# Review
## of 2021

A full report of the activities of the Game & Wildlife Conservation Trust

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Game & Wildlife Conservation Trust

# REVIEW OF 2021

## Game & Wildlife Conservation Trust

## Issue 53

A full report of the activities of the Game & Wildlife Conservation Trust (Registered Charity No. 1112023) during the year

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### GAME & WILDLIFE CONSERVATION TRUST CHARITABLE OBJECTS

- To promote for the public benefit the conservation of game and its associated flora and fauna.
- To conduct research into game and wildlife management (including the use of game animals as a natural resource) and the effects of farming and other land management practices on the environment, and to publish the useful results of such research.
- To advance the education of the public and those managing the countryside in the effects of farming and management of land which is sympathetic to game and other wildlife.
- To conserve game and wildlife for the public benefit including: where it is for the protection of the environment, the conservation or promotion of biological diversity through the provision, conservation, restoration or enhancement of a natural habitat; or the maintenance or recovery of a species in its natural habitat on land or in water and in particular where the natural habitat is situated in the vicinity of a landfill site.



Game & Wildlife
CONSERVATION TRUST

# Council
as of 1 January 2022



# President and Vice-Presidents



# Chairmen of GWCT county committees in 2021



*Names in brackets were chairmen that stepped down during 2021*

# CONTENTS

*Review of 2021*

© Peter Thompson

## WELCOME



## PARTRIDGE AND BIOMETRICS RESEARCH



## UPLANDS RESEARCH



## FARMLAND RESEARCH



## RESEARCH AND DEMONSTRATION FARMS



## PREDATION RESEARCH



## FISHERIES RESEARCH



## LOWLAND GAME RESEARCH



## WETLAND RESEARCH



## GWCT ROUNDUP



Game & Wildlife
CONSERVATION TRUST

# A year of change

Teresa Dent CBE,
Chief Executive

© Hugh Nutt

*The new ELM scheme seeks to reward farmers for the delivery of environmental goods and services – the provision of Natural Capital. © Peter Thompson*

- COP26 has helpfully focused the debate on both climate change and biodiversity loss – a balance rather than biodiversity playing second fiddle.
- Launch of a new Advisory Service - GWCT Natural Capital Advisory.
- Thank you to all our staff, trustees, donors and members for their incredible support in 2021.

2021 was a year of change, and one of the changes was the narrative. COP26 means everything is now framed within the narrative of the climate change crisis and the biodiversity crisis. COP26 put equal weight on biodiversity, meaning policy should not sacrifice wildlife in the pursuit of carbon sequestration. A good thing as it should mean it's possible to manage heather uplands for curlew as well as for people and peatland restoration. A balance, not a single objective.

Alongside that, as Minette Batters, President of the NFU has been saying, we are seeing the biggest change to farming and countryside since 1947. In 2020, we saw the introduction of the Westminster Agricultural Bill laying the path for Defra's new Environmental Land Management (ELM) scheme, which seeks to reward farmers for the delivery of environmental goods and services – the provision of Natural Capital (see page 6). Then we had the passing of the Westminster Environment Bill in 2021 which set out the concept of biodiversity net gain and future environmental trades.

And if that were not enough, the pressures on game management also escalated. In Wales, the Government continued its pressure to stop shooting as a leisure activity which risks losing the biodiversity net gain in the Welsh countryside that goes with good game management (see page 8). In Scotland the decision was made to go further than the recommendations of the Werritty Review of Driven Grouse Moor Management and look to license driven grouse shooting alongside the banning of mountain hare culling (see page 7). In England releasing gamebirds on European Protected sites now needs a licence, albeit a General Licence.

Natural Capital works well for sustainable game and wildlife management. The latter by definition delivers a net biodiversity gain and therefore an increase in natural capital. It's a concept that the game management community should embrace. It is also how species recovery and environmental goods and services are going to be delivered in the future.

Defra has accepted that there is an enormous funding gap between environmental outcomes it would like to achieve in the countryside and what it can afford through taxpayers' schemes like ELM. It wants to bridge the gap with private sector finance and create what it calls a blended finance model. Much of this blended finance will come in through environmental trades, which means farmers and land managers trading their ability to deliver a net biodiversity gain, carbon sequestration, nutrient reduction in rivers and natural flood management. During 2021, the GWCT has been working with farmers to think about how they can deliver key environmental outcomes and achieve a fair reward for doing that. We have also started a new branch of our advisory service, Natural Capital Advisory (see page 10).

