wider wildlife are well documented such as migratory warblers which nest in shrubby cover. In the woodland environment, gamekeepers play an important role in reducing the impacts of browsing species, such as deer, which if left unchecked can cause significant damage to the ground flora and tree regeneration. See the Woodland Case Study on p24.

p35



IMPORTANCE OF SPHAGNUM ON MOORLAND

Many areas managed by keepers carry Sites of Special Scientific Interest (SSSI) and Special Protection Area (SPA) designations for iconic bird species. Restoration and regeneration work can be a large part of a gamekeeper's role and the Moorland Case Study on page 35 highlights work to restore an area of moor for red grouse which has had benefits for other bird species such as black grouse, curlew and lapwing.

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WORKING WITH CONSERVATION PARTNERS

Gamekeepers across the country work closely with wildlife and conservation partners including Natural England, Scottish Natural Heritage and National Parks. Projects that they are involved in include improving the quality of Sites of Special Scientific Interest, conserving red-listed waders, bird-tagging and monitoring and helping to design wildlife-friendly stewardship schemes. See the Moorland Case Study in the main report on p58.



A gamekeeper using a sweep net to check for insects in a conservation headland which will provide food and shelter for farmland bird chicks. © Peter Thompson

Introduction

Shooting can deliver benefits for flora and fauna by providing the incentive to manage land by establishing and maintaining habitats. Research has identified some of the effects (both positive and negative) of this activity, with sustainable game management aiming to achieve a net positive impact on the environment. In April 2019, three organisations representing members who manage land for shooting, the National Gamekeepers' Organisation, Scottish Gamekeepers Association and Game & Wildlife Conservation Trust distributed an online and postal questionnaire to find out what habitat management their members provide.

This survey repeated, in part, a similar project commissioned by the NGO and SGA in 2011 entitled *Gamekeepers and Wildlife: a new survey: 2011*. The 2011 survey collated information on the number of people involved in managing land for shooting, the area managed, the amount of game cover planted, and heather burnt or cut, as well as some information on wildlife distribution and attitudes in the gamekeeping community to wildlife. The current 2019 survey asked respondents to provide more detailed information than the 2011 survey, specifically concerning game cover, supplementary food provision, woodland and moorland management. This information will improve our understanding of what management is taking place on shoots across the UK and document the changes that have taken place since 2011.

Details on the analysis undertaken can be found in the Appendix, followed by results from the analysis of the respondents in terms of their employment status and the size of shoots they represent, with comparisons with the respondents to the 2011 survey.

The work of gamekeepers and the benefits for flora and fauna is not always recognised, but these survey results will change that

The amount of land covered

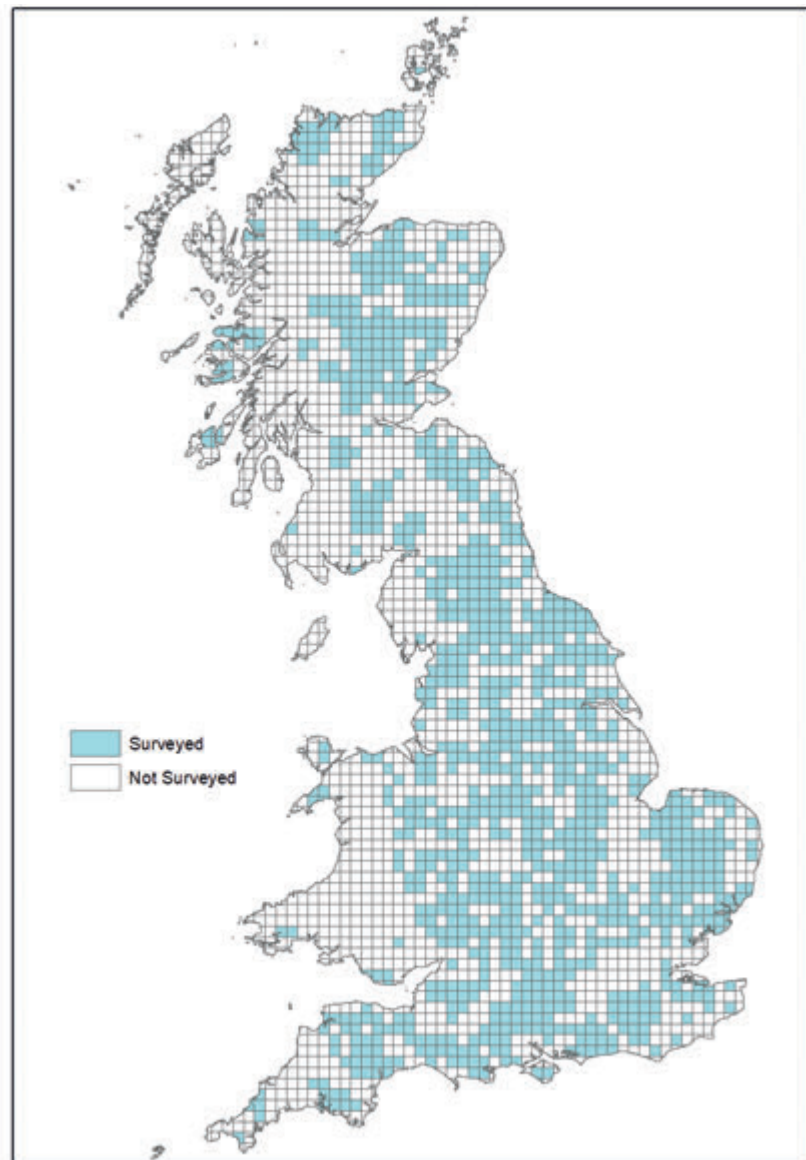
Approximately one-third of gamekeepers responded covering 1,625,216 hectares, which is about 65% of the area covered by the terrestrial protected areas

We contacted gamekeeper members of the NGO, SGA and GWCT by email and post in April 2019. Members who had provided an email address were provided with a login for an online survey on the Survey Monkey platform (www.surveymonkey.co.uk). This resulted in initial emails to 2,337 NGO members, 425 GWCT members and 675 SGA members. A further 1,887 NGO members, 529 GWCT members and 307 SGA members were contacted through the post, each being sent a printed copy of the survey and a prepaid return envelope. No attempt was made to deduplicate the contacts (due to concerns regarding General Data Protection Regulation, GDPR) and we assumed that many of the target audience held memberships in more than one of the contacting organisations. The online survey link was also publicised thoroughly by all three contributing organisations through press and online media campaigns. For instance, the survey featured several times in the GWCT's weekly newsletter, which goes out to more than 40,000 recipients.

Of the 965 responses, 887 were able to be mapped to a location (although only 872 of these provided an area for subsequent geographical analysis, see Figure 1).

Figure 1

Map of the total area from which returns were received in 2019, with geographic location mapped using postcodes.



Of the 887 that were mapped, 736 (83%) were in England, 125 (14.1%) were in Scotland, 24 (2.7%) were in Wales, and one (0.1%) was in Northern Ireland. The total area recorded as surveyed was 1,625,216ha, with 36 (3.8%) of respondents not specifying the area that they managed. To put this area into context, it is roughly 65% of the area covered by the terrestrial protected areas of England, Scotland and Wales as at 31 May 2019 (SSSI, MCZ, NCMPA, NNR, Ramsar, SAC and SPA site designations – a total of 2,489,000ha, Joint Nature Conservation Committee (JNCC) 2019 [jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/](https://www.jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/)). Our sample represents approximately one third of the estimated 3,000 full-time gamekeepers in the UK, with a similar proportion of the estimated 3,000 part-time gamekeepers (The National Gamekeepers' Organisation 2019, www.nationalgamekeepers.org.uk/about-gamekeeping). If we assume that the remaining two-thirds of gamekeepers manage similar amounts to our sample, it would mean that gamekeepers are responsible for managing a substantial proportion of the British countryside, over 4,875,000ha, which would equate to 76% of all terrestrial protected areas, plus all the additional area covered by 'on land' AONBs, National Scenic Areas and National Parks in England, Scotland and Wales (6,383,000ha, JNCC 2019 – [jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/](https://www.jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/)).

Habitat and feeders put in place by gamekeepers benefit game and farmland birds.





36% reported environmental designations on the land they manage... 85% of these had a Site of Special Scientific Interest (SSSI) 

Working for the environment

Agri-environmental schemes

A total of 631 respondents overall (66.2%) indicated that the land they manage is involved in some sort of Government-funded environmental stewardship scheme, with 39 (4.1%) leaving this question blank. Of the former group, 186 (25.3% of the English shoots) reported having Entry Level Schemes, 272 (37.0% of the English shoots) Higher Level Schemes and 320 (43.5% of the English shoots) Countryside Stewardship Schemes, with three (12.5% of Welsh shoots) in Glastir Schemes and 25 (20.0% of Scottish shoots) in the Scottish Rural Development Programme (see Table 1).

66% indicated that the land they manage is involved in some sort of Government-funded environmental stewardship scheme

Table 1

Membership of English, Scottish and Welsh agri-environmental schemes as reported by respondents to the 2019 survey, as a percentage of the respondents in each country

Country	Agri-environment scheme membership	Respondents (%)
England (N = 736)	Entry Level Only	80 (10.9%)
	Higher Level Only	126 (17.1%)
	Countryside Stewardship Only	184 (25.0%)
	ELS & HLS	42 (5.7%)
	ELS & Countryside Stewardship	32 (4.3%)
	HLS & Countryside Stewardship	72 (9.8%)
	ELS, HLS & Countryside Stewardship	32 (4.3%)
	Unknown*	29 (3.9%)
Wales (N = 24)	Glastir Scheme	3 (12.5%)
	Unknown*	1 (4.2%)
Scotland (N= 125)	Scottish Rural Development Programme	25 (20.0%)
	Unknown*	5 (4.0%)

*Reported that they were in an agri-environmental scheme but did not give details

Environmental designations

A total of 345 respondents (35.8% of the 965 respondents) reported environmental designations on the land that they manage, just over a third of respondents (see Table 2). Of these, 292 reported that their land has a Site of Special Scientific Interest (SSSI) on it, representing 84.6% of those with environmental designations or just over 30% of all survey respondents.

Table 2

Respondents reporting environmental designations on the land that they manage in 2019 (from 354 of the 965 respondents)

Environmental designations	Respondents (%)
Local Nature Reserve (LNR)	27 (2.8%)
National Nature Reserve (NNR)	7 (0.7%)
Site of Special Scientific Interest (SSSI)	292 (30.6%)
Special Protection Area (SPA)	44 (4.6%)
Special Areas of Conservation (SAC)	42 (4.4%)
RAMSAR	7 (0.7%)
National Park	81 (8.5%)
Area of Outstanding Natural Beauty (AONB)	67 (7.0%)



Cover for game and farmland birds

Planting wild bird cover can provide a variety of songbirds with a 'major food source' for key species such as redpoll, tree sparrow, reed bunting, song thrush, linnet, yellowhammer and goldfinch depending on the mix used

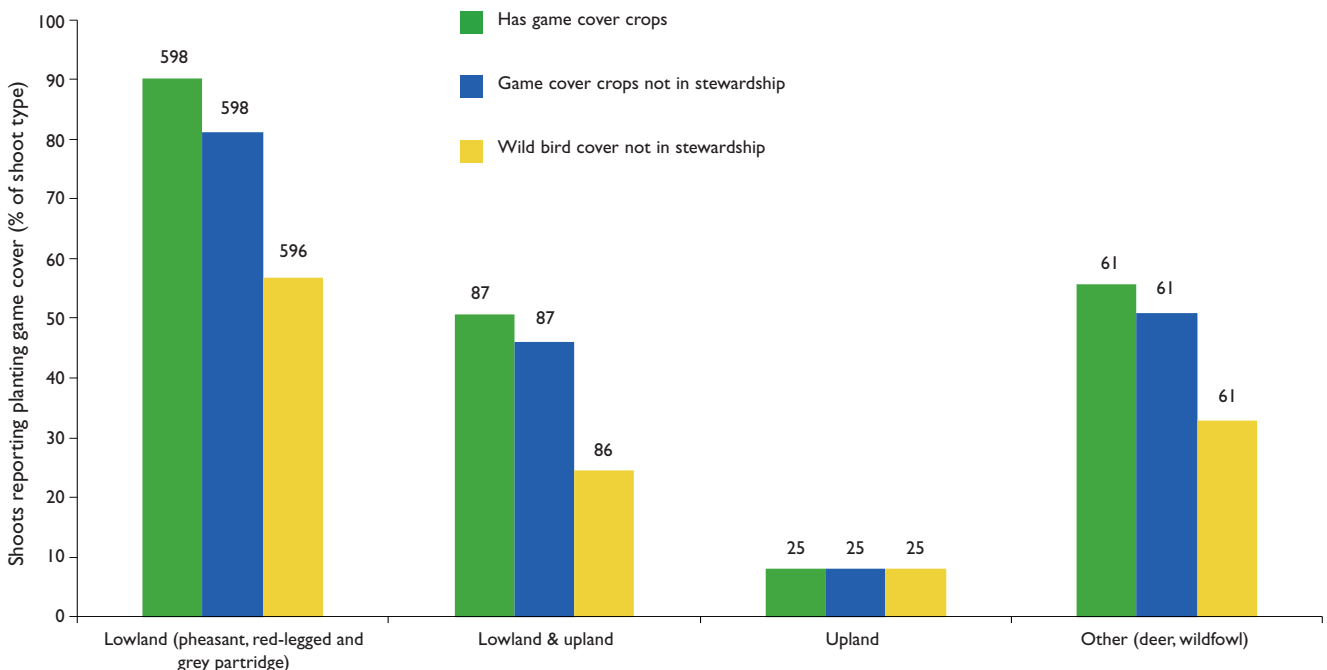
To compare the results from 2019 with those from 2011, we selected respondents that reported quarry species, allowing us to divide respondents into four groups reflecting their location and quarry species, as had been done in 2011, restricting the analysis to those who had filled in details on game cover management (n = 775). These groups were: shoots in the lowland (with a sporting interest in pheasant, red-legged partridge and grey partridge), shoots that had both upland (red grouse) and lowland sporting interests, shoots only in the uplands (mainly red grouse sporting interests) and shoots with other sporting interests (for example deer, wildfowl). We first compared those that reported planting game cover in 2019 with those that reported planting it in 2011. Overall there was a significant difference in the proportion that reported planting game cover in 2019 ($\chi^2_4 = 11.30, P = 0.023$). Comparing the findings of the current survey to those of the 2011 survey, the proportion of shoots reporting the planting of game cover has not changed significantly for three out of the four categories. For the lowland category, however, significantly more gamekeepers have reported planting game cover in the 2019 survey than they did in 2011 (90% planted game cover in 2019 compared with 84% in 2011, $\chi^2_1 = 5.64, P = 0.018$). In the 2019 survey we asked respondents to tell us about the area of game cover they planted that was not in a stewardship scheme. We wanted to find out how much additional game cover was established without recourse to public funds. Out of the 775 respondents that gave detailed information on their habitat management and quarry species, 558 (72%) reported having game cover crops not in a stewardship scheme. Most lowland shoots planted game cover (81%) and wild bird cover (57%) that was not in a stewardship programme (see Figure 2). More than 45% of shoots reporting quarry species from both the lowlands and the uplands, and shoots with other sporting interests, had game cover crops not in stewardship, with more than a quarter planting wild bird cover not in stewardship.

Figure 2

The proportion of shoots of four types that reported planting game cover crops overall and game cover and wild bird cover that were not part of a stewardship agreement
Numbers on/above bars reflect the number of shoots in each category

Food for songbirds

A large proportion of respondents said that they planted wild bird cover which can provide a variety of songbirds with a 'major food source' for key species such as redpoll, tree sparrow, reed bunting, song thrush, linnet, yellowhammer and goldfinch depending on the mix used (Stoate et al., 2003). In contrast to wild bird cover, maize has been shown to be less beneficial for songbirds, particularly in terms of food



Wild bird cover provides
a major food source for
key songbirds

The area of wild
bird cover funded
privately is worth over
£2.25m



© Laurie Campbell

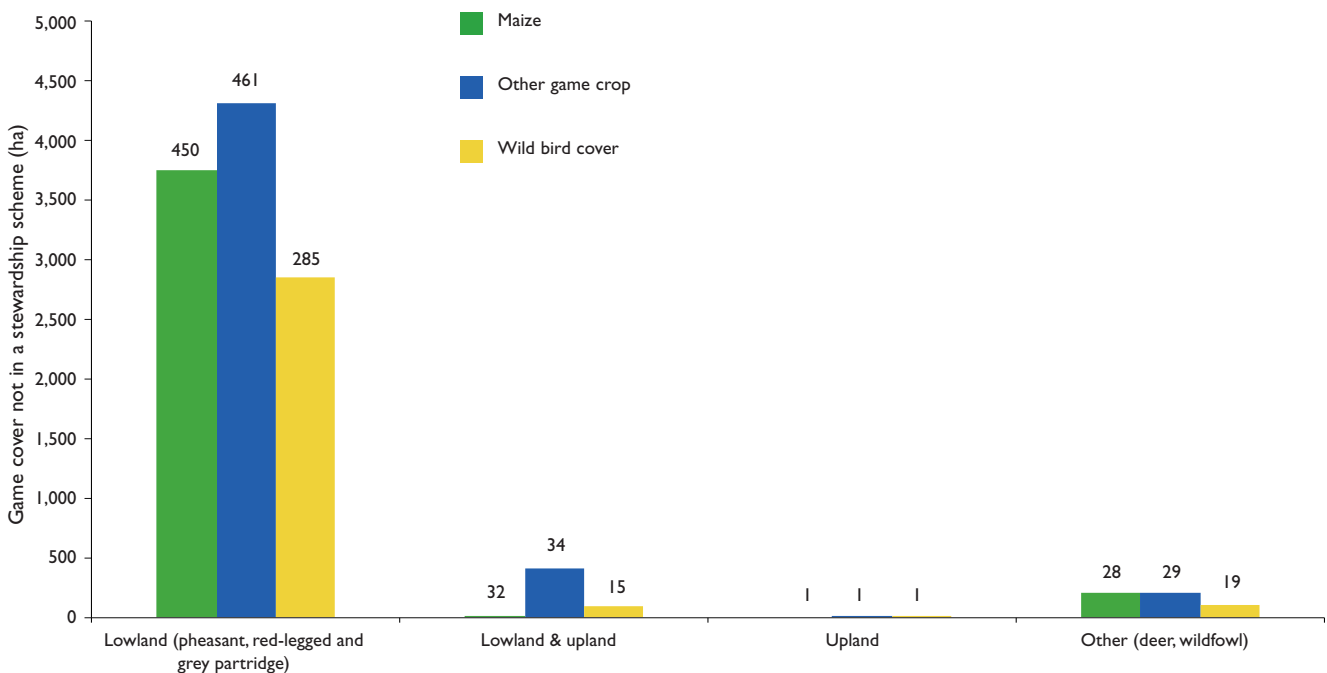


(L-R) Linnets are one of many farmland birds that benefit from wild bird seed mix planted for game shooting.

supply (Stoate et al., 2004). Furthermore, maize cultivation can result in negative environmental impacts such as erosion and runoff (Laloy & Biielders, 2010). In the future more gamekeepers could be encouraged to favour mixes that have been shown to be more beneficial for passerines with a lower environmental impact, to maximise the conservation value of the cover planted for game. A total of 558 respondents said that they have game cover crops on their land that were not in stewardship and 525 of respondents provided the area of such crops; 511 specified the area covered by maize and 320 the area of wild bird cover that is not in a stewardship agreement (see Figure 3). The area of game cover crop not covered by a stewardship agreement ranged between 0.001 to 500ha, giving an average of 17ha of crop cover per shoot. The area of maize cover averaged 7.7ha per shoot. The area of wild bird cover not in a stewardship agreement ranged from 0.5ha to 600ha, with an average of 11 ha per shoot. These results are encouraging from the point of view of songbirds. If provided under Countryside Stewardship this would be a substantial cost – wild bird cover in Countryside Stewardship, generates £640/ha for farmers – this figure is designed to cover establishment and management costs and income forgone (for not growing a crop). This would be a cost of £2,252,800 to the public purse if provided through Countryside Stewardship. We asked respondents to provide an estimate of their cost of the establishment of non-maize game cover crops, the average cost provided by 209 respondents was £435 per ha – this is less than the value from Countryside Stewardship – it would amount to £1,531,200.