2020 was a difficult year for every charity in the country. GWCT was no exception and our income fell by £1.3 million. Staff accepted furlough and a temporary pay cut but nonetheless achieved most of the research field work we needed to get done; a considerable achievement. Fieldwork was easier in 2021 but we are still catching up with writing up the science and other tasks. I am extremely grateful to staff who worked so hard in 2021, very grateful to donors who have stepped up to help compensate for income lost and we are in much better shape than this time last year. Members have supported us like never before, as have our chairman and trustees who have helped steer us through this difficult time.

# Continuing to raise standards

Sir Jim Paice
GWCT Chairman

Many people have said "we live in interesting times". None more than last year. It started in the depths of Covid-19 but with vaccinations beginning and hope springing that things would return to normal. Now the Omicron variant has surged but we seem to have got through without lockdown at least in England. Everything seems to be gradually returning to normal. I hope those words do not come back to haunt me. But not only has GWCT survived so far but we are in a better position than we had feared a year ago. Thanks to continued sacrifices by our loyal staff, our finances allowed us to continue with most of the important research and communication which sets us apart. You will read about much of it in this *Review.* However, it would be remiss of me not to also thank many of our county groups who have managed to hold various fundraising events. Thank you.

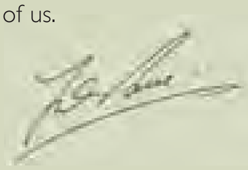
I hoped 2021 would see a major change in the way shooting organisations and those sympathetic to them work together. So I am pleased that the Game Fair at Ragley saw the launch of 'Aim to Sustain'. This is a partnership of eight shooting organisations to which GWCT is scientific adviser. We are happy to use our science and best practice knowledge to actively support its development and advise its committees. Perhaps most importantly in the area of shoot standards and self-regulation. Aim to Sustain will build on the *GWCT's Principles of sustainable game management* (published September 2019), our Codes of Practice, and we expect our various courses to be critical in raising the standard of all shoots to that of the best. My hope is that less progressive views do not prevent the organisations from getting the shooting house in order.

Many of our members are involved in shooting but we must never forget that the GWCT remit is much wider. Our work on modern farming techniques, carbon sequestration, wild bird populations, squirrel control and fisheries are all testament to our breadth of skills. We should be proud of our role at the forefront of countryside research.

"We should be proud of our role at the forefront of countryside research"

Finally, 2021 has seen the Environment Act come on to the Westminster statute book and almost daily there is more information on the new agricultural schemes to replace the Common Agricultural Policy in England, Wales and Scotland. In the Westminster Parliamentary process we now have an Animal Welfare (Sentience) Bill. The GWCT continues to press both MPs, Peers and the respective Governments to base their proposals on science and not give way to many unproved emotive assertions which are coming from some worrying quarters.

Whatever 2022 brings let me assure you that the GWCT will continue to serve our wildlife to the best of our ability and to the high standard which people expect of us.



# Sharing our knowledge and influencing policy

Alastair Leake
Director of Policy and
Parliamentary Affairs

© Hugh Nutt

*2021 saw a transition away from the rules and regulations of the CAP to a new scheme for farmers based on the principle of 'public payments for public goods'. © Peter Thompson*

England

- The importance of soil is recognised by the Government
- Our proposals for the structure of a new environment scheme were adopted.
- Our science is still needed to shape effective policy.

2021 was an important year for the future of farming and wildlife in England. As we transition away from the rules and payments of the Common Agricultural Policy (CAP) the support payments given to farmers have begun to diminish. In place of these payments, the Government is introducing a new scheme based on the principle of 'public payments for public goods'. How we define both what these goods are and how we value them has involved a combination of legislative amendments through the Environment Bill, and a co-design process with Defra and other stakeholders. For example, the first iteration of the Environment Bill included no reference to soil. If soil is not considered to be of any public benefit, then it is not possible to use public money to support measures that farmers implement to improve soil health. The GWCT English policy team worked with others to successfully amend this.

The new Environmental Land Management (ELM) scheme emerging is remarkably similar in structure to that put forward by the GWCT back in 2017 in our *Farming through Brexit: a vision for the future* policy paper published in 2018. In our vision we proposed a three-tiered proposal that made payments to farmers for delivering basic environmental goods based on broad 'standards' such as hedgerows, grassland, arable land, soils etc. This is now known as the Sustainable Farming Incentive and within each criteria there are three levels of ambition allowing farmers to deliver more and be rewarded for it. This is a welcome replacement to the CAP cross compliance approach which involved detailed inspections and fines for transgressions.

The second tier of the scheme will focus on Local Nature Recovery, with a strong emphasis on farmers working together to achieve this through GWCT Famer Cluster type approaches. This scheme will contain many elements familiar to farmers who have previously engaged with Countryside or Environmental Stewardship schemes, although the payments promised should be more attractive and the rules more flexible, focusing on outcomes rather than process, with a 'partnership' relationship with Government Agencies.

The third Tier will focus on Landscape Recovery. The pilot for this will see 15 projects of between 500 and 5,000 hectares selected, focusing on threatened native species recovery and measures to improve water quality. The scheme appears to favour a non-interventionist approach coupled with abandonment of land management to encourage nature to take over. It is certain that adopting this approach is not going to be successful for some of our key threatened species. GWCT research over many decades has shown that when populations are severely depleted, more intervention is needed, not less. Through 2022 we are going to continue to need to draw upon our substantial body of scientific evidence built up over many years, combined by new research from our scientists, to continue to shape policies that really deliver for wildlife.

## Scotland

- The ministerial statement on Grouse Moor shoot licensing in late 2020 framed much of the policy work in 2021.
- Data recording tools were developed and promoted so stakeholders can contribute to an evidence-led approach to potential legislation.
- Carbon audit and natural capital work at GWSDF Auchnerran contributed to Scottish Government policy development regarding climate change, biodiversity and future farming support.

Ross MacLeod,
Head of Policy, Scotland

Delivering on the Werritty Grouse Moor Management Review was very much the order of the year in 2021. In November 2020, the then Minister for Rural Affairs and Natural Environment, Mairi Gougeon, said to Scottish Parliament that a 'licensing scheme should be introduced for the shooting of grouse'. The Scottish National Party retained power, though as a minority administration in the May 2021 Scottish election. This statement could then be taken forward by NatureScot, the agency tasked with developing licensing proposals.

We responded in two ways. We contributed to the landowner task force that maintains direct engagement with the Scottish Government and also focused on advising NatureScot and the grouse moor sector directly. Initially we scoped the wide range of views on the need for and look of potential licensing approaches. We then used this knowledge in promoting evidence gathering, especially mobile technology-based information recording. This captures the practices of moorland management and allows estates to describe the public-value outcomes. That evidence has been fed back into discussions with public policymakers about the need for more, or less regulation.

The work on funding and supporting the development of a new vaccine against tick-borne Louping-Ill disease progressed with the Moredun Research Institute during 2021 despite restrictions imposed by Covid-19. Preliminary data from vaccine trials displayed a strong immune response in lambs to the prototype vaccine, which has allowed the project to move forward, paving the way for initial discussions on commercialisation with potential manufacturers.