Figure 3

The overall area of different types of game cover (not paid for through stewardship) established by respondents to the 2019 survey
Numbers on/above bars reflect the number of shoots in each category



Providing supplementary food for farmland birds



Supplementary feeding is particularly beneficial for farmland birds during the winter through to spring, known as 'the hungry gap' (during which their natural food sources become increasingly scarce)

23,426

tonnes of supplementary food are provided during the shooting season

4,309

tonnes are provided after the shooting season



98% carry on providing supplementary food through the hungry gap after the shooting season

23,426 tonnes of supplementary food are provided during the shooting season

4,309 tonnes are provided after the season

An average of **59** feeders per shoot

In addition to providing food for gamebirds and songbirds by planting game and wild bird cover crops, gamekeepers also provide supplementary food by supplying grain directly, which can benefit a variety of different bird species (Siriwardena et al., 2007). Supplementary feeding is particularly beneficial for these birds during the winter and throughout the late winter/early spring period known as ‘the hungry gap’ (Siriwardena et al., 2007), during which their ‘natural’ food sources become increasingly scarce reflecting the lack of seed resources in the environment, associated with the increased efficiency of farm equipment and a desire for a tidy countryside (Stoate et al., 2004). Supplementary food is typically administered as grain held in hoppers or spread along rides, tracks and hedgerows (Sánchez-García, et al., 2015). Out of the 800 respondents that gave detailed information on their quarry species and supplementary feeding (see Figure 4), 624 reported information on supplementary food, with 589 (94%) reporting that they supplementary feed and 554 providing information on how much food was provided in 2018. The amount of food reported ranged from 0.5 to 3,000 tonnes, with an average of 50 tonnes per site.

Figure 4

Shoots that reported providing supplementary food in 2019

Numbers on/above bars reflect the number of shoots in each category

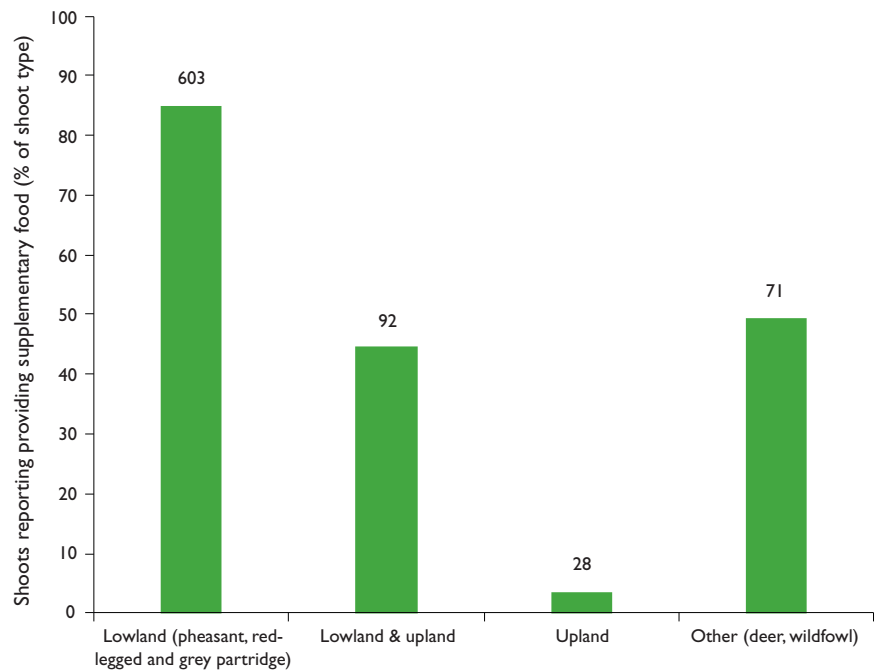
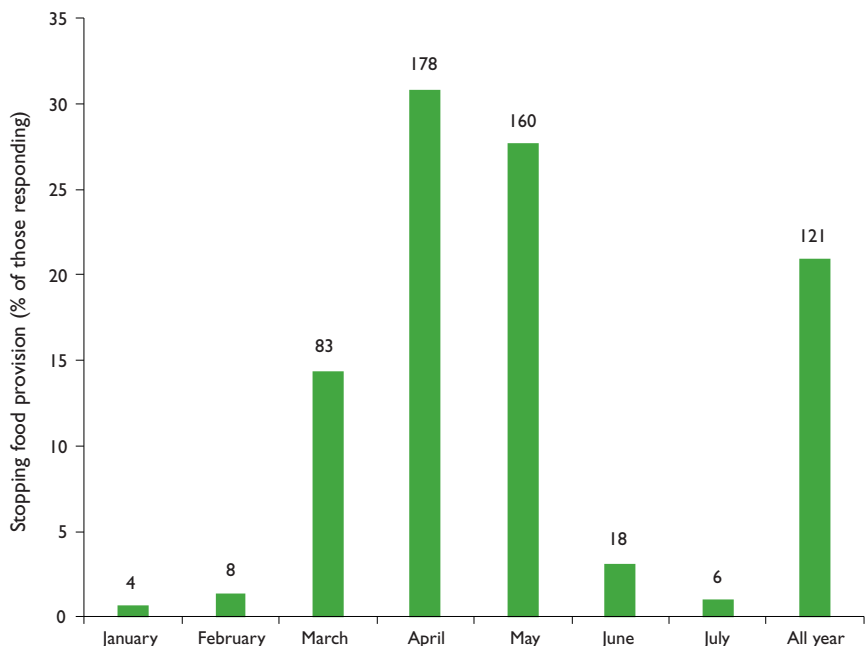


Figure 5

Most respondents reported carrying on supplementary feeding after the 2018/19 shooting season (n = 578)

Numbers on/above bars reflect the number of shoots in each category





(L-R) Feeders or spreading were the main ways to provide supplementary food catering for birds like goldfinch that prefer to feed off the ground, whereas yellowhammer feed on the ground; small birds feeding on a cold winter's day; tree sparrow also benefit from supplementary food.

Most of the shoots who told us they provide supplementary food (569, 98%) said that they carried on providing that food past the shooting season, with just a fifth providing food all year round. Just over 30% of the shoots that gave us details on when they provide supplementary food, stopped feeding during April, with almost 30% stopping in May (see Figure 5).

Overall, 23,426 tonnes of supplementary food were supplied by respondents during the shooting season, with 4,309 tonnes (18%) provided after the shooting season. This was an average of just over 40 tonnes per shoot for those with a lowland game interest during the shooting season and between 6.5 and 8 tonnes after the shooting season (see Figure 6). Of 603 who responded to the question regarding stewardship funding of supplementary food, only 62 (10%) reported that they were funded to provide supplementary food under a stewardship scheme.

The GWCT recommends that shoots continue to provide supplementary food through spring to help gamebirds maintain a healthier body condition during the nesting period, which can have subsequent benefits for pheasant chick production and densities (Draycott et al., 1998, 2002, ,2005). Furthermore, hen pheasants that have been provided with spring supplementary food, have been shown to lay another clutch after brood or nest loss twice as quickly as those without it (Hoodless et al., 1999). Providing supplementary food past the shooting season is also included in the Code of Good Shooting Practice, so all shoots should strive to meet that standard.

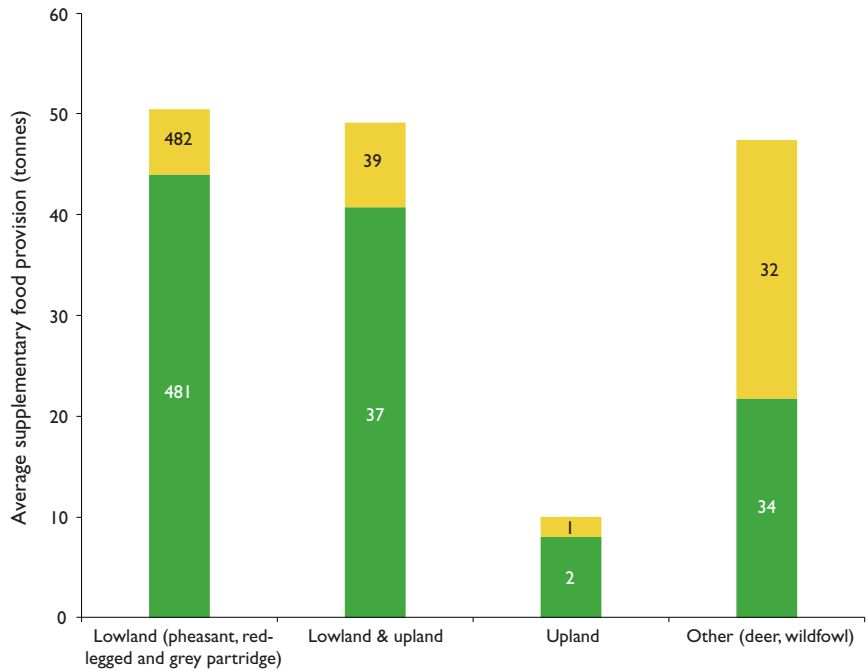


Figure 6
The average amount of supplementary food provided, both before and after the 2018/19 shooting season, based on 554 respondents to the 2019 survey
Numbers on/above bars reflect the number of shoots in each category

- After 1 February
- Before 1 February

Most shoots provide supplementary feeding after the shooting season which is of huge benefit to farmland birds 



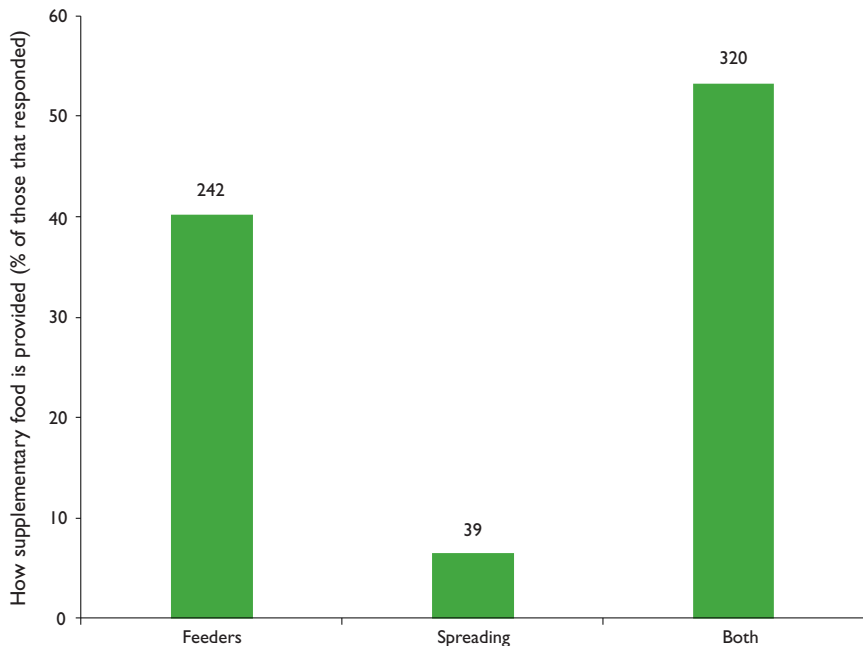
The majority of shoots use hoppers and spreading as ways of providing supplementary food. © GWCT

Although most of the shoots that provide supplementary food report providing it after the shooting season, they do report reducing the amount of food they provide (see Figure 6). This will reflect the fact that there are fewer gamebirds on the ground post-shooting (about 85% fewer due to shooting and non-shooting losses).

Of the 601 respondents that gave details of how they provided supplementary food, the majority (53%) used both feeders and spreading, followed closely by those that used feeders only (40%), while only 39 (6%) reported spreading only (see Figure 7). It is good news that the majority use hoppers and spreading as some birds prefer to

Figure 7

Means whereby supplementary food was provided, based on 601 respondents to the 2019 survey who undertook supplementary feeding and gave details on it
Numbers on/above bars reflect the number of shoots in each category



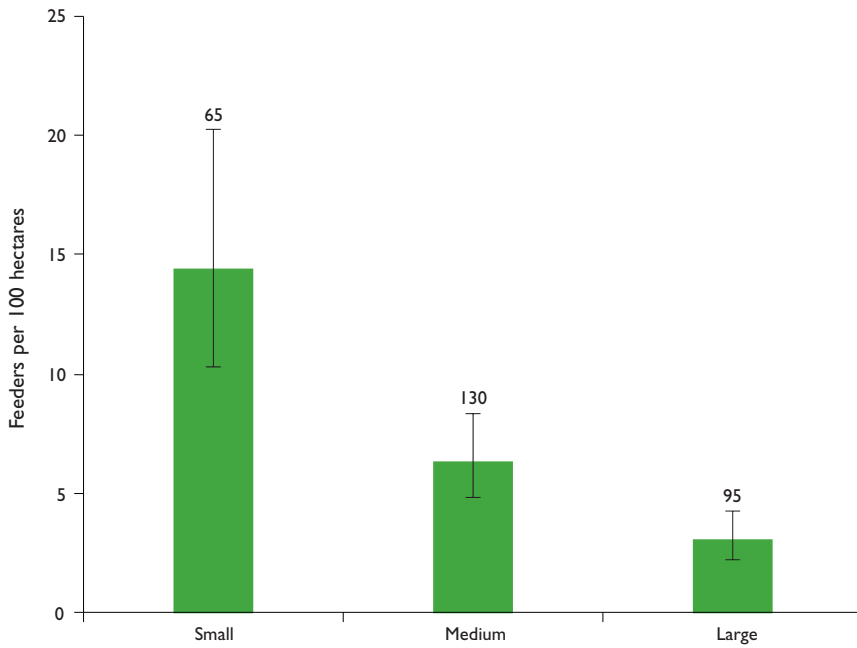


Figure 8
 The density of feeders in 2019 was highest on small shoots ($P < 0.05$), with the density on medium shoots higher than large shoots but not significantly different ($N = 290$). Numbers on/above bars reflect the number of shoots in each category, error bars are back-transformed 95% confidence intervals.

feed on the ground (eg. yellowhammers) and others off the ground (eg. goldfinch). A total of 296 respondents told us how many feeders they used, with an average of 59 (± 5.5) feeders per shoot. This varied by size of the shoot, with small shoots having an average of 29 (± 3.2) feeders, medium shoots 50 (± 5.0) feeders and large ones 93 (± 14.9) feeders (see Figure 8). Considering the density of feeders, overall this varied between the size of shoot ($F_{2,110} = 21.15, P < 0.001$). Small shoots that provided food through feeders had a higher density of feeders (a back-transformed average of 14.4 feeders per 100ha) than medium shoots (a back-transformed average of 6.4 feeders per 100ha) which in turn had a higher density than large shoots (a back-transformed average of 3.1 feeders per 100ha, $P < 0.05$).

Supplementary food supplied by gamekeepers, either by feeders or wild bird seed mixes, feed farmland birds through the winter and hungry gap from February until natural food is abundant in May/June. © Peter Thompson



Gamekeepers and game cover

90% planted game cover in 2019

1 in 4 respondents planted wild bird cover not in stewardship

£2,252,800 the value of wild bird cover that is privately funded

17ha the average area of game cover crop not covered by stewardship and 11ha the average area of wild bird cover not covered by stewardship

£435 per hectare the private cost of establishment of non-maize cover crops

Species group attendance at game feeders

Study at the GWCT's Allerton Project, Loddington (2007-08)

Pigeons and doves



341

minutes that **stock doves** used feeders. More than woodpigeons who were only there for 38 minutes

Gamebirds



5,443

minutes that **pheasants** spent at game feeders

Mammals



1,543

minutes that **rats** spent at feeders with other mammals such as squirrels and mice also using them



Small birds



4,332

minutes that **songbirds** such as yellowhammers spent at feeders

Corvids



827

and 445 minutes that **rooks and jackdaws** respectively spent at game feeders

Supplementary food can benefit a range of species when food is scarce. © Paul Quagliana





Woodland management and shooting

192,051

hectares of woodland
are managed by
survey respondents

71%

are planting trees to
create new woodland
which benefits wildlife

Ecological benefits of managing woodland

81.7% reported that they had woodland, and 747 (95.9% of those with woodland) reported that they managed this woodland. The average area that was managed was 244.5ha, which benefits birds and wildlife species



Speckled wood butterflies flourish in woodlands with 71.4% of respondents planting trees, and 45% planting them for shooting. © Peter Thompson

Woodland management and wildlife

The survey did not ask for a figure for the total area of woodland on each estate/area of land managed. However, we estimated it based upon the proportion of woodland (as indicated by the 2015 landcover map, Rowland et al., 2017) that falls within circular representations of each estate's total area, centred around the location of the postcode for each estate. The estimate is approximately 192,051 hectares which equates to 11.8% of the total area surveyed. This estimate is very similar to the national UK percentage of 13% (Forestry Commission, 2017).

We asked respondents to tell us if they had woodland on their shoot and responses to this question indicate that woodland is a common habitat on the areas managed by the respondents, with 779 (81.7%) reporting that they had woodland, and 747 (95.9% of those with woodland) reporting that they managed this woodland. Based on 650 respondents who specified the area of woodland that was managed, the average area managed was 244.5ha (± 24.8). Such a high proportion of respondents engaging in management of their woodland and a large average area of managed woodland is encouraging from an ecological standpoint. For instance, additional light is allowed in where gamekeepers undertake targeted canopy clearance and tree thinning. This can substantially increase ground vegetation in these woodlands and subsequently help to create favourable conditions for some woodland bird species (Draycott et al., 2008). Butterflies have also been found to benefit from similar management methods (Robertson et al., 1988).

Tree planting

In all, 680 (71.4%) respondents reported planting trees, with 47.3ha (± 11.4) planted on average; 533 respondents (78.4%) used guards to protect the trees against damage from hare, rabbits, deer and squirrels. Of the 680 shoots that planted trees, 329 (48%) reported planting trees for a specific reason. Of these 148 (45%) reported shooting as a reason for planting trees (see Figure 9), a quarter (82) reported conservation as a reason for tree planting and nearly a fifth (61) commercial forestry. Almost 30% of the respondents (97) gave other reasons that did not fit into one of the categories – for example, amenity, climate change, landscape etc. Oldfield

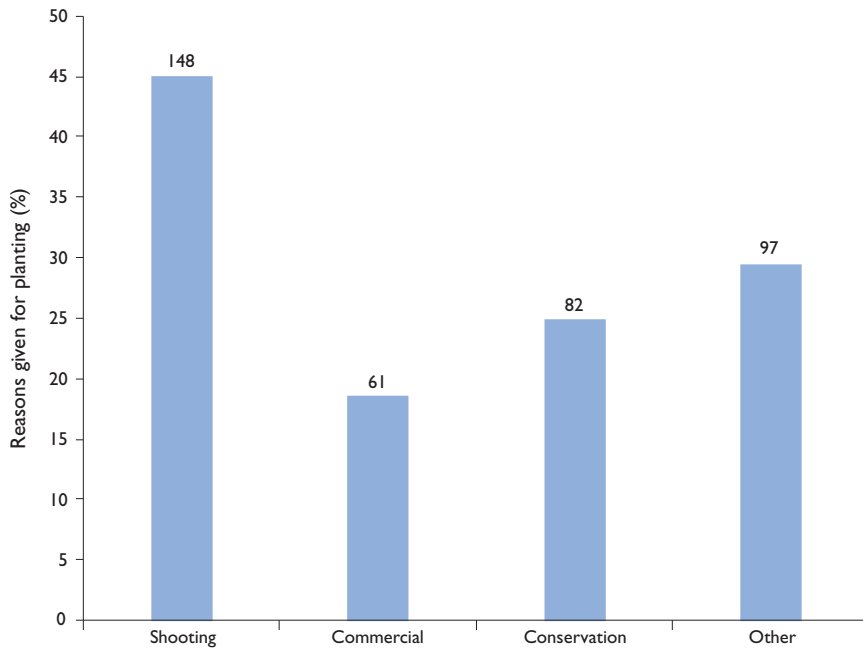


Figure 9

Reasons for planting woodland given by 329 respondents in the 2019 survey
Numbers on/above bars reflect the number of shoots in each category

et al. (2003) found that tree planting was more common among landowners who participate in country sports.

The use of woodland for game does not always result in a positive outcome in terms of biodiversity. Within release pens research has shown that high stocking densities can have negative impacts on woodland invertebrate composition (Neumann et al., 2015) and also result in a greater area of bare ground in release pens, reduced vegetation cover and reduced diversity of certain shade tolerant plant species (Sage et al., 2005). Woodland can begin to recover if left unused for at least 10 years and if original stocking densities were $\leq 1,000$ pheasants/ha (Capstick et al., 2019). Thus while the high proportion of landowners managing their woodland for shooting has benefits, it is important that woodland managers should also minimise any associated detrimental effects by ensuring that they follow GWCT sustainable releasing guidelines when releasing gamebirds www.gwct.org.uk/sustainable-releasing.



Where gamekeepers undertake targeted canopy clearance and tree thinning, additional light is allowed in which can substantially increase ground vegetation such as herb-Paris (above) and foxgloves (below). © Tim Weston/Peter Thompson





Balancing woodland and deer

Chris Rogers is the estate deer manager at Euston Estate, near Thetford.

Chris Rogers has been a full-time deer stalker/keeper since 2001 and trained at Sparsholt College. Based in East Anglia, he has been on the Euston Estate near Thetford for the last 14 years.

The Thetford area contains some of the highest deer densities in the country. Red, fallow, roe and muntjac are all present in the Breckland. The major impact that deer have in the area is damage to woodland habitat and commercial forestry.

The team at Euston work closely with Natural England who survey the deer impacts in the SSSI woodland every few years. The team has established a number of enclosure areas that exclude deer, as a quick and easy way to monitor the impacts that deer have in woodland.

The largest block of woodland was a traditional hazel coppice where the practice of coppicing has been re-started. **It provides nesting habitat for woodland birds and small mammals, in addition to providing traditional materials for roof thatching.**

Chris and his team face a tricky balancing act as the deer have an aesthetic as well as a commercial value to the estate, while trying to limit the impact they have on the ground. Despite the high deer numbers, they are an asset and are an essential part of the wildlife mix.



Moorland management and shooting

81%

of moorland
gamekeepers
undertake some form
of heather canopy
management.
Heather is a key food
resource for livestock,
deer, mountain hare
and grouse



Cutting and burning are the two main methods of managing heather moorland. © Lindsay Waddell

Uplands - heather moorland

Heather-dominated moorland supports a distinctive suite of plant communities including species of berry, grass, sedge and mosses such as *Sphagnum*, which together define habitats that are listed as priorities under the EU's Conservation of Natural Habitats and of Wild Flora and Fauna Directive

The unique heather uplands

The extensive UK heather uplands are unique. Heather-dominated moorland supports a distinctive suite of plant communities including species of berry, grass, sedge and mosses such as *Sphagnum*, which together define habitats that are listed as priorities under the EU's Conservation of Natural Habitats and of Wild Flora and Fauna Directive (Thompson et al., 1995).

Of the 965 respondents, 165 (17.1%) reported heather moorland on the land they manage. Of these 134 (81.2%) undertake some form of heather canopy management on this moorland (see Figure 10). Half of these use both cutting and burning to manage heather, with 40% burning only and 10% cutting.

Heather is a key food resource for livestock, deer, mountain hare and grouse. Burning is primarily undertaken to allow new heather to grow which is more palatable and nutritious for these species. Furthermore, in following The Heather and Grass Burning Code, small pre-determined areas of heather are burned on a rotational basis leaving a patchwork landscape of heather and other plant species at different stages in their life cycles, providing food in the form of both new shoots and greater numbers of invertebrates (Buchanan et al, 2006). In addition, the resulting landscape provides both cover from predators and suitable breeding areas (Miller, 1980).

In the 2011 survey we asked respondents to tell us if they have burned heather but did not ask for details of burning versus cutting of heather, so in this report we only compare the proportion that burnt heather with responses in 2011. Overall there were no significant differences between the percentage reporting burning in the

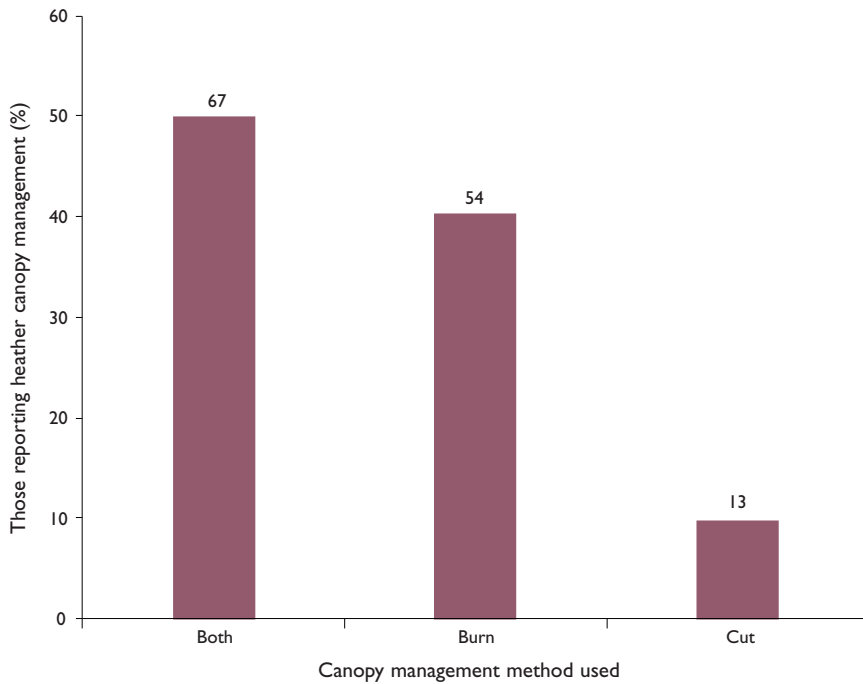


Figure 10

Half of 134 respondents in 2019 who reported undertaking heather management both burn and cut, with 40% burning only and 10% cutting only

Numbers on/above bars reflect the number of shoots in each category



Burning encourages new heather to grow which mitigates wildfire and is more palatable and nutritious for livestock, deer, mountain hare and grouse.

different groups in 2011 and 2019 ($\chi^2_3 = 7.53, P = 0.057$). In the 2019 survey 86% of shoots with an interest in grouse shooting reported undertaking heather burning compared to nearly 90% in the 2011 survey, (see Figure 11). For shoots that had grouse present but not shot, 42% reported heather burning in 2011, compared with 35% in 2019. In 2011 2% of shoots without grouse reported burning, while 0.2% of shoots without grouse reported burning in 2019.

We compared the percentage of moorland reported burned by grouse estates on estates where grouse were present but not shot, to those where grouse were shot, however, there was no significant difference ($t_{95} = 0.15, P = 0.884$, see Figure 12). Comparing the survey results in 2019 with those in 2011, again there was no significant difference between the types of estates ($F_{2,200} = 0.66, P = 0.520$), but there was a significant difference between the surveys in the percentage of moorland

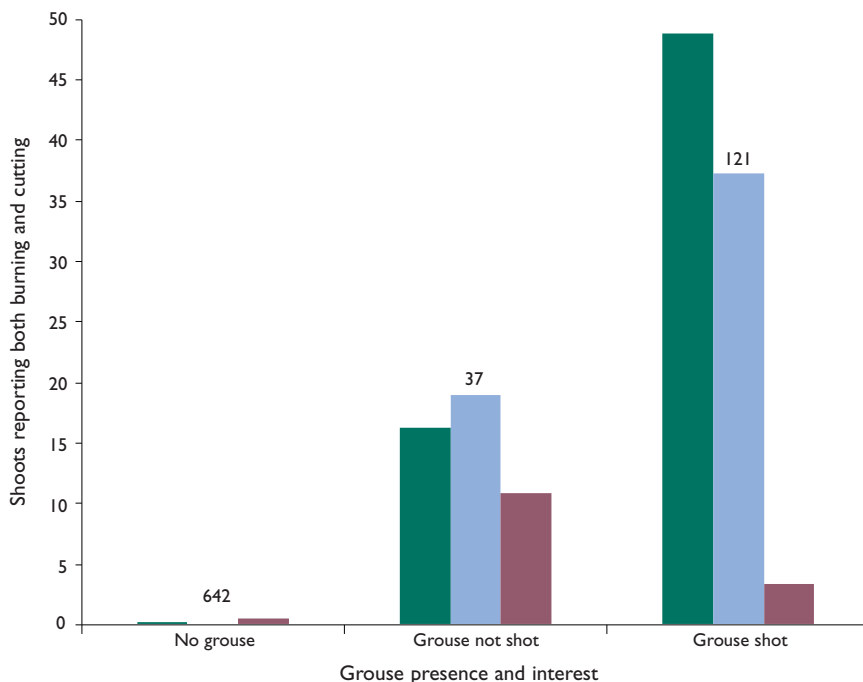


Figure 11

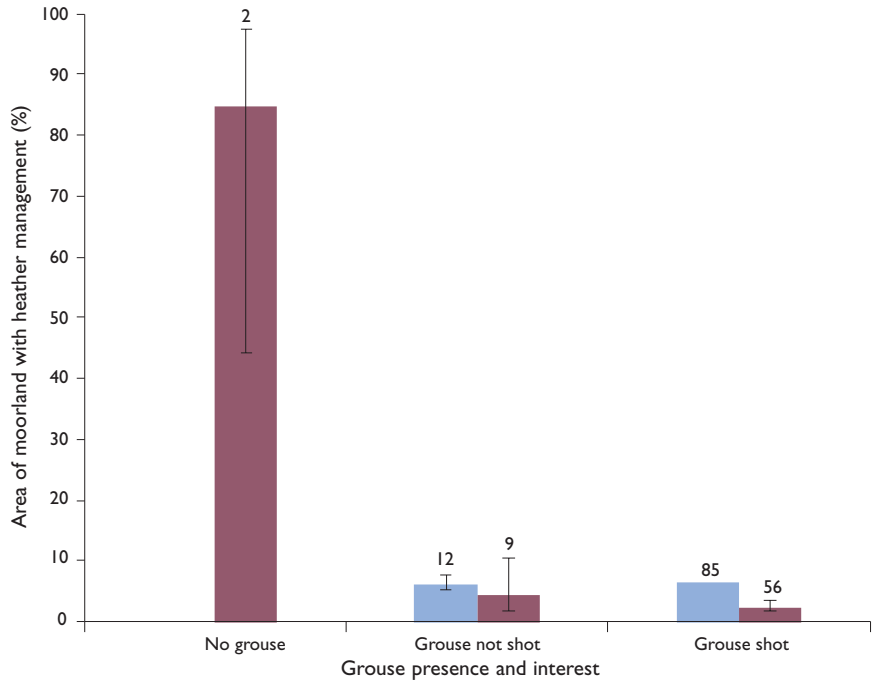
Most of the 121 respondents who managed land for grouse shooting in 2019 reported burning heather (86%), with just over 40% reporting cutting heather as a means of canopy management. For the 37 with grouse present but not shot, 35% burn and 27% cut. For the 642 without grouse under 1% do either

- Burn and cut heather
- Burn heather
- Cut heather

Figure 12

Percentage of heather moorland reported managed by respondents to the 2019 survey, by burning and cutting separately, error bars are the 95% back-transformed confidence intervals from the comparisons between types of estates
 Numbers reflect the number of shoots in each category

Burnt
 Cut



reported burnt ($F_{1,200} = 27.95, P < 0.001$). In the current survey a back-transformed average of 6.5% (4.9% to 8.6%, back-transformed 95% confidence interval) of heather was burned per year, while in 2011 a back-transformed average of 2.2% (1.7% to 2.9%, back-transformed 95% confidence interval) was reported burned. In 2019, there was a significant difference between the types of estates in the percentage of moorland cut ($F_{2,64} = 15.40, P < 0.001$). The two estates with no grouse that cut heather moorland and reported an area cut, had cut an average of 85% of their area, significantly more ($P < 0.05$) than on estates where grouse were present but not shot (4.5% cut) and on estates where grouse were shot (2.4%) – which did not differ in the percentage of their area cut.



Heather provides food (inset) and both cover and suitable breeding areas for grouse. © Lindsay Waddell

Moorland management

38%

of moorland keepers
who completed the
survey reported
blocking up grips to
'rewet' moorland



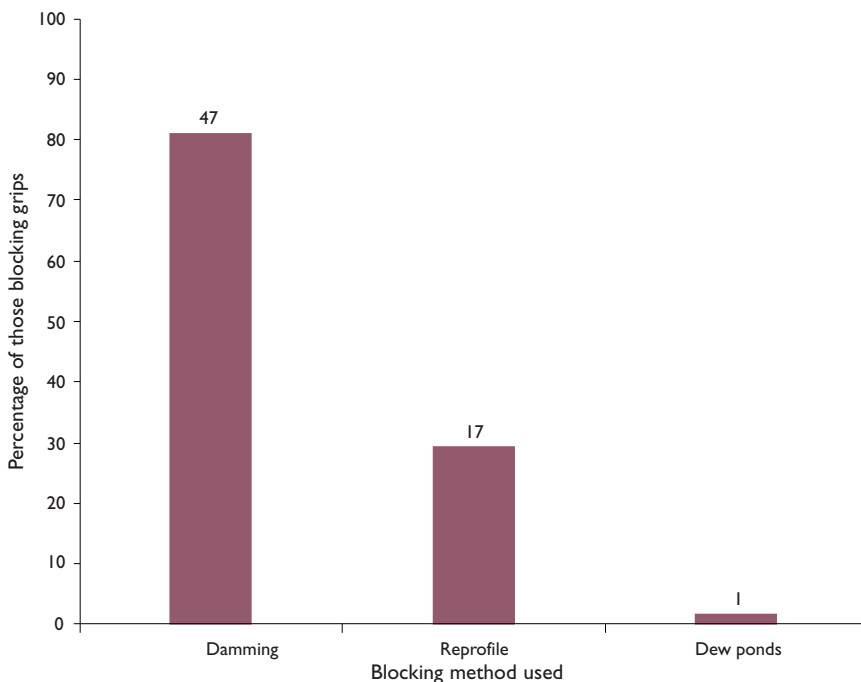
Blocking up grips helps to keep water on the moor.
© North Pennines AONB

Rewetting moorland

Large amounts of moorland were drained after the Second World War to provide a greater area of land for agricultural production and forestry (Werritty et al., 2015; Chesterton, 2009; Holden, 2004). This was predominantly achieved by creating ditches or 'grips' through which the water can run off the moor (Coulson et al., 1990). Although many people believe that grouse moor managers continue to drain the water from grouse moors, many are in fact doing the opposite and 'rewetting' the moorland. Within this survey, 62 (37.6%) of those with heather moorland on the land they manage undertook moorland rewetting in the last five years. Blocking grips is the most common means by which those who manage grouse moors go about rewetting them, with 58 (93.5%) of the 62 respondents using this method and 35 respondents reporting an average of 27% ± 5.4% of their grips blocked. Of those that reported the method used to block grips (N = 58), four-fifths reported using damming, nearly 30% reprofiling and one indicated that they had installed dew ponds (note seven respondents reported multiple methods, see Figure 13). Grouse and wader chicks can get stuck in grips, so blocking helps reduce these fatalities, while wet areas created by blocking can increase invertebrate numbers as an important food source for these birds (LIFE Active Blanket Bog in Wales Project, 2006; Coulson, 1990). Wider environmental benefits of grip blocking include; restoring bog vegetation cover including *Sphagnum* moss as a highly important species for peat formation and protection, as well as improving river water quality and possibly carbon stores, reducing peat sediment runoff and flood risk.

Figure 13

Most of the 58 respondents in 2019 who reported blocking grips within the last five years said that they dammed them, nearly 30% reprofiled and one constructed dew ponds
Numbers on/above bars reflect the number of shoots in each category, note seven shoots reported more than one method



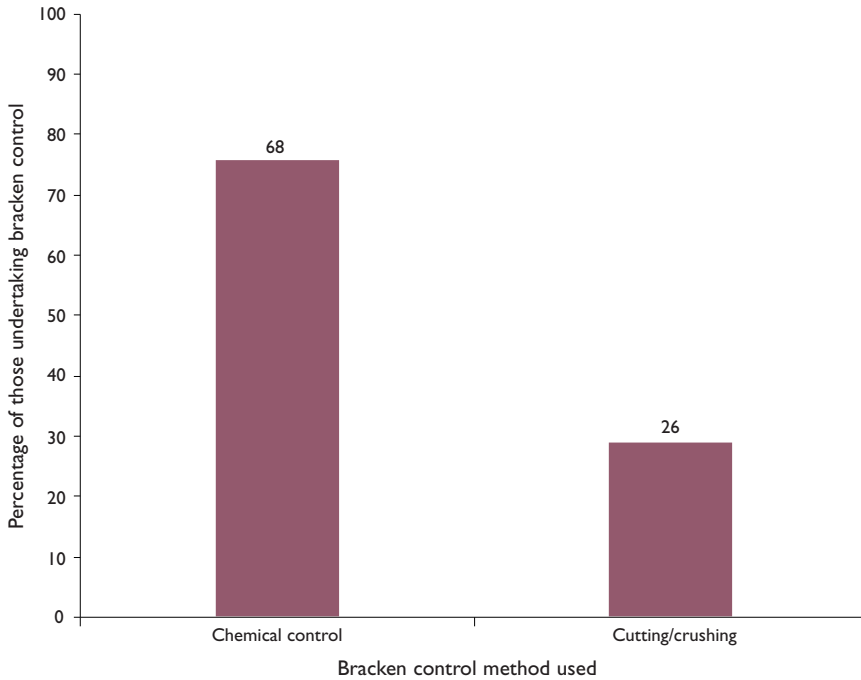


Figure 14

Most of the 90 respondents in 2019 who reported a method of bracken control used chemical control, nearly a third used cutting/crushing

Numbers on/above bars reflect the number of shoots in each category, four shoots reported both methods



WHY CONTROL BRACKEN

- Controlling bracken aims to prevent the loss of heathland, moorland and grassland of conservation value, and to restore, enhance or maintain their open nature. Restoring a more open structure to the existing vegetation will encourage characteristic native plants to thrive and provide breeding and feeding grounds for associated wildlife. Priority species that may benefit include juniper, pearl-bordered fritillary, northern brown argus, slender scotch burnet, black grouse and skylark.