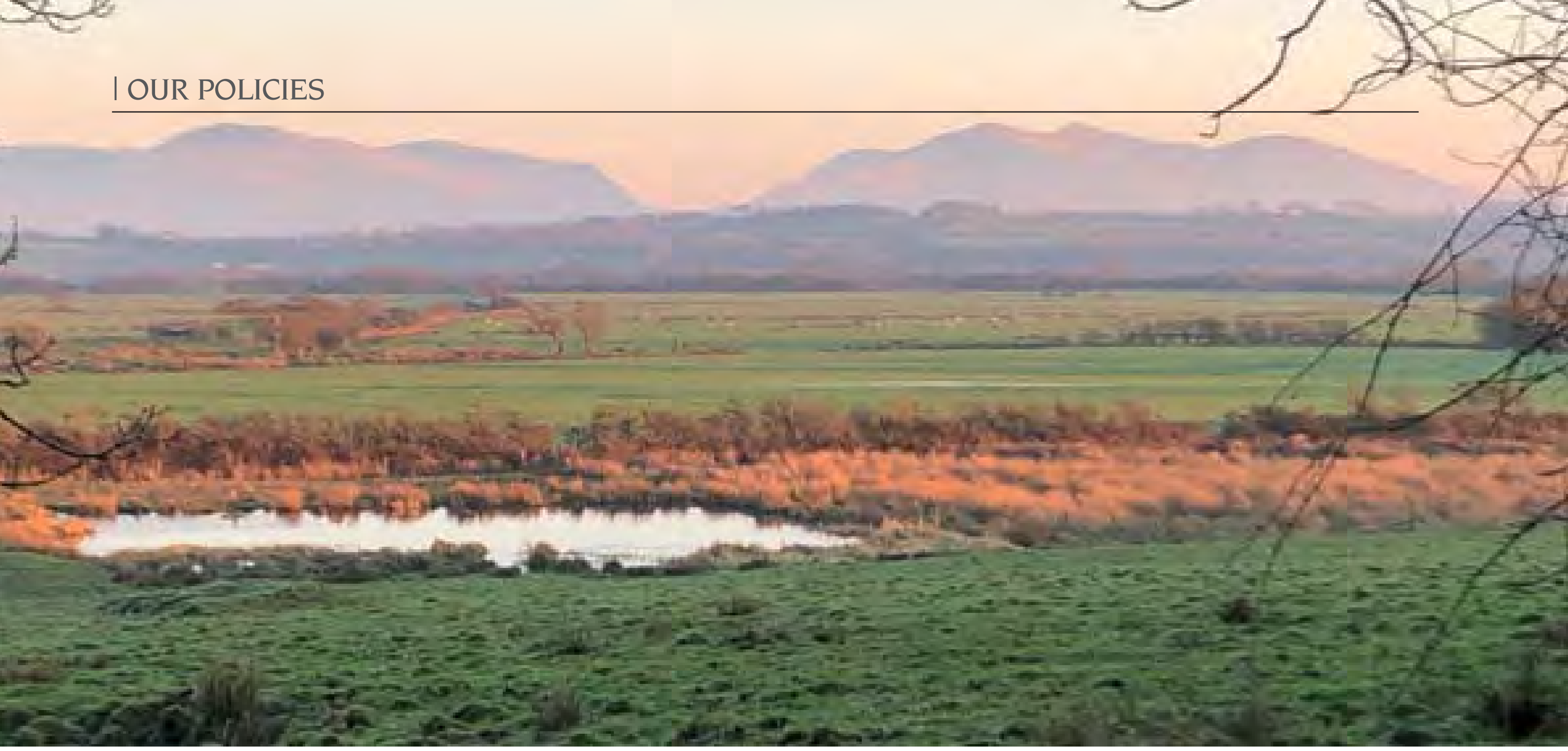
*NatureScot is tasked with developing licensing proposals for grouse moors. © Adam Smith/GWCT*

Our 'evidence-led' approach fits with the other key focus for Scottish policy: the increasing need to demonstrate game and wildlife conservation's relevance to climate change and biodiversity challenges. These are driving much of the Scottish Government's rural policy agenda, yet some policy concepts are contradictory (constraining muirburn may limit net carbon sequestration) or are poorly evidenced in terms of need or benefit (tree planting on organic-rich soils).

The carbon audit and natural capital assessments undertaken at our Scottish Demonstration Farm in Aberdeenshire have helped identify the extent of greenhouse gas emissions and carbon sequestration, allowing us to address imbalances through farm management plans. Appraisal of these mechanisms allowed us to contribute to the successful development of a Heritage Lottery Fund project led by the Cairngorm National Park Authority and to take a seat on NatureScot's Natural Capital External Advisory Group. Both these developments afford opportunities for us to represent important policy development insights regarding future farming and net biodiversity gain policies in Scotland.

We continue to share our policy knowledge on uplands and farmland with Scottish sporting and land management organisations via the Rural Environment and Land Management (RELM) group.

*Curlew on our Auchnerran farm where we have carried out carbon audit and natural capital assessments. © Elizabeth Ogilvie/GWCT*



# Political pressure is mounting despite evidence

Sue Evans, Director of Wales

*Political pressure against the shooting of live quarry and the associated management for game has been building in 2021. © GWCT*


*Updates on our projects, including encouraging farmers across Ceredigion to perform supplementary feeding for farmland birds, are featured in short videos at* gwct.org.uk/walesvideo.