Controlling bracken

Bracken is a very successful invasive plant, covering large swaths of the countryside. It can reduce the area available for livestock grazing and overrun heather moorland. It is important to manage and control its spread, with 'The Bracken Control Group' (www.brackencontrol.co.uk) providing help and support to those involved in that control.

Of 165 respondents with heather moorland, 90 (54.5%) undertook bracken control, with three-quarters of those practising chemical control and almost 30% using cutting/crushing as a means of control (see Figure 14, four used both chemical and cutting/crushing as a means of bracken control).

Of the 75 respondents who reported the area of bracken control undertaken over the last five years, the average area controlled was 85ha (± 40.3 ha). Of the 90 who responded about the outcome, nearly half felt that bracken had decreased in area, while the remainder were evenly split between those that considered it had increased versus those that thought it had remained stable (see Figure 15).

We asked the respondents to give a reason for their perceptions regarding changes in bracken on the area that they manage. The majority (74%) of those who thought bracken had decreased indicated that this was due to the effectiveness of control methods, with those who considered that bracken had remained stable were more evenly spread in their reasons for this (see Figure 16). For those who considered that

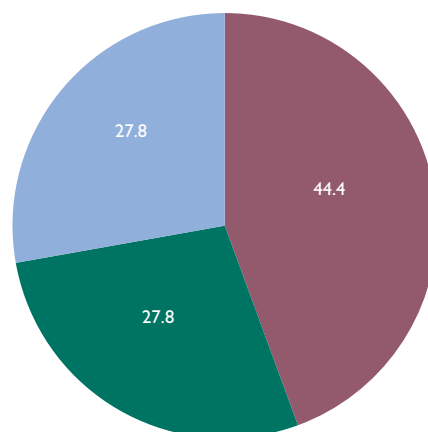


Figure 15

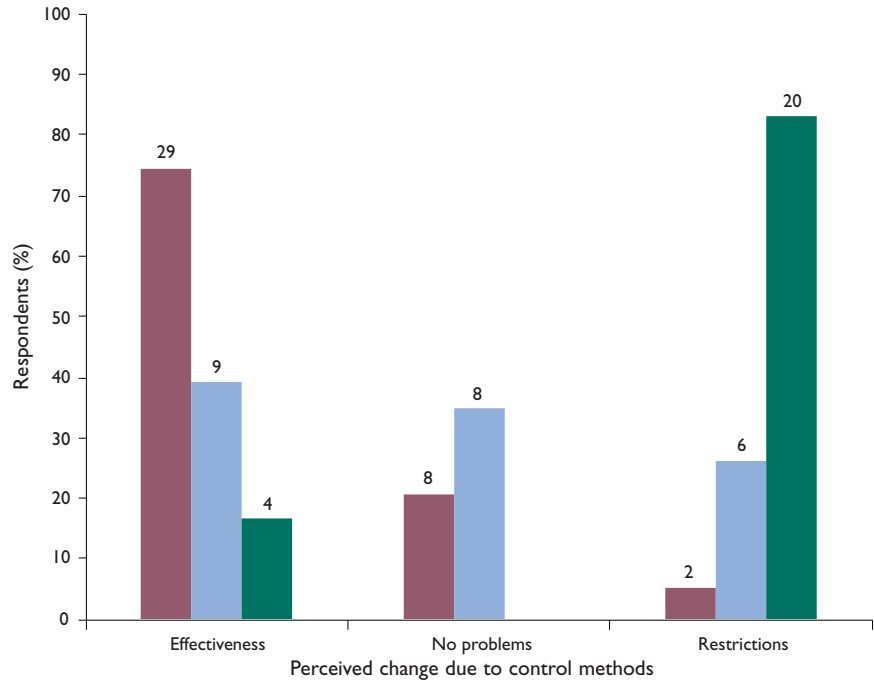
Nearly half of the 90 respondents in 2019 who responded to the question about perceived changes in the area of bracken felt the area had decreased

- Decreased
- Increased
- Remained stable

Figure 16

The reasons given for gamekeeper's perception of changes in bracken on their area. The majority of the 39 who perceived that bracken had decreased put this down to the effectiveness of the control methods, while the majority of the 24 who considered that bracken had increased ascribed this to restrictions on the control methods. The 23 who felt that the area had remained stable were more evenly split regarding the reasons why things were stable. Numbers on/above bars reflect the number of shoots in each category.

Decreased
Increased
Remained stable



bracken had increased, the majority (83%) put this down to the restrictions on control methods, more than the effectiveness of available methods.

Improving heather moorland

Of the 165 respondents with heather moorland on the land they manage, 23 (14%) reported reseeding moorland in the last five years. Of the 19 who gave an area for reseeding, an average of 82ha (± 20.7 ha) was reported as being reseeded over the last five years. Twenty-one (12.7% of those with heather moorland) reported using *Sphagnum* inoculation in the last five years. The majority (71%) of the inoculation was through spore spreading, while the remainder used plug planting (see Figure 17).

We asked the respondents who had used these methods of heather reseeding

Reseeding moorland achieves a balance of heather, grasses and berries. © GWCT





Plug planting to reseed common cottongrass. © North Pennines AONB



HEATHER BEETLE

- Heather beetle is a widespread and common insect species found across Britain. The larvae (and to a lesser extent the adult beetles) feed on the leaves of heather plants, stripping them bare and damaging the health of the heather. In a normal year, small patches of heather will be 'beetled', but it is usually the case that the plants recover in a few months.
- Periodically, heather beetle populations expand into huge outbreaks, in which millions of beetle grubs can decimate hundreds of hectares of carefully managed heather.

(ie. *Sphagnum*) to report their perception of their success. The majority of those that reported plug planting considered that *Sphagnum* had increased (83%) following this treatment (see Figure 18), while the perceptions of the success of spore spreading were more evenly divided, with only 54% considering that this method had increased *Sphagnum*.

Of the 165 respondents with heather moorland, nearly two thirds (64%) reported loss of heather to heather beetle attack over the last five years, with an average of 182.7ha (± 42.7 ha) lost. Of 165 respondents with heather moorland, 23.4% reported

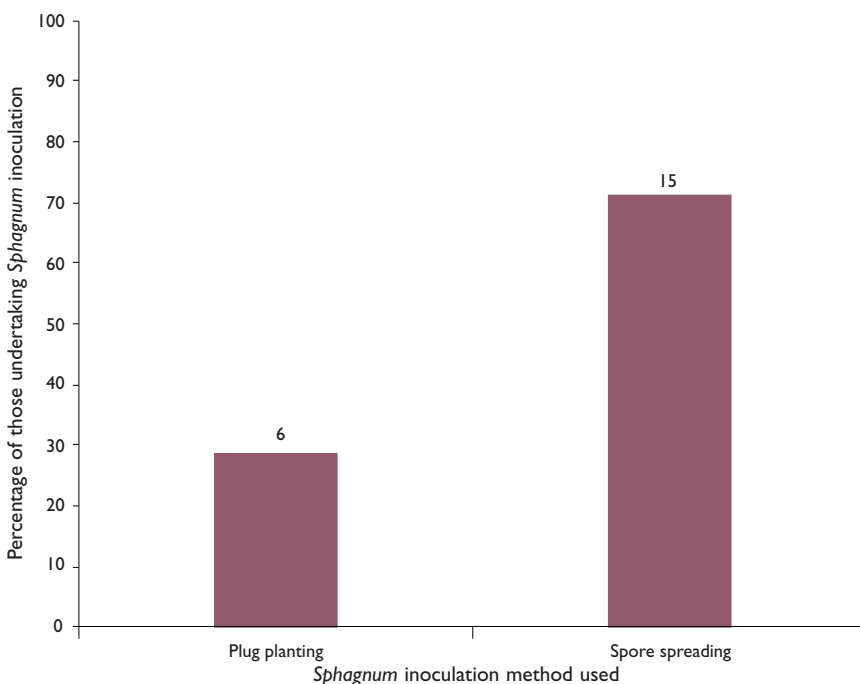


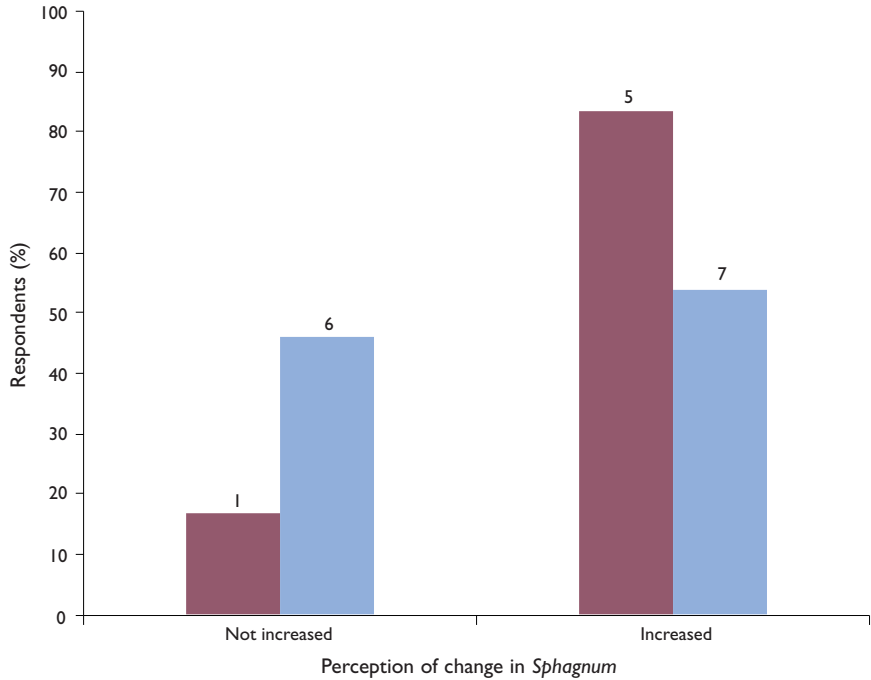
Figure 17

Two-thirds of the 21 respondents in 2019 who reported *Sphagnum* inoculation in the last five years on the ground they manage used spore spreading, one third used plug planting. Numbers on/above bars reflect the number of shoots in each category.

Figure 18

How 19 gamekeepers using different reseedling methods perceived the success of those methods. Plug planting was perceived by a majority who used it as successful, while the results for spore spreading were less positive. Numbers on/above bars reflect the number of shoots in each category

Plug planting
Spore spreading



82ha the average area of moorland reseeded by survey respondents in the last five years

21 used *Sphagnum* inoculation in the last five years

71% used spore spreading, while the remainder used plug planting for inoculation

81% of respondents had undertaken path or track maintenance over the last five years

taking part in a peatland restoration scheme in the last five years, with an average of 536.7ha (± 213 ha) involved. Finally, 80.5% of the 165 with heather moorland said that they had undertaken path or track maintenance over the last five years, spending an average of £13,259 ($\pm £2,235$) per year for this purpose.

© North Pennines AONB



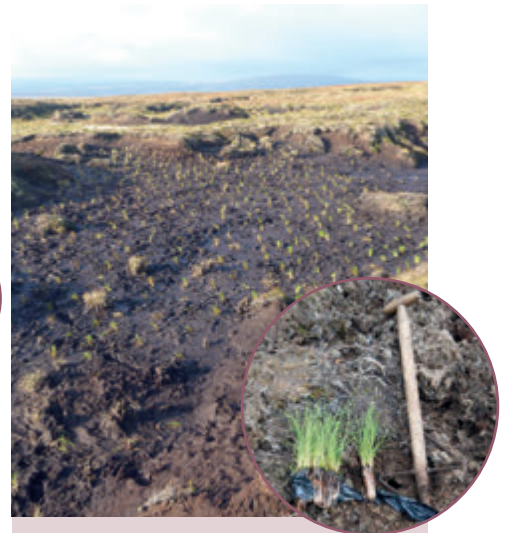
IMPORTANCE OF SPHAGNUM

- *Sphagnum* is the fundamental building block of all globally important blanket bog habitat across the UK. It holds vast amounts of water and is key to future carbon sequestration and flood alleviation policies. *Sphagnum* does not naturally regenerate on the bare peat. Intervention in the form of *Sphagnum* gels or beads is needed so bogs recover peat accumulating functions in a reasonable time scale.



RESEEDING

- An important first step for heather reseedling is to carry out soil samples from potential heather regeneration sites. This then helps to determine the type and rate of re-seeding needed to ensure a site specific and cost-effective solution. A combination of spraying, burning and mulching is then used to prepare the ground to reduce the competition from existing plant communities.



PLUG PLANTING

- This involves hand planting of potted plants into often bare peatland sections of the moor. Common cotton grass (*Eriophorum angustifolium*) is a common species chosen for this type of work as is Crowberry (*Empetrum nigrum*).



Moorland and tree regeneration

Mark Wood is head gamekeeper at Pitcarmick Estate, Perthshire

Pitcarmick's main sporting offering is stalking and fishing. Mark operates as a single-handed keeper, with some part-time assistance as required and management is now taking place to restore an area of moor for red grouse. **The estate carries SPA and SSSI designations for hen harrier, merlin and black grouse.** "We do lek counts every year and we now have 80 lekking males," says Mark. **"The estate has oak plantations and promotes native tree regeneration** but the black game are actually on the open hill, you barely see them in the regeneration."

Work to revive the moor has focused around targeted heather burning to break up continuous rank heather and predator control (mainly foxes and crows). **Mark manages the deer population and sheep are treated regularly as part of tick management**, with Louping Ill virus being an issue on the estate.

Since the moorland recovery work began, **curlew numbers have risen from one pair to four pairs.** "It is good to see the curlew and, on the estate, you used to see maybe two or three lapwing. **Now, we are starting to get flocks of 20-30.**" Although initially there were two young red grouse per covey, 3.5 to four young is now more usual as the work gradually begins to bears fruit.

In recent years, a harrier nest fell prey to raven predation but there are hopes that, if they can ascertain how Louping Ill virus is affecting the bottom of the food chain, harrier recovery can begin.



Quarry species



© Lindsay Waddell/Peter Thompson

Quarry species on the ground

We asked respondents to tell us about the quarry species they had on their ground (see Table 3). Most of the shoots with red grouse, pheasants and red-legged partridges reported that they were a sporting interest. For the geese species, 50% or fewer of respondents considered them a sporting interest while mallard, teal, wigeon, tufted duck and gadwall were of sporting interest for more than 50% of shoots where they were present. Pochard, goldeneye, pintail and shoveler were a sporting interest on roughly a third of the shoots where they were present, and a similar percentage of shoots with woodcock and snipe considered them to be of sporting interest. Less than 10% of shoots with golden plover considered them of sporting interest and no shoots reported an interest in ptarmigan. Less than a third of shoots with grey partridges considered them of sporting interest and less than a fifth of shoots with brown hare shot them. This reflects the fact that a lot of shoots choose not to harvest such species because they are interested solely in their conservation. We were able to make comparisons between the results of the present survey and the 2011 survey for 11 of the species listed in Table 3. There was a significant difference overall in the percentage of respondents who recorded these species as present (in either

Most of the shoots with red grouse, pheasants and red-legged partridges reported that they were a sporting interest

Table 3

Information on quarry species, present on the ground managed by a sample of 800 respondents in 2019

Quarry species	Present in summer	Present in winter	Present in summer or winter	Shoots where a sporting interest*
Red grouse**	147 (18.4%)	146 (18.3%)	149 (18.6%)	121 (82.9%)
Black grouse**	88 (11.0%)	89 (11.1%)	92 (11.5%)	12 (13.5%)
Canada goose	414 (51.8%)	379 (47.4%)	466 (58.3%)	155 (40.9%)
Greylag goose	307 (38.4%)	310 (38.8%)	367 (45.9%)	140 (45.2%)
Pink-footed goose	9 (1.1%)	20 (2.5%)	21 (2.6%)	10 (50.0%)
White-fronted goose	5 (0.6%)	17 (2.1%)	17 (2.1%)	4 (23.5%)
Mallard	669 (83.6%)	693 (86.6%)	713 (89.1%)	524 (75.6%)
Teal	357 (44.6%)	594 (74.3%)	613 (76.6%)	412 (69.4%)
Wigeon	132 (16.5%)	331 (41.4%)	342 (42.8%)	222 (67.1%)
Tufted duck	40 (5.0%)	51 (6.4%)	57 (7.1%)	26 (51.0%)
Pochard	46 (5.8%)	116 (14.5%)	124 (15.5%)	41 (35.3%)
Goldeneye	51 (6.4%)	99 (12.4%)	113 (14.1%)	27 (27.3%)
Pintail	24 (3.0%)	67 (8.4%)	73 (9.1%)	24 (35.8%)
Shoveler	32 (4.0%)	96 (12.0%)	101 (12.6%)	35 (36.5%)
Gadwall	52 (6.5%)	106 (13.3%)	109 (13.6%)	55 (51.9%)
Woodcock**	376 (47.0%)	740 (92.5%)	753 (94.1%)	276 (37.3%)
Snipe**	343 (42.9%)	593 (74.1%)	611 (76.4%)	215 (36.3%)
Golden plover**	185 (23.1%)	250 (31.3%)	323 (40.4%)	24 (9.6%)
Pheasant**	714 (89.3%)	733 (91.6%)	750 (93.8%)	692 (94.4%)
Grey partridge**	404 (50.5%)	413 (51.6%)	425 (53.1%)	129 (31.2%)
Red-legged partridge**	621 (77.6%)	638 (79.8%)	656 (82.0%)	568 (89.0%)
Ptarmigan**	6 (0.8%)	5 (0.6%)	6 (0.8%)	0 (0%)
Brown hare**	638 (79.8%)	647 (80.9%)	658 (82.3%)	116 (17.9%)
Mountain hare**	64 (8.0%)	67 (8.4%)	68 (8.5%)	27 (40.3%)
Rabbit	725 (90.6%)	731 (91.4%)	750 (93.8%)	421 (57.6%)

*Percentage calculated from those shoots where present in winter.

** Species was able to be compared to results from the 2011 survey by means of a Chi-square test.



There appears to be an increased interest in the conservation of brown hare and woodcock.
© GWCT/Peter Thompson

winter or summer for the 2019 survey, present overall in 2011, $X^2_{11} = 26.70$, $P = 0.005$). Considering each species separately it was only in the case of pheasant where there was a significant difference (94% in 2019 versus 97% in 2011, $X^2_1 = 11.77$, $P < 0.001$). The broader trend, from shoots that submitted data to the National Gamebag Census, was of an increase in the number of pheasants released in Britain over a similar time frame (Aebischer 2019). We then compared the percentage of shoots that shot a species that was present in both surveys, with a significant difference overall ($X^2_{11} = 213.70$, $P < 0.001$). The percentage of shoots that shot red grouse, black grouse, pheasant, red-legged partridge and mountain hare showed no significant difference between the two surveys. However, the percentage of respondents in 2019 that reported shooting woodcock (37% in 2019 versus 66% in 2011, $X^2_1 = 143.28$, $P < 0.001$), snipe (36% in 2019 versus 51% in 2011, $X^2_1 = 31.65$, $P < 0.001$), golden plover (10% in 2019 versus 14% in 2011, $X^2_1 = 6.09$, $P < 0.014$), grey partridge (31% in 2019 versus 38% in 2011, $X^2_1 = 6.09$, $P < 0.014$) and brown hare (18% in 2019 versus 25% in 2011, $X^2_1 = 11.31$, $P < 0.001$) was significantly smaller than the percentage of respondents reporting shooting them in 2011. This is likely to reflect an increased interest in conservation of these species.





Conservation for gamebirds

We asked respondents to tell us if they were undertaking conservation actions directed towards three gamebird species (black grouse, grey partridge and capercaillie) that are traditionally considered quarry species in the UK and have undergone dramatic declines in abundance over the past century*.

88.5% of respondents with black grouse on their ground are undertaking conservation action for black grouse which is encouraging as they are a species of high conservation concern. © Lindsay Waddell

Black grouse conservation

Sixty-one respondents reported undertaking conservation action for black grouse, with 54 of those (88.5%) currently having black grouse present on their managed land. Of the 12 respondents reporting an interest in black grouse shooting, seven (58.3%) reported actively undertaking conservation measures for them.

Why is this important? Black grouse have been declining throughout virtually all their European range over the last century. In Britain they were once widespread but following a severe decline in numbers over the last 150 years, the species is now confined to upland fringe areas in Scotland, north-eastern England and north Wales. In the early 1990s national surveys estimated the population at 25,000 displaying males, but by 2016 only 4,850 remained (Sim et al., 2008, Woodward et al. 2020enclos). Of these, two-thirds were found in Scotland, with approximately 1,000 males in northern England and 200 males in north Wales. Black grouse are a species of high conservation concern, are 'red-listed' and recognised as a priority species for biodiversity conservation in section 41 of the Natural Environment and Rural Communities Act 2006.

Grey partridge conservation

Two hundred and twelve respondents reported undertaking grey partridge conservation, with 198 (93.4%) of these reporting having grey partridge on their managed land. Of the 129 respondents reporting an interest in grey partridge shooting, 70 (54.3%) reported actively undertaking conservation for them.

Why is this important? In the 19th century, numbers of grey partridges dramatically increased following the period of land enclosure – with the patchwork-quilt landscape and quick-set hedges that we cherish today. After the Agricultural Revolution there

**Capercaillie are currently subject to a voluntary moratorium on shooting.*

was increased interest in managing game for sport and, by 1911, there were about 25,000 gamekeepers nationwide protecting gamebirds. At this time, we estimate from bag data that there must have been more than a million pairs of grey partridges breeding in Britain.

In the 1950s, a sharp decline in partridge numbers followed the introduction of herbicides into modern cereal-growing systems. This was exacerbated by a loss of hedgerows and the employment of fewer gamekeepers. In the early 1990s there were around 145,000 partridge pairs, but by 2016 this had declined to an estimated 37,000 pairs (Woodward et al., 2020). Grey partridges thrive only where the conditions are right. Hedgerow loss, herbicide and insecticide use and an increase in numbers of generalist predators have contributed to their decline and grey partridges are now most common where targeted conservation work is undertaken.

Capercaillie conservation

Four (21.1%) of the 19 respondents whose location put them within the breeding distribution of capercaillie as reported in the 2007-2011 British Breeding Bird Atlas (Balmer et al., 2013), reported undertaking capercaillie conservation.

Why is this important? Originally restricted to Scotland, Ireland and northern England, the capercaillie became extinct in the 18th century following extensive felling of pinewood habitats and a run of cold, wet summers in the 'Little Ice Age'. It was re-introduced into Scotland in the mid-19th century by landowners with an interest in shooting and spread to eastern and central Scotland. In recent years, numbers have decreased to an estimated 1,114 males in the winter of 2015-16 (Wilkinson et al. 2018).

The reasons for the recent reductions in numbers and range are poorly understood, but may include habitat deterioration, increased predation, fence collisions and insect shortages in June causing poor chick survival. The Scottish population is a small proportion of the world population, which is also declining over most of its range in association with losses of mature forest and human disturbance. When they were more common, capercaillie were often shot either as trophies or on organised drives, but bags have never been large. Since the recent reduction in numbers there has been a voluntary moratorium by landowners on shooting, however, there is no sign that this has reversed the decline.

(L-R) Since the recent reduction in capercaillie numbers there has been a voluntary moratorium by landowners on shooting, however, there is no sign that this has reversed the decline. Grey partridges are now most common where targeted conservation work is undertaken.
© Laurie Campbell/Lindsay Waddell





Collective effort for grey partridges

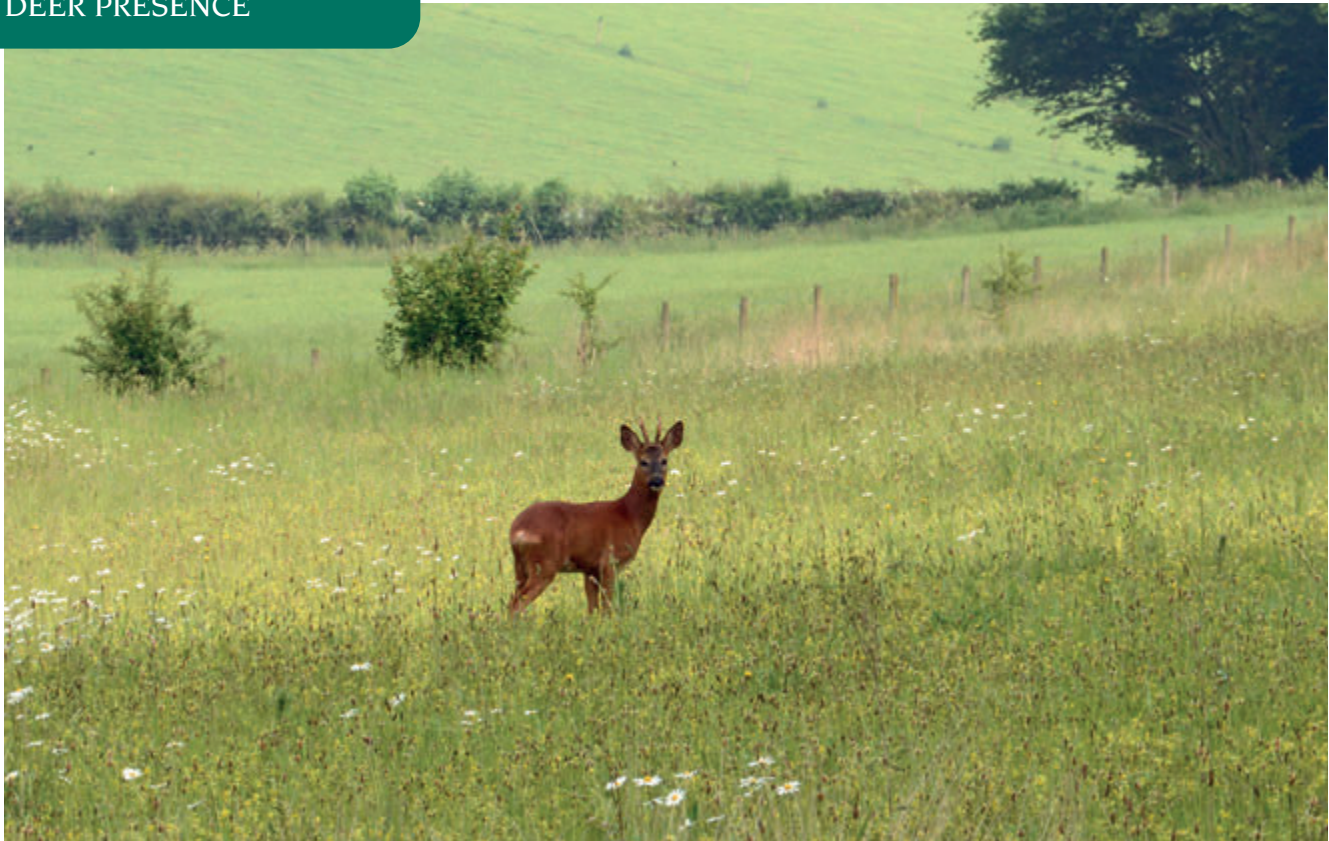
Will Pratt is gamekeeper at the Calmsden Manor Estate near Cirencester.

Will Pratt joined the Calmsden Manor Estate in 2014, six years after it won its first GWCT award for grey partridge conservation. **In five years, he has overseen the grey partridge spring pair count increase from seven pairs in 2014 to 53 pairs in 2019.** In 2018, Calmsden became the first ever double winner of the GWCT Cotswold Grey Partridge Trophy.

For the estate owners, Mark and Jane Tufnell, the project's success has been achieved by a collective effort across a range of estate departments. A comprehensive predator control program works alongside the **Higher Level Stewardship (HLS) options that were completely redesigned to provide maximum benefit for wildlife. Interlinking wildlife corridors across the estate were used to break up blocks of arable crops.** Supplementary feeding is also used throughout the year, helping to maintain a broad range of farmland bird species.

The grey partridge counts are submitted to the GWCT's Partridge Count Scheme that has more than 75 years' worth of data charting the fortunes of this much-loved bird and can monitor the progress of each individual site.

Wild game management is a roller coaster of emotion and the spring and autumn counts are eagerly awaited and dreaded with equal measure. The most rewarding feeling for the team is a progressive spring count followed by a good young-to-hen average after harvest.



Roe deer were the most commonly reported species of deer. © Peter Thompson

Deer presence and management

Roe deer was by far the most commonly reported species of deer on the shoots surveyed, while Chinese water deer was the least commonly reported, followed closely by sika (see Table 4). Overall the percentage of respondents reporting deer species in 2019 differed from the 2011 survey ($\chi^2_6 = 60.06, P < 0.001$). A higher percentage of those responding to the survey this year reported the presence of red deer (23% in 2019 versus 17% in 2011, $\chi^2_1 = 9.91, P = 0.001$), roe deer (88% in 2019 versus 76% in 2011, $\chi^2_1 = 41.54, P < 0.001$) and muntjac (49% in 2019 versus 44% in 2011, $\chi^2_1 = 4.29, P = 0.038$). Overall no significant difference was found between the surveys in the percentage of those that had a sporting interest in deer species where they were present ($\chi^2_6 = 6.32, P = 0.389$).

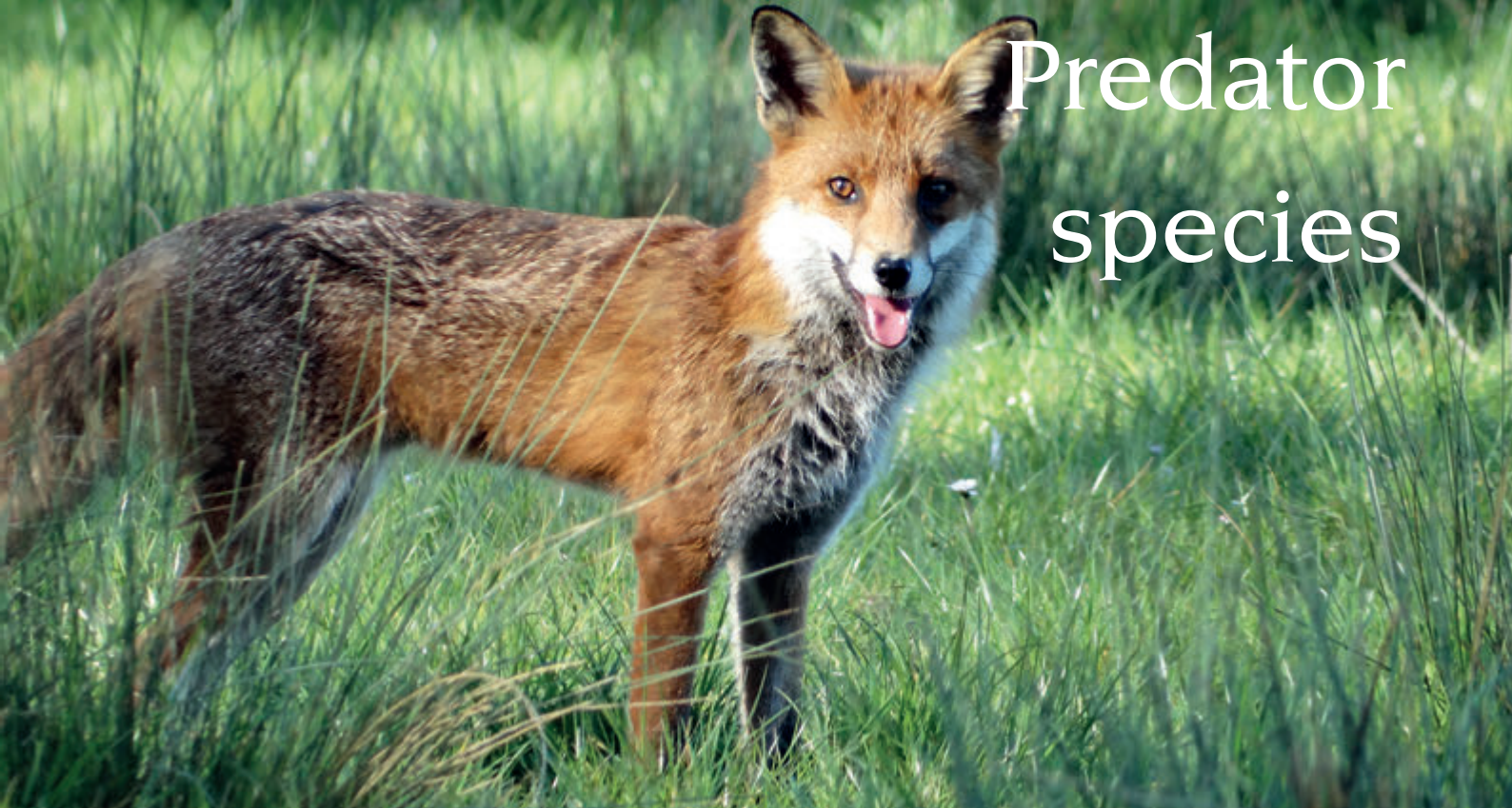
A total of 101 sites provided an estimate of deer fencing costs in the past five years. The average amount of money spent on deer fencing across these shoots was £9,627. One site reported the presence of Père David's deer.

Table 4

Information on deer presence and management from the 753 respondents who answered at least one question in 2019 pertaining to deer presence or management

Species	Present (% of total respondents)	Sporting interest	Culled	Total	Average annual cull
Red deer	176 (23.4%)	101 (57.4%)	104 (59.1%)	1-650	67
Roe deer	664 (88.2%)	352 (53.0%)	360 (54.2%)	1-350	28
Fallow deer	298 (39.6%)	185 (62.1%)	177 (59.4%)	1-350	41
Sika deer	58 (7.7%)	28 (48.3%)	32 (55.2%)	1-240	21
Muntjac deer	371 (49.3%)	222 (59.8%)	212 (57.1%)	1-250	29
Chinese water deer	45 (6%)	25 (55.6%)	21 (46.1%)	2-40	12

The percentages in the 'sporting interest' and 'culled' columns are out of the total number of responses recording the corresponding species as present i.e. for red deer this would be 176.



Predator species



© Peter Thompson



Predator control

Expenditure on predator control, entirely funded by individual shoots and scientifically proven to benefit a wide range of wildlife species, is a clear example of the private sector delivering public goods

More than 90% of respondents reported fox, rats, carrion crow, magpie and jackdaw present and over 80% reported rook, jay, grey squirrel, stoat – an indication of how common these species are (see Table 5). Nearly three quarters of respondents reported weasels present on their shoots, almost 50% reported American mink, just under 40% reported feral cats and a little over 10% reported grey crows. Overall, there was a significant difference between the presence of predators that are controlled to protect game in the 2019 survey compared with the one in 2011 ($\chi^2_{13} = 50.59, P < 0.001$). Respondents in the current survey were less likely to report the presence of American mink (50% in 2019 versus 56% in 2011, $\chi^2_1 = 5.66, P = 0.017$), stoats (84% in 2019 versus 89% in 2011, $\chi^2_1 = 12.70, P < 0.001$) and weasels (74% in 2019 versus 83% in 2011, $\chi^2_1 = 17.06, P < 0.001$) and more likely to report the presence of jackdaws (90% in 2019 versus 85% in 2011, $\chi^2_1 = 8.80, P = 0.003$).

More than 90% of respondents that have fox, grey squirrel, mink, rats, carrion crows and magpie on the ground they manage report culling these species, and more than 80% of those with feral cats, grey crows, jackdaw, jays and rooks cull them. Just under 80% of shoots reporting having stoats say they cull them and just over 70% reporting weasels cull them. Overall the percentage of respondents reporting culling predators that were present on their ground in 2019, differed from respondents reporting culling predators in the 2011 survey ($\chi^2_{13} = 37.97, P < 0.001$). Respondents in 2019 were less likely to report the culling of stoats (80% in 2019 versus 84% in 2011, $\chi^2_1 = 4.96, P = 0.026$) and weasels (74% in 2019 versus 80% in 2011, $\chi^2_1 =$

85% reported culling jackdaws in 2019 compared with 78% in 2011. © Peter Thompson



Table 5

Predators culled to protect game and wildlife (from 770 responses in 2019)

Species culled	Shoots where present	Shoots where culled (of those where present)
Fox	760 (98.7%)	732 (96.3%)
Grey squirrel	678 (88.1%)	665 (98.1%)
American mink	383 (49.7%)	358 (93.5%)
Brown rat	721 (93.6%)	697 (96.7%)
Stoat	643 (83.5%)	512 (79.6%)
Weasel	572 (74.3%)	422 (73.8%)
Feral cat*	296 (38.4%)	249 (84.1%)
Carrion crow	731 (94.9%)	697 (95.3%)
Hooded (grey) crow	92 (11.9%)	78 (84.8%)
Jackdaw	694 (90.1%)	588 (84.7%)
Jay	675 (87.7%)	550 (81.5%)
Magpie	722 (93.8%)	701 (97.1%)
Rook	685 (89.0%)	578 (84.4%)

*A feral cat is a domesticated cat that has returned to the wild. It is distinct from the Wild Cat (*Felis silvestris*), a different species found in the north of Scotland which is protected. It is also distinct from a stray cat, which is a pet cat that has been lost or abandoned. Some estimates put the UK Feral Cat population at between one and two million individuals.

6.19, $P = 0.013$) and more likely to report the culling of jackdaws (85% in 2019 versus 78% in 2011, $X^2_1 = 9.28$, $P = 0.002$) and rooks (84% in 2019 versus 78% in 2011, $X^2_1 = 9.68$, $P = 0.002$) when they have them.

Of those respondents that provided information on predator control, 682 specified the time spent on predator control, with an average 1,596 (\pm £153) man hours annually. 584 respondents gave details of the cost of their predator control, with on average £7,868 (\pm £1,525) spent per respondent. This expenditure on predator control, entirely funded by individual shoots and scientifically proven to benefit a wide range of wildlife species, is a clear example of the private sector delivering public goods. In total 740 respondents gave information on how predator control had changed over the last five years (see Figure 19), with half of these respondents indicating that this had remained stable, 39% reported that predator control had increased and 11% that it had decreased.

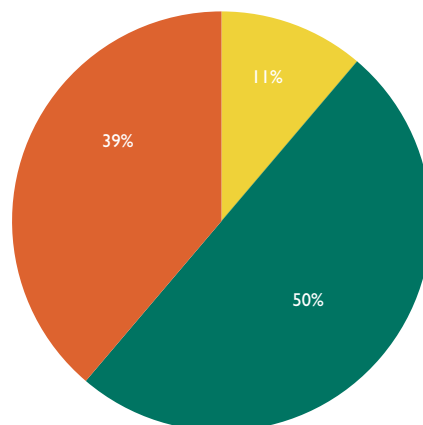


Figure 19

Respondents perception of the change in predator control over the five years ending in 2019, with half reporting that it remained stable, from a total of 740 respondents

- Decreased
- Increased
- Remained stable

84.8% reported culling hooded crows in 2019.
© Peter Thompson



Protected avian predators

Kestrels were found throughout the UK but had no reported effect on either game or ground-nesting birds. © Lindsay Waddell

The most common protected avian predators reported by the 716 gamekeepers that filled out this section were buzzard, sparrowhawk, kestrel, barn owl and tawny owl. Eagle owl, white-tailed sea eagle, golden eagle, marsh harrier and hen harrier were the least commonly sighted (see Table 6). There was a significant difference overall in the percentage of those reporting protected avian predators in 2019 compared with respondents in 2011 ($\chi^2_{19} = 162.79$, $P < 0.001$). A higher percentage of respondents reported goshawk (38% in 2019 versus 26% in 2011, $\chi^2_1 = 24.15$, $P < 0.001$), peregrine (54% in 2019 versus 49% in 2011, $\chi^2_1 = 5.20$, $P = 0.023$), white-tailed sea eagle (7% in 2019 versus 4% in 2011, $\chi^2_1 = 6.55$, $P = 0.010$), red kite (66% in 2019 versus 47% in 2011, $\chi^2_1 = 61.84$, $P < 0.001$), barn owl (87% in 2019 versus 83% in 2011, $\chi^2_1 = 5.85$, $P = 0.016$), short-eared owl (27% in 2019 versus 23% in 2011, $\chi^2_1 = 3.88$, $P = 0.049$) and raven (66% in 2019 versus 53% in 2011, $\chi^2_1 = 26.09$, $P < 0.001$) in 2019 than in 2011. The percentage reporting little owls (56% in 2019 versus 65% in 2011, $\chi^2_1 = 13.22$, $P < 0.001$) and cormorants (46% in 2019 versus 51% in 2011, $\chi^2_1 = 4.10$, $P = 0.043$) was lower in 2019 than in 2011. Where possible, we compared the changes in reports of presence on shooting estates with findings in the most recent Breeding Bird Survey (BBS 2018, Harris et al., 2019), covering the years 2012 to 2017. Our significant results differ from the BBS for two species; the BBS reported a (non-significant) 14% decline in peregrine abundance which contrasted with a significant perceived 5% increase in peregrine presence reported by gamekeepers. Additionally, the BBS found a 4% increase in cormorant numbers while comparisons between the two gamekeeper surveys suggests a significant 5% decrease. The significant 9% decline in reported little owl sightings between the two surveys is in line with the BBS results for this species (8% non-significant decline), as is the significant 19% increase in red kite presence (76% significant increase in the BBS), 4% increase



Barn owl, peregrine, buzzard and red kite.
© Lindsay Waddell/Peter Thompson

in barn owl presence (16% non-significant increase in the BBS), 13% increase in raven presence (13% non-significant increase in the BBS) and 9% decrease in little owl presence (8% non-significant decrease in BBS). We did not find a significant difference in the reported presence of buzzard (-1% between our surveys) but the BBS found a significant 10% increase in buzzard abundance. Additionally we did not find a significant change in sparrowhawk presence (3% decrease) compared with a significant 18% decline in sparrowhawk abundance in the BBS. The BBS found a non-significant increase in marsh harrier abundance (8% compared with our 2% increase) and a non-significant decrease in tawny owl numbers (10% compared with our 1%).

Table 6

Information on protected avian predators present on the land managed by a sample of 716 respondents in 2019

Protected predators	Breeding	Visitor	Shoots where present	Effect on game	Effect on ground-nesting birds
Kestrel	559 (78.1%)	144 (20.1%)	638 (89.1%)	45 (7.1%)	99 (15.7%)
Buzzard	674 (94.1%)	152 (21.2%)	688 (96.1%)	563 (81.6%)	512 (74.2%)
Sparrowhawk	617 (86.2%)	170 (23.7%)	661 (92.3%)	455 (68.9%)	471 (71.3%)
Goshawk	147 (20.5%)	172 (24.0%)	271 (37.8%)	242 (89.3%)	205 (28.6%)
Hen harrier	46 (6.4%)	145 (20.3%)	167 (23.3%)	92 (55.1%)	97 (13.5%)
Marsh harrier	22 (3.1%)	96 (13.4%)	104 (14.5%)	65 (62.5%)	64 (8.9%)
Montagu's harrier	0 (0%)	3 (0.4%)	3 (0.4%)	1 (33.3%)	1 (0.1%)
Peregrine	140 (19.6%)	308 (43.0%)	389 (54.3%)	182 (46.8%)	170 (23.7%)
Merlin	121 (16.9%)	116 (16.2%)	205 (28.6%)	9 (4.4%)	37 (5.2%)
Golden eagle	20 (2.8%)	36 (5.0%)	50 (7.0%)	24 (48.0%)	21 (2.9%)
White-tailed sea eagle	13 (1.8%)	40 (5.6%)	49 (6.8%)	19 (38.8%)	21 (2.9%)
Red kite	210 (29.3%)	344 (48.0%)	475 (66.3%)	191 (40.0%)	191 (40.0%)
Barn owl	616 (86.0%)	119 (16.6%)	624 (87.2%)	13 (2.1%)	24 (3.8%)
Tawny owl	632 (88.3%)	106 (14.8%)	620 (86.6%)	291 (46.9%)	209 (29.2%)
Little owl	388 (54.2%)	90 (12.6%)	402 (56.1%)	51 (12.7%)	46 (6.4%)
Short-eared owl	114 (15.9%)	115 (16.1%)	196 (27.4%)	45 (23.0%)	50 (7.0%)
Eagle owl	5 (0.7%)	13 (1.8%)	16 (2.2%)	5 (31.3%)	4 (0.6%)
Cormorant	118 (16.5%)	263 (36.7%)	330 (46.1%)	62 (18.8%)	82 (11.5%)
Goosander	98 (13.7%)	98 (13.7%)	168 (23.5%)	39 (23.2%)	42 (5.9%)
Raven	310 (43.3%)	241 (33.7%)	471 (65.8%)	277 (38.7%)	315 (44.0%)



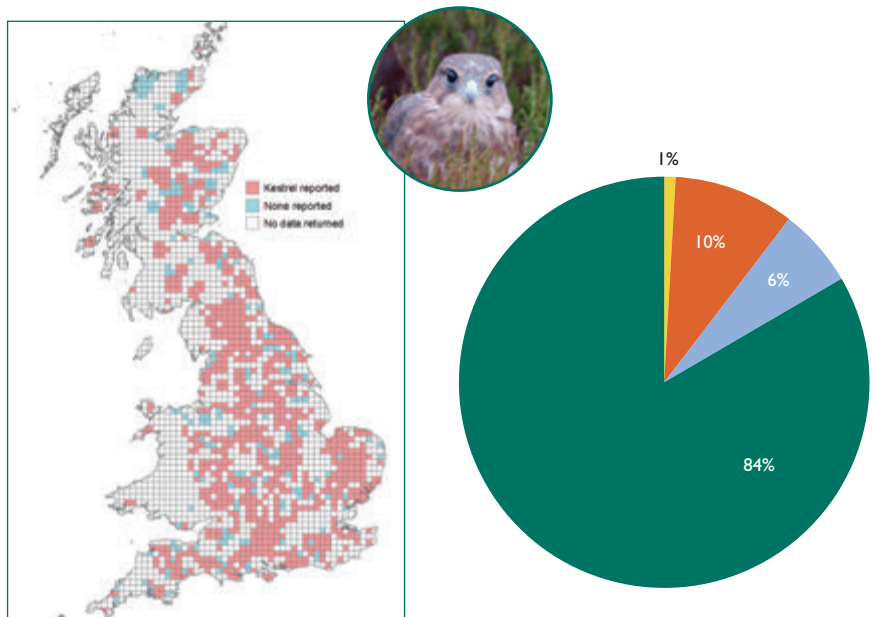
Cormorants were found on 46.1% of shoots.
© Peter Thompson

We compared the perception of the respondents in the two surveys in terms of whether these protected avian predators influenced game or ground-nesting birds (other wildlife in 2011). Overall the perceptions of the respondents of the effects on game differed between the two surveys ($\chi^2_{18} = 159.71, P < 0.001$). For kestrel, a smaller percentage of the respondents in 2019 reported a perceived effect on game (see Figure 20) than the respondents of the 2011 survey (7% in 2019 versus 12% in 2011, $\chi^2_1 = 10.74, P = 0.001$). The opposite was true for the perception of buzzard (82% in 2019, Figure 21, versus 76% in 2011, $\chi^2_1 = 7.17, P = 0.007$), goshawk (89% in 2019 versus 70% in 2011, $\chi^2_1 = 28.13, P < 0.001$), marsh harrier (63% in 2019, versus 8% in 2011, $\chi^2_1 = 73.09, P < 0.001$) and red kite (40% in 2019, Figure 22, versus 22% in 2011, $\chi^2_1 = 32.06, P < 0.001$), where respondents in 2019 perceived more of an effect on game than respondents did in 2011. We did a similar comparison of perception of effects of the protected predators on ground-nesting birds, omitting the comparison of the effect of cormorant and goosander on ground-nesting birds, where we found a significant difference between the two surveys overall ($\chi^2_{16} = 178.90, P < 0.001$). Again, for kestrel a smaller percentage of the respondents in 2019 reported a perceived effect on ground-nesting birds than the respondents of the 2011 survey did on other wildlife (16% in 2019 versus 22% in 2011, $\chi^2_1 = 8.66, P = 0.003$) and a similar response was seen for barn owl (4% in 2019, Figure 23, versus 8% in 2011, $\chi^2_1 = 8.94, P = 0.003$). The opposite was true for the perception of buzzard (74% in 2019 versus 63% in 2011, $\chi^2_1 = 22.63, P < 0.001$), goshawk (76% in 2019 versus 64% in 2011, $\chi^2_1 = 8.03, P = 0.005$), marsh harrier (62% in 2019 versus 7% in 2011, $\chi^2_1 = 73.79, P < 0.001$) and red kite (40% in 2019 versus 19% in 2011, $\chi^2_1 = 46.94, P < 0.001$). The respondents to both the 2011 and the 2019 surveys has similar perceptions regarding the effect of sparrowhawks on game (69% in 2019, Figure 24, versus 72% in 2011, $\chi^2_1 = 2.24, P = 0.135$) or wildlife (71% in both surveys, $\chi^2_1 = 0.01, P = 0.981$).

Figure 20

Kestrels were found throughout the UK and most gamekeepers who had them on the area they managed (n = 632) reported that they had no effect on either game or ground-nesting birds

- Effect on game only ■
- Effect on ground-nesting birds only ■
- Effect on game and ground-nesting birds ■
- No effect ■



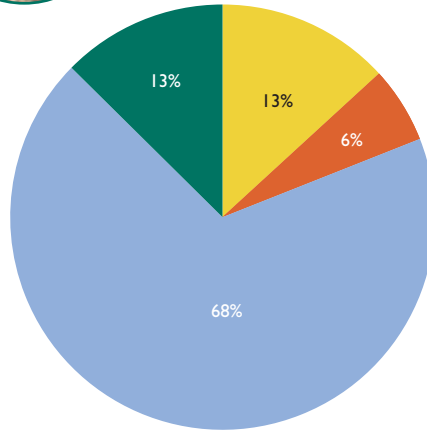
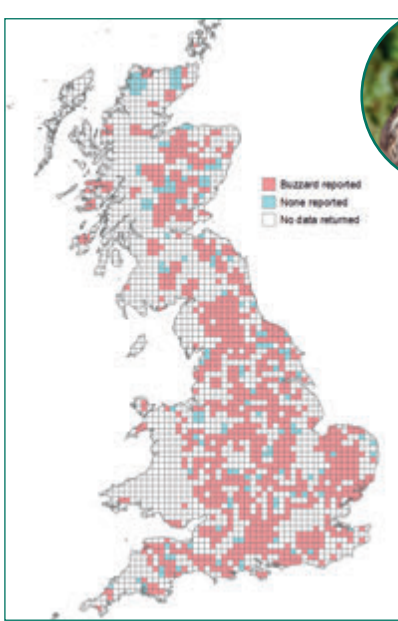


Figure 21

Most gamekeepers who reported buzzards on their land considered that they had a negative effect on both game and ground-nesting birds. Buzzards were reported as being present across the UK

- Effect on game only
- Effect on ground-nesting birds only
- Effect on game and ground-nesting birds
- No effect

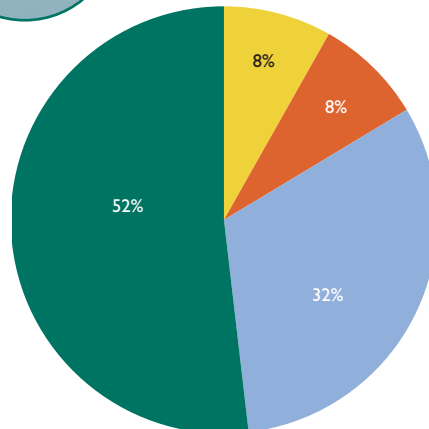
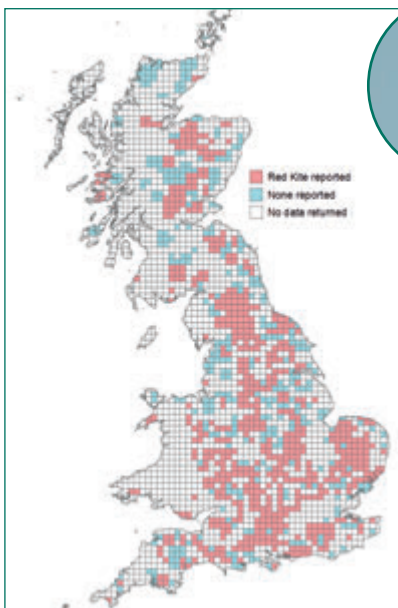


Figure 22

Red kites have spread and were reported on gamekeeper land throughout the UK. Most gamekeepers feel that they have no effect on game or ground-nesting birds

- Effect on game only
- Effect on ground-nesting birds only
- Effect on game and ground-nesting birds
- No effect

*Buzzards were considered to have a negative effect on both game and ground-nesting birds.
© Dave Kjaer*



Figure 23

Barn owls were also reported throughout most of the area managed by gamekeepers, with most gamekeepers reporting that they had no effect on game or ground-nesting birds

- Effect on game only ■
- Effect on ground-nesting birds only ■
- Effect on game and ground-nesting birds ■
- No effect ■

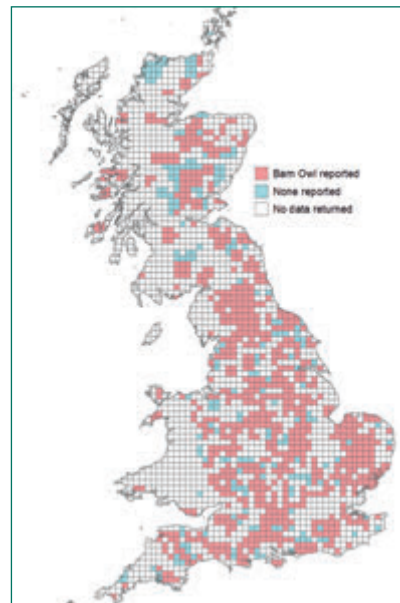
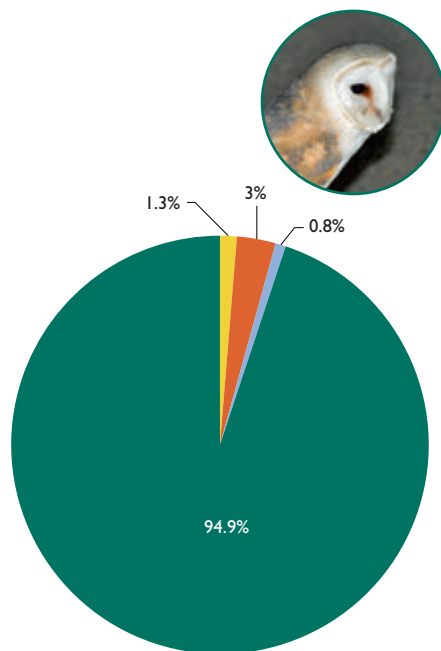
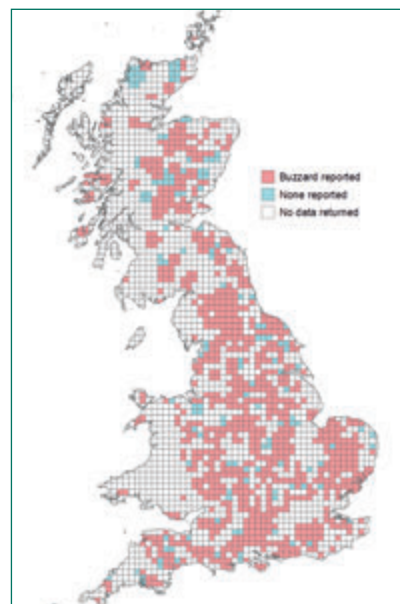
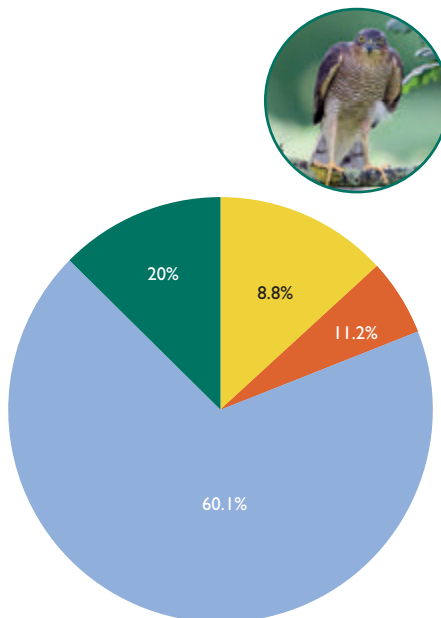


Figure 24

Sparrowhawks were reported as being present on the land they manage by most gamekeepers, with most of those gamekeepers with sparrowhawks reporting a negative effect of them on both game and ground-nesting birds

- Effect on game only ■
- Effect on ground-nesting birds only ■
- Effect on game and ground-nesting birds ■
- No effect ■



(L-R) A gamekeeper ringing barn owl chicks which enable the individuals to be followed throughout their lifetime; red kites were perceived to have more of an effect on game in 2019 than in 2011. © Ian Sleight/Dave Kjaer





Protected mammalian predators

The most commonly reported protected mammal was badger, followed by hedgehog, otter, polecat and pine marten (see Table 7). Comparing the presence in 2019 with that in 2011, there was an overall difference ($\chi^2_5 = 40.74$, $P < 0.001$). Compared to the 2011 survey, a higher percentage of respondents from the 2019 survey reported the presence of otter (91% in 2019 versus 89% in 2011, $\chi^2_1 = 14.85$, $P < 0.001$), pine marten (10% in 2019 versus 6% in 2011, $\chi^2_1 = 6.24$, $P = 0.012$) and polecat (36% in 2019 versus 27% in 2011, $\chi^2_1 = 17.51$, $P = < 0.001$). Nearly 70% of respondents with badgers on their ground thought that they had an adverse effect on game (see Figure 25). Of the respondents reporting the presence of each species, over 70% thought that pine martin and polecat negatively affected game. Over 50% of respondents with otters felt that they negatively affected wild fish stocks. A little over a fifth of

Badgers were found throughout the UK and were considered to have a negative effect on both game and ground-nesting birds. © Peter Thompson

Table 7

Information on the presence of protected mammalian predators from the 744 respondents in 2019

Protected mammalian predator	Present	Effect on game or wild fish stocks	Effect on ground-nesting birds/songbirds
Badger	679 (91.3%)	474 (69.8%)	566 (83.4%)
Otter	337 (45.3%)	180 (53.4%)	145 (35.9%)
Pine marten	72 (9.7%)	53 (73.6%)	59 (81.9%)
Polecat	270 (36.3%)	190 (70.4%)	206 (76.3%)
Hedgehog	595 (80.0%)	125 (21.0%)	237 (78.6%)



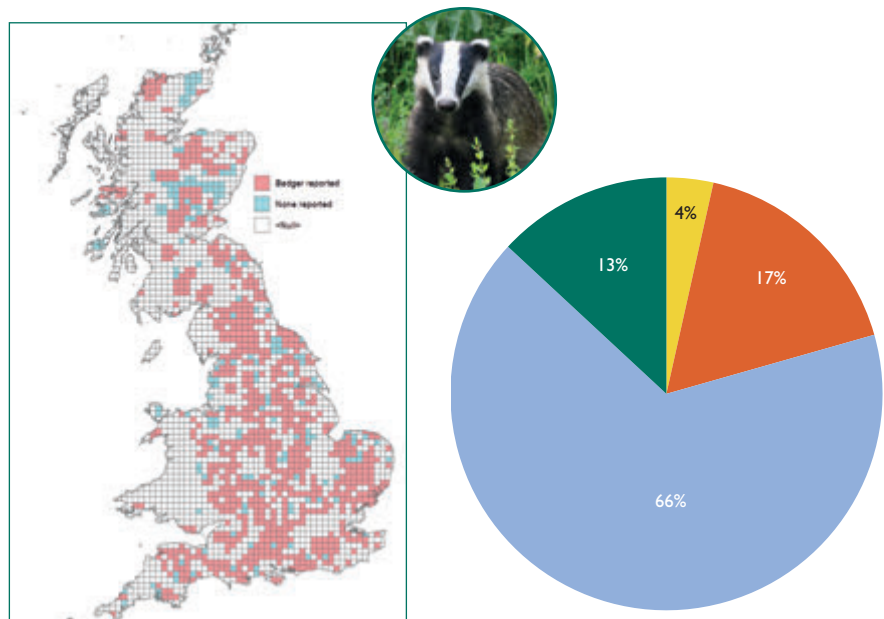
It was felt that otters negatively affected wild fish stocks. © Peter Thompson

respondents with hedgehogs thought that they negatively affected game. Comparing survey respondents' perceptions of an effect on game in 2019 to those in the 2011 survey, there was an overall difference ($\chi^2_5 = 133.34, P < 0.001$). A lower proportion of respondents from the current survey considered that badger (70% in 2019 versus 75% in 2011, $\chi^2_1 = 4.38, P = 0.036$), polecat (70% in 2019 versus 83% in 2011, $\chi^2_1 = 10.58, P = 0.001$) and hedgehog (21% in 2019 versus 48% in 2011, $\chi^2_1 = 102.42, P < 0.001$) had an effect on game, while more thought that otter had a negative effect on wild fish stocks (53% in 2019 versus 38% in 2011, $\chi^2_1 = 15.81, P < 0.001$). Over 80% of respondents thought that badgers and pine marten adversely affected ground-nesting birds, with over 75% of respondents thinking the same for polecat and hedgehog. Comparing the results for this survey to those in 2011, there was an overall difference in the perception of respondents on effects on ground-nesting birds/wildlife of protected mammalian predators ($\chi^2_5 = 27.67, P < 0.001$). Considering the effects of the individual species the only significant differences was for badger, where a higher percentage of respondents in the current survey thought that badger (83% in 2019 versus 72% in 2011, $\chi^2_1 = 25.15, P < 0.001$) had an adverse effect on ground-nesting birds/wildlife.

Figure 25

Badgers were reported across the mainland of the UK, with most gamekeepers who had them on the land they manage reporting that they consider they have a negative effect on both game and ground-nesting birds

- Effect on game only ■
- Effect on ground-nesting birds only ■
- Effect on game and ground-nesting birds ■
- No effect ■





Rare & charismatic species

1 in 4

reported red
squirrels and half
had water voles and
harvest mice on
their land



© Laurie Campbell

Rare and charismatic species



40% of respondents had harvest mice on their land. Harvest mice are protected in the UK under the Wildlife and Countryside Act, 1981. © Dave Kjaer

Half of the 504 who responded to questions about rare and charismatic species reported the presence of water vole and harvest mice

Half of the 504 who responded to questions about rare and charismatic species reported the presence of water vole and harvest mice on the land that they manage, and nearly a quarter reported red squirrel (see Table 8). Dormouse were commonly reported with two-fifths of the 504 respondents stating that they had this species on their land. Beyond this, there were a variety of other rare and charismatic species reported by the respondents. Comparing the results from this survey to the one in 2011 there were only two species where this was possible, red squirrel and water vole, but there was a significant difference overall, ($X^2_2 = 76.27, P < 0.001$). More respondents reported red squirrel (24% in 2019 versus 14% in 2011, $X^2_1 = 21.25, P < 0.001$) and water vole (50% in 2019 versus 30% in 2011, $X^2_1 = 55.02, P < 0.001$) in 2019 than in 2011.



The water vole is under serious threat from habitat loss and predation by the non-native American mink but 50% of respondents reported seeing them in 2019 compared with 30% in 2011. © Peter Thompson

Table 8

504 respondents in 2019 that answered at least one question pertaining to rare and charismatic mammal species present on the land that they manage

Rare and charismatic species	Shoots where present (%)	Increased presence (%)*	Stable presence (%)*	Decreased presence (%)*
Red squirrel	122 (24.2%)	36 (29.5%)	51 (41.8%)	42 (34.4%)
Water vole	254 (50.3%)	20 (7.9%)	121 (47.6%)	98 (38.6%)
Common dormouse	216 (42.8%)	16 (7.4%)	117 (54.2%)	71 (32.9%)
Harvest mouse	256 (50.7%)	28 (10.9%)	145 (56.4%)	71 (27.7%)
Other**	13 (2.6%)	-	-	1 (7.7%)

*Of those reporting presence. **Adder, common shrew, shrew, common frogs, grass snake, great crested newt, short-tailed vole, slow worm, common toad, wild cat, wood mouse – note only one respondent told us about change, ie. perception of decrease of common toad.

Table 9

Information on exotic species from a sample of 155 respondents in 2019 who answered at least one question pertaining to exotic species

Exotic species	Shoots where present	Increased presence (%)*	Stable presence (%)*	Decreased presence (%)*
Egyptian goose	104 (67.1%)	58 (57.4%)	38 (37.6%)	5 (5.0%)
Ring-necked parakeet	20 (12.9%)	17 (77.3%)	4 (18.2%)	1 (4.5%)
Wild boar	14 (9.0%)	6 (46.2%)	4 (30.8%)	3 (23.1%)
Edible dormouse	9 (5.8%)	3 (33.3%)	4 (44.4%)	2 (22.2%)
European beaver	4 (2.6%)	4 (100%)	0 (0.00%)	0 (0.0%)

*Of those reporting presence.

The most commonly reported exotic species was Egyptian goose (reported by two-thirds of those that responded to this portion of the questionnaire), followed by ring-necked parakeet, wild boar, edible dormouse and European beaver (see Table 9). There was a significant difference overall between the respondents in 2019 compared with the respondents in 2011 in the reported presence of the three exotic species (wild boar, edible dormouse and parakeets) where comparisons were possible ($\chi^2_3 = 30.39$, $P < 0.001$). In all cases the percentage of respondents reporting species in 2019 was higher than those in 2011 (wild boar, 9% in 2019 versus 2% in 2011, $\chi^2_1 = 8.41$, $P = 0.004$; edible dormouse, 6% in 2019 versus 1% in 2011, $\chi^2_1 = 6.75$, $P = 0.009$ and parakeet, 13% in 2019 versus 3% in 2011, $\chi^2_1 = 15.22$, $P < 0.001$).



The Egyptian goose was the most commonly reported exotic species. © Dave Kjaer



Lapwing were commonly reported, along with song thrush, starling and skylark. © Peter Thompson

Other rare and charismatic birds

A total of 721 respondents answered this section. A species was considered present if respondents reported them either breeding or visiting. The most commonly reported rare and charismatic birds were song thrush, starling, lapwing and skylark (see Table 10). The species least reported amongst the 721 respondents were whinchat, avocet, bittern and stone curlew. The proportion reporting a species presence in the current survey were compared with those of the 2011 survey, and overall there was a significant difference ($\chi^2_{16} = 36.29$, $P = 0.002$). There were only four significant differences: a smaller percentage of respondents in the current survey reported bittern present, compared to respondents in 2011 (5% in 2019 versus 8% in 2011, $\chi^2_1 = 4.27$, $P = 0.039$) while a higher percentage reported the presence of avocet (5% in 2019 versus 3% in 2011, $\chi^2_1 = 4.50$, $P = 0.034$), oystercatcher (40% in 2019 versus 31% in 2011, $\chi^2_1 = 8.71$, $P = 0.003$); and ring ouzel (15% in 2019 versus 10% in 2011, $\chi^2_1 = 4.30$, $P = 0.038$).

The respondents were also asked about their perceptions of how the presence of these species had changed over the last five years. For all rare and charismatic species there were none where most respondents indicated that these species were increasing. For five species (highlighted in white in Table 10) more respondents reported they were declining than stable, with smaller numbers reporting increases. These were cuckoo, curlew, lapwing, stone curlew and turtle dove. For the remaining species in Table 10, more respondents reported them as stable, and only in the case of avocet was the percentage of respondents reporting increases higher than the percentage reporting decreases (note this is also a species where a significantly higher percentage of respondents reported its presence in 2019 compared with 2011). The general feeling is that the respondents have a very negative opinion of how the numbers of these species are changing, even though the results from the reported presence do not bear that out.

The negative perceptions of respondents to this survey regarding most of the species in Table 10 is not shared by the results from the 2018 Breeding Bird Survey, when considering changes from 2012 to 2017. The BBS reported significant increases in the abundance of cuckoo, skylark and song thrush over this time, with non-significant increases in the abundance of corn bunting, golden plover, lapwing and ring ouzel. Our respondents have a contrasting negative view (either through the reporting of the presence of a species, or the perception of change), particularly for cuckoo and lapwing. The BBS found significant short term (2012-2017) declines in numbers of oystercatcher, wheatear and yellowhammer and nonsignificant declines for curlew,

Table 10

Other rare and charismatic birds present on the ground managed by 721 respondents in 2019

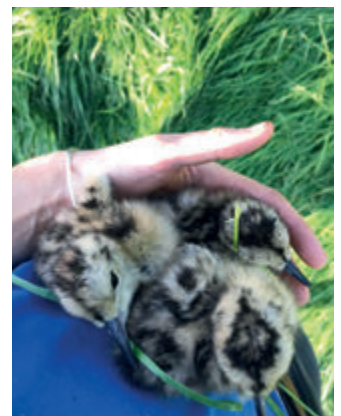
Rare and charismatic species	Present (%)	Increase (%)*	Stable numbers (%)*	Decrease (%)*
Avocet	34 (4.7%)	5 (20.8%)	15 (62.5%)	4 (16.7%)
Bittern	36 (5.0%)	3 (10.3%)	17 (58.6%)	9 (31.0%)
Corn bunting	107 (14.8%)	19 (20.9%)	39 (42.9%)	33 (36.3%)
Cuckoo	547 (75.9%)	37 (7.6%)	213 (43.6%)	239 (48.9%)
Curlew	351 (48.7%)	58 (17.8%)	110 (33.8%)	157 (48.3%)
Golden plover	343 (47.6%)	39 (13.1%)	144 (48.5%)	114 (38.4%)
House sparrow	571 (79.2%)	116 (21.8%)	252 (47.5%)	163 (30.7%)
Lapwing	594 (82.4%)	91 (16.9%)	181 (33.6%)	267 (49.5%)
Oystercatcher	291 (40.4%)	51 (19.1%)	138 (51.7%)	78 (29.2%)
Ring ouzel	108 (15.0%)	12 (13.8%)	48 (55.2%)	27 (31.0%)
Skylark	563 (78.1%)	109 (20.8%)	269 (51.3%)	146 (27.9%)
Song thrush	609 (84.5%)	73 (13.1%)	287 (51.6%)	196 (35.3%)
Starling	604 (83.8%)	145 (26.6%)	239 (43.9%)	161 (29.5%)
Stone curlew	57 (7.9%)	4 (9.1%)	17 (38.6%)	23 (52.3%)
Tree sparrow	394 (54.6%)	45 (12.3%)	206 (56.3%)	115 (31.4%)
Turtle dove	200 (27.7%)	24 (13.75%)	65 (37.1%)	86 (49.1%)
Wheatear	229 (31.8%)	21 (10.3%)	128 (63.1%)	54 (26.6%)
Whinchat	18 (2.5%)	3 (21.4%)	7 (50.0%)	4 (28.6%)
Yellowhammer	481 (66.7%)	105 (24.2%)	212 (48.8%)	177 (27.0%)

*Of those reporting presence.

house sparrow, starling and tree sparrow. Our respondents appear more positive in the cases of oystercatcher and yellowhammer where they indicated presence had increased for oystercatcher and remained the same for yellowhammer (no comparison was possible for wheatear as it was not surveyed in 2011).

This contrast may be due to several factors. Firstly, it is important to remember that unlike the BBS, the findings from this survey are based upon the perceptions of the participating gamekeepers and not on any standardised surveying methodology. As such it may be reasonable to suggest that the opinions of the respondents have been influenced by media publication of the long-term decline of these species, and that their perceptions may reflect the long-term BBS trends rather than the short-term ones. In reference to yellowhammer, it is conceivable that management practice conducted by gamekeepers on their ground, such as supplementary feeding and game cover, may be more readily attracting this species to their land despite overall declines.

(L-R) Gamekeeper, Tim Lowry ringing stone curlew with the RSPB in Wiltshire; respondents often had a negative perception of how birds were faring, which might be influenced by media publication of the long-term decline of these species – oystercatcher, avocet and curlew chicks.



© Peter Thompson/Ian Sleightholm/Tim Weston



Helping threatened curlew in Yorkshire

Ian Sleightholm is head keeper at Bolton Castle Estate in Wensleydale, North Yorkshire.

Ian and his underkeeper Daniel Place, work with the estate team, comprising Tom Orde-Powlett the son of Lord and Lady Bolton, to ensure that curlew thrive on their estate. **Conservation efforts have been hugely successful** and by providing a safe haven for curlew, numbers have soared by up to 1,000 overwintering birds.

Ian, said: **“Helping curlew is our number one conservation task on the estate.** We have studied curlew closely on our managed moorland areas and estimate that we have 170-220 pairs of breeding curlews.

“We work with a range of partners including the RSPB, colour-ringing adults and chicks to keep track of them, the furthest afield being Roscarbery in County Cork. We have also been working on a trial with the **British Trust for Ornithology (BTO)** which included nest monitoring and developing a new method of surveying called ‘Trapline Surveys’. This is showing really positive results and helps to identify areas where our curlew conservation practices are working.”

Bolton Castle was singled out for the BTO study because it was already carrying out extensive conservation work for curlews. **Ian and his team also work with Natural England on hen harrier brood management, monitoring merlin numbers for the BTO and a forthcoming extensive programme of grip-blocking to help re-wet the moors.**

Engaging with the public





Engaging with the public

The National Gamekeepers' Organisation regularly runs events and training.
© Jon Farmer

The types of public engagements that gamekeepers are involved in can be divided into two groups – those more traditional ones involving face-to-face or in-print interactions and those that fall into the use of 'Social Media' and online content (see Table 11). Of those who responded, nearly a third provided shoot walks or open days, with a quarter running education tours and a fifth having participated in a speaking event held away from their shoot. Although not many of the respondents said they undertook Open Farm Sundays, those who did were involved in an average of 40 over the past five years, while those who had participated in photographic or education tours, shoot walks or off-shoot speaking events had been engaged in 19 to 25 of these over the past five years. Ten percent or fewer respondents told us that they had been involved



Events are an important way of educating future generations. © NGO

Table 11

Of the 953 respondents in 2019, 358 answered at least one question regarding their public engagement activities, with details given on the number of these over the last five years

Activity	Undertaken (%)	Range	Average undertaken
Wildlife tours	52 (15%)	1-100	12.5
Photographic tours	26 (7%)	1-200	19.5
Education tours	86 (24%)	1-825	25
Shoot walk/open day	110 (31%)	1-1000	19
Open Farm Sunday	31 (9%)	1-500	40
Speaking event off shoot	71 (20%)	1-1000	20.5
Mainstream press interview	30 (8%)	1 to 30	4
Written mainstream press article	24 (7%)	1 to 50	6
Shooting press interview	35 (10%)	1 to 24	4
Personally, written shooting press article	36 (10%)	1 to 60	9
Online blog/article	20 (6%)	1-150	31
Facebook	172 (48%)	N/A	N/A
Twitter	32 (9%)	N/A	N/A
Instagram	68 (19%)	N/A	N/A

Table 12

Types of green energy schemes reported by the 203 who gave details of their schemes
(several respondents reported more than one)

Schemes reported	Number reported (%)
Anaerobic digestion plant	7 (3.4%)
Biomass (miscanthus, willow, etc.)	59 (29.1%)
Chip/pellet boiler	12 (5.9%)
Ground source heating	6 (3.0%)
Hydro scheme	25 (12.3%)
Solar (panels and fields)	72 (35.5%)
Water wheel	1 (0.5%)
Wind farm	35 (17.2%)
Wind turbine	5 (2.5%)

** 'Anaerobic digestion plant' includes the following responses from the number of participants as indicated in parentheses – 'Anaerobic digestion plant' (6) and 'Bio plant' (1).

in press related public engagement, including interviews, or writing these articles themselves – this included online blogs or articles. However, nearly half said that they used Facebook, which may indicate a possible means of disseminating information quickly to those involved in gamekeeping in the future. Other reported activities included creating Youtube content, featuring in a game cookbook, hosting dog training, hosting bird-watching events, and RSPB ringing on-site. Six hundred and ninety-five respondents filled in the section on tick management activities, with 98 reporting that they carry out tick management. Sixty-two of these 98 informed us of how many hours they spend annually on tick management, which ranged from one to 4,500 hours (72 hours on average). Of the 98 respondents that carry out tick management, 91 informed us of the presence of deer on-site in the Quarry Species section. Of these 98, 66 (67%) also had a shooting interest in deer.

A total of 688 responded to the question regarding investment in green energy schemes on the ground that they managed, with 30.7% reporting such investment. Solar energy schemes and biomass were the most commonly reported schemes (see Table 12), with over a third of those responding reporting these on their shoots and nearly 30% reporting biomass on their ground. Wind farms were found on 17% of the shoots that responded to this section.



National events such as Countryfile Live provide the opportunity to promote the benefits of game to the wider public. © Jon Farmer

References

- Aebischer, N.J. 2019. Fifty-year trends in UK 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. doi: 10.1007/s10344-019-1299-x.
- Balmer, D. E., Gillings, S., Caffrey, B. J., Swann, R. L., Downie, I. S., & Fuller, R. J. 2013. *Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland*. BTO Books, Thetford.
- Brewin, J. & Dimbleby, J. 2018. *The Knowledge: Every Gun's guide to conservation*. Game & Wildlife Conservation Trading Ltd. Burgate Manor, Fording-bridge SP6 1EF.
- Brewin, J. 2019. *The Moorland Balance: The science behind grouse shooting and moorland management*. Edited by Dave Baines, Joe Dimbleby, Nick Hesford, Sonja Ludwig, David Newborn, Jonathan Reynolds, Adam Smith and Sian Whitehead.
- Buchanan, G.M., Grant, M.C., Sanderson, R.A. & Pearce-Higgins, J.W. 2006. The contribution of invertebrate taxa to moorland bird diets and the potential implications of land-use management. *Ibis*, **148**: 615-628.
- Capstick, L.A., Sage, R.B., & Hoodless, A. 2019. Ground flora recovery in disused pheasant pens is limited and affected by pheasant release density. *Biological Conservation*, **231**: 181-188. doi: 10.1016/j.biocon.2018.12.020.
- Chesterton, C. 2009. Environmental impacts of land management. *Natural England Research Report NERRO30*.
- Coulson, J.C., Butterfield, J.E.L. & Henderson, E. 1990. The effect of open drainage ditches on the plant and invertebrate communities of moorland and on the decomposition of peat. *Journal of Applied Ecology*, **27**: 549-561.
- Draycott, R.A.H., Hoodless, A.N., Ludiman, M.N., & Robertson, P.A. 1998. Effects of spring feeding on body condition of captive-reared ring-necked pheasants in Great Britain. *Journal of Wildlife Management*, **62**: 557-563.
- Draycott, R.A.H., Parish, D.M.B., Woodburn, M.I.A., & Carroll, J.P. 2002. Spring body condition of hen pheasants *Phasianus colchicus* in Great Britain. *Wildlife Biology*, **8**: 261-266.
- Draycott, R.A.H., Woodburn, M.I.A., Carroll, J.P., & Sage, R.B. 2005. Effects of spring supplementary feeding on population density and breeding success of released pheasants *Phasianus colchicus* in Britain. *Wildlife Biology*, **11**: 177-182.
- Draycott, R.A.H., Hoodless, A.N., & Sage, R.B. 2008. Effects of pheasant management on vegetation and birds in lowland woodlands. *Journal of Applied Ecology*, **45**: 334-341.
- Forestry Commission. 2017. <https://www.forestryresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/>.
- Harris, S.J., Massimino, D., Eaton, M.A., Gillings, S., Noble, D.G., Balmer, D.E., Pearce-Higgins, J.W. & Woodcock, P. 2019. *The Breeding Bird Survey 2018*. BTO Research Report 717. British Trust for Ornithology, Thetford.
- Holden, J. 2004. Artificial drainage of peatlands: hydrological and hydrochemical process and wetland restoration. *Progress in Physical Geography*, **28**: 95-123.
- Hoodless, A.N., Draycott, R.A.H., Ludiman, M.N., & Robertson, P.A. 1999. Effects of supplementary feeding on territoriality, breeding success and survival of pheasants. *Journal of Applied Ecology*, **36**: 147-156.
- Joint Nature Conservation Committee (JNCC) 2019. <https://jncc.gov.uk/our-work/uk-biodiversity-indicators-2019/>. Assessed 10/10/2019.
- Laloy, E., & Bielders, C. L. 2010. Effect of intercropping period management on runoff and erosion in a maize cropping system. *J. Environ. Qual.* **39**: 1001-1008. doi: 10.2134/jeq2009.0239.
- LIFE active blanket bog in Wales project. 2006. http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=Blanket_bogs_Grip_Blocking.pdf.
- Miller, G.R. 1980. The burning of heather moorland for red grouse. *Bulletin of Ecology*, **11**: 725-733.
- National Parks UK. 2016. <https://nationalparks.uk/about-us>.
- Neumann, J.L., Holloway, G.J., Sage, R.B., & Hoodless, A.N. 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., Leader-Williams, N. 2003. Field sports and conservation in the United Kingdom. *Nature*, **423**: 531-533.
- Robertson, P.A., Woodburn, M.I.A., & Hill, D.A. 1988. The effects of woodland management for pheasants on the abundance of butterflies in Dorset, England. *Biological Conservation*, **45**: 159-167.
- Rowland, C., Morton, D., Carrasco Tornero, L., McShane, G., O'Neil, A., Wood, C. 2017. Land Cover Map 2015 (vector; GB). NERC Environmental Information Data Centre 12 April 2017, <https://doi.org/10.5285/6c6c9203-7333-4d96-88ab-78925e7a4e73> [Output (Electronic)].
- Sánchez-García, C., Buner, F.D., & Aebischer, N.J. 2015. Supplementary winter food for gamebirds through feeders: which species actually benefit? *Journal of Wildlife Management*, **79**: 832-845.
- Siriwardena, G.M., Calbrade, N.A. & Vickery, J.A. 2008. Farmland birds and late winter food: does seed supply fail to meet demand? *Ibis*, 585-595.
- Sage, R.B., Ludolf, I.C., & Robertson, P.A. 2005. The ground flora of ancient semi-natural woodlands in pheasant release pens in England. *Biological Conservation*, **122**: 243-252.
- Sim, I. M. W., Eaton, M. A., Setchfield, R. P., Warren, P. K., & Lindley, P. 2008. Abundance of male black grouse *Tetrao tetrix* in Britain in 2005 and change since 1995-96. *Bird Study* **55**: 304-313.
- Siriwardena, G., Danaë K. Stevens, Guy Q. A. Anderson, Vickery, J., Calbrade, N., & Dodd, S. 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.
- Stoate, C., Szczyr, J., & Aebischer, N.J. 2003. Winter use of wild bird cover crops by passerines on farmland in northeast England. *Bird Study*, **50**: 15-21.
- Stoate, C., Henderson, I.G., & Parish, D.M.B. 2004. Development of an agri-environment scheme option: seed-bearing crops for farmland birds. *Ibis*, 146 Supplement **2**: 203-209.
- The Code of Good Shooting Practice. <http://www.codeofgoodshootingpractice.org.uk/>
- The National Gamekeepers' Organisation (NGO), 2019. <https://www.nationalgamekeepers.org.uk/about-gamekeeping>.
- Thompson, D.B., MacDonald, A.J., Marsden, J.H. & Galbraith, C. 1995. Upland heather moorland in Great Britain: a review of international importance, vegetation change and some objectives for nature conservation. *Biological Conservation*, **71**: 163-178.
- Werritty, A., Pakeman, R.J., Shedden, C., Smith, A., and Wilson, J.D. 2015. *A Review of Sustainable Moorland Management*. Report to the Scientific Advisory Committee of Scottish Natural Heritage. SNH, Battleby.
- Wilkinson, N. I., Eaton, M. A., Marshall, G., & Haysom, S. 2018. The population status of capercaillie *Tetrao urogallus* in Scotland during winter 2015-16. *Bird study*, **65**, 20-35.
- Woodward, I., Aebischer, N., Burnell, D., Eaton, M., Frost, T., Hall, C., Stroud, D.A. & Noble, D. (2020). Population estimates of birds in Great Britain and the United Kingdom. *British Birds*, **113**: 69-104.

Appendices

Statistical analysis

Comparisons between the number of respondents reporting activities between the two surveys (this one and the one undertaken in 2011) were done using chi-square analysis. First an overall test was undertaken that compared the number of respondents across all categories. If a significant effect was found overall, then the number of respondents reporting activities on different types of shoots were compared, for example lowland shoots in 2011 were compared to lowland shoots in 2019. A similar approach was used when comparing categories of management, the presence of quarry species, the sporting interest in these quarry species and the presence of protected or rare species both within the 2019 survey and between the two surveys.

An appropriate generalised linear model (GLM) was used to compare gamekeeper numbers, feeder numbers (GLM with poisson error, log link), gamekeeper density, feeder density (ln-transformed data, GLM with normal error, identity link), or the amounts of habitat management (percentage of heather rotationally burned, logit-transformed, GLM with normal error, identity link). Average and standard errors are provided where appropriate as a measure of variation, except in case of the data analysed using transformations, where the back-transformed means and 95% confidence intervals were reported.

Respondents' details

A total of 965 responses were received, with 923 (96%) from active gamekeepers, 15 (2%) from retired gamekeepers and 27 (3%) from respondents who did not indicate what their gamekeeper status was. Of these 887 gave the location of their shoot, with 736 (83%) in England, 125 (14.1%) in Scotland, 24 (2.7%) in Wales and 1 (0.1%) in Northern Ireland. Nearly half of gamekeepers returning the survey were in full-time employment, a third were amateurs and a sixth part-time (Appendix, Figure 1). This did not differ to the employment status reported by respondents in the 2011 questionnaire ($\chi^2_2 = 2.03, P = 0.363$).

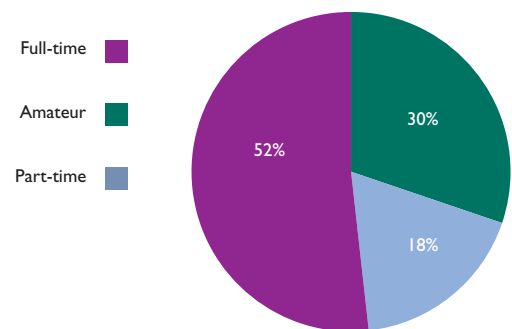
We asked the respondents to specify the number of full-time, part-time and amateur keepers on the shoot they managed, in addition to themselves. According to the respondents returning

the questionnaire there were a total of 2003 gamekeepers on the shoots covered by the survey. This included 605 amateur gamekeepers, 361 part-time gamekeepers and 1,037 full-time gamekeepers (Appendix, Figure 2). These figures differed significantly from the 2011 survey ($\chi^2_2 = 121.88, P < 0.001$), where there were a smaller proportion of amateur keepers reported (19%) and a larger proportion of part-time gamekeepers (32%), but a similar proportion of full-time keepers.

A total of 917 of the 965 respondents (95% of respondents) specified the size of the shoot that they manage. Small shoots (19% of those who gave an area) were up to 250ha, medium shoots (38%) were between 250 and 1000ha and large shoots (43%) were above 1,000ha (Appendix, Figure 3).

Appendix Figure 2

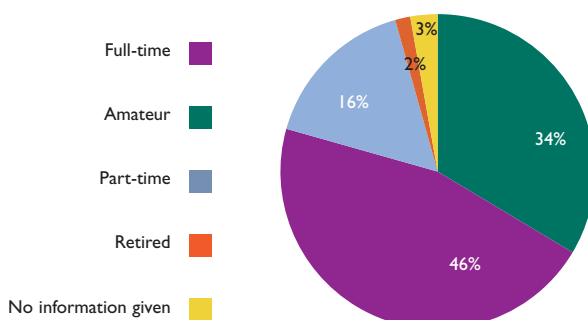
Employment status of the 2003 gamekeepers on the 923 estates covered by the respondents in 2019



The distribution of the size of shoots responding to this survey differed to the one in 2011 ($\chi^2_2 = 16.68, P < 0.001$), with a higher proportion of large shoots in the current survey (34% of the sample were large shoots in 2011), a slightly smaller proportion of medium shoots (41% of the sample were medium shoots in 2011) and a much smaller proportion of small shoots (25% of the sample was from small shoots in 2011). Large shoots varied from 1,000 to over 42,000ha in size, with 21 shoots covering more than 10,000ha.

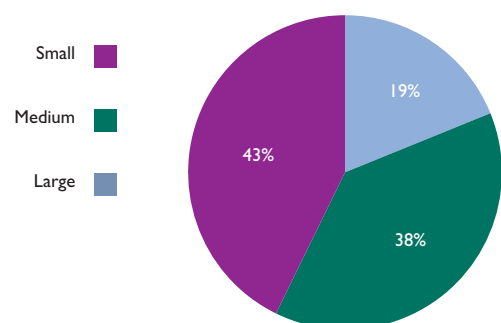
Appendix Figure 1

The employment status of the 965 respondents filling in the questionnaire in 2019



Appendix Figure 3

Size of the 917 shoots covered by the questionnaire returns in 2019



Not surprisingly, shoots of different sizes employed different types of gamekeeper (Appendix, Figure 4). Full-time keepers were more common on large shoots (deviance ratio₂ = 228.43, P < 0.001), with medium shoots having more than small shoots but less than large ones (P < 0.05). Small shoots reported more amateur keepers (deviance ratio₂ = 50.66, P < 0.001), again with fewer on medium-sized shoots and fewer still on large shoots (P < 0.05). There was no difference between shoots in the number of part-time keepers (deviance ratio₂ = 2.93, P = 0.054).

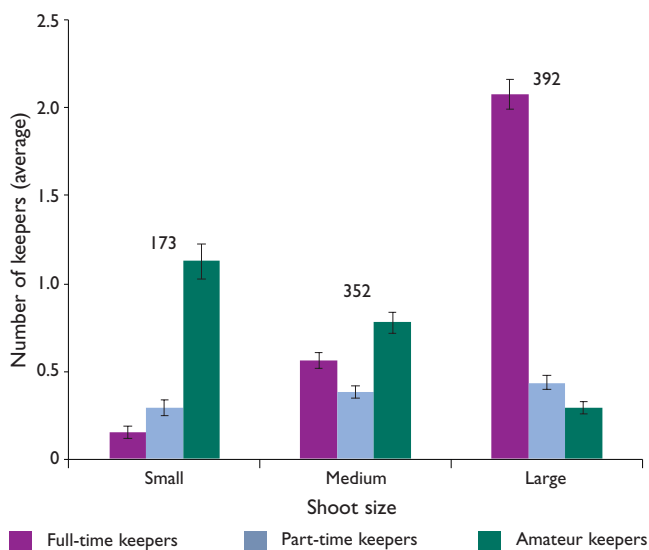
The number of full-time gamekeeper equivalents was calculated, with a full-time keeper weighted as one keeper; a part-time keeper weighted as 0.5 of a keeper and each amateur keeper weighted as 0.25 of a keeper. Overall there were more keepers on large estates (Deviance ratio₂ = 214.94, P < 0.001, with an average of 2.37 overall), compared to an average of 0.95 keepers per medium shoot, where there were more keepers

between the surveys and the size of the shoots (F_{2,1793} = 4.02, P = 0.018). There was no significant differences in keeper density between the two surveys on medium (F_{1,712} = 0.43, P = 0.511) or large shoots (F_{1,691} = 0.14, P = 0.708), but small shoots had a higher keeper density in 2019 (back-transformed average of 0.46 keepers per 100ha, 0.40 to 0.53 keepers per 100, back-transformed 95% confidence intervals) that in 2011 (back-transformed average of 0.36 keepers per 100ha, 0.32 to 0.42 keepers per 100, back-transformed 95% confidence intervals, F_{1,390} = 6.81, P = 0.009).

Of the 953 individuals returning a survey form and filling in this section, the majority – as expected – were members of the NGO (684, 71.8%), just over a tenth were members of the SGA (107, 11.2%) and just over a fifth were members of the GWCT (209, 21.9%, Appendix, Table 1). Nearly a fifth of respondents were members of two of the three organisations (164, 17.2%), while only 0.4% were members of all three. There were 121 respondents that did not indicate what organisations they were members of (12.7%).

Appendix Figure 4

Average number of keepers of different employment status reported from 917 shoots of different sizes in 2019. Numbers on/above bars reflect the number of shoots in each category, error bars are standard errors

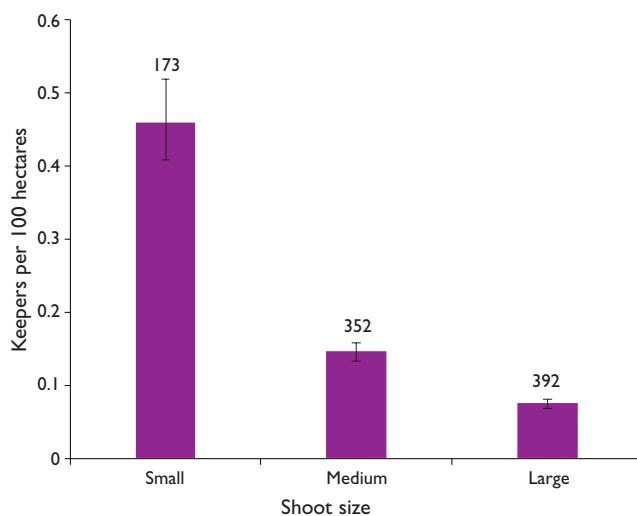


than on small shoots (0.58 keeper per small shoot, P < 0.05). No difference was found in the overall number of keepers per estate between the current survey and the one in 2011 (deviance ratio₁ = 1.11, P = 0.291), controlling for the significant effects between sizes of shoots (deviance ratio₂ = 425.89, P < 0.001).

Keeper density was estimated by substituting the number of full-time equivalents for the number of keepers and dividing by the area of the shoot (expressed in km² or 100ha). Keeper density (ln-transformed) differed between the three sizes of shoots (deviance ratio₂ = 319.51, P < 0.001). The keeper density was significantly higher on small shoots, at four-fifths of a keeper equivalent per km², than on large shoots (one tenth of a full-time keeper equivalent per km²) and on medium shoots (just under one fifth of a keeper equivalent per km², Appendix, Figure 5). Comparing the current responses to those from the 2011 survey, there was a significant interaction in keeper density

Appendix Figure 5

Average keeper density in 917 shoots of different sizes. Numbers on/above bars reflect the number of shoots in each category and the error bars are 95% back-transformed confidence intervals



Appendix Table 1

Membership of gamekeeper and other organisations, based on 953 returns in 2019

Organisation	Respondents (%)
National Gamekeepers' Organisation	684 (71.8%)
Scottish Gamekeepers Association	107 (11.2%)
Game & Wildlife Conservation Trust	209 (21.9%)
Members of two organisations	164 (17.2%)
Members of three organisations	4 (0.4%)
Membership not specified	121 (12.7%)