Wales

- The Labour Minister says Welsh Government does not support the shooting of live quarry as a leisure activity.
- Snares will be banned as the GWCT ask for a licence to use Humane Cable Restraints.
- GWCT commissioned to write a report for NRW on curlew recovery.
- Plans made to hold the first GWCT Welsh Game Fair in September 2022.

Political pressure against the shooting of live quarry and the associated management for game in Wales has been building in 2021. Following the 2018 ban of shooting on Welsh Government owned land and the Judicial Review of General Licences in January 2021 brought about by Wild Justice, Labour Ministers have made plain their position on shooting-related matters.

The Labour Manifesto for the May 2021 elections committed to banning the use of snares which was reiterated by the First Minister at Questions in Plenary in October. This will have a significant impact on the protection of ground-nesting species and may hamper any curlew recovery.

The Petitions Committee of the Welsh Parliament is considering the petition, to 'Ban the shooting of critically endangered birds'. A case has been made against red- and amber-listed species including woodcock, pochard, black grouse and snipe being allowed to be shot in Wales. This is a highly emotive subject on which the GWCT has sent evidence to the enquiry.

Our response to Natural Resources Wales' (NRW) Wildbird Review Consultation on its approach to regulating the shooting and trapping of wild birds in Wales is at **gwct.org.uk/nrwconsultation**. Our evidence shows that magpies should be kept on the General Licences, challenging external pressure for them to be removed.

We attended the first meeting of the Welsh Government's Land Management Reform Stakeholder Group in November to feed into the development of the Future Sustainable Farming Scheme. We will continue to work to bring game management principles and practices, particularly the 'three-legged stool' approach pioneered by the late Dick Potts, into mainstream farming. Our suite of projects across Wales is a great demonstration for good practice, and we have engaged with members, policy officers, politicians and other interested parties.

The GWCT was commissioned to write a report for NRW on curlew recovery, and the online cross-party launch of the Welsh Curlew Recovery Plan followed in November. However, it remains to be seen what action and financial support will result.

We aim to bring the rural community together in September for the first GWCT Welsh Game Fair to demonstrate our research and provide a platform on which to showcase the good that game related management can achieve.



# Identifying issues and devising solutions

- Much GWCT research has broad relevance beyond gamebirds.
- Insect declines on farmland require widespread adoption of new measures, but our work points the way.
- Understanding what is driving predator numbers and finding solutions to predation requires good science.

Andrew Hoodless,
Director of Research

The *Review* provides an insight into the breadth of research conducted at the GWCT. Although some projects may seem quite niche, some have very broad relevance to conservation. During the last three to four years we have heard increasing concerns about insect declines and the prospect of 'insect armageddon'. This is a worry because insects play so many roles in ecosystems, from decomposition and nutrient cycling to pollination and providing food for birds, bats and small mammals. Our Sussex Study on the South Downs provides a unique dataset on insects on arable farmland, so an analysis in 2021 of trends in insect abundance and diversity since 1970 was timely. The article on pages 40-43 describes these trends and presents long-term monitoring data from our Allerton Project at Loddington, along with short-term sampling results from 10 other farms. It makes sobering reading: chick-food availability for grey partridges in cereal crops is typically half the level required for population stability. More surprisingly, most conservation habitats at field edges are failing to produce sufficient insects.

It is not too late to address the situation. At the Allerton Project, the field edges supported sufficient chick-food, demonstrating that sensitive management pays off. The latest results of our long-term bird monitoring show 76% higher Biodiversity Action Plan species abundance in 2021 than the baseline year in 1992 (see pages 48-49). The performance of our Advanced PARTRIDGE mix, developed at Rotherfield through our EU Interreg PARTRIDGE project, is particularly encouraging, having outperformed all conventional mixes for insect abundance in the last four years. It is now part of a Defra Test & Trial.

Our work on addressing predation also has broad relevance. March 2021 saw Jonathan Reynolds retire at the end of a distinguished career which included work on fox ecology, the impact of predation and its control on wildlife populations, and development of the GWCT mink raft and a Defra CoP-compliant fox snare. The projects conducted by Jonathan and his team exemplified the considered, scientific approach necessary to providing evidence and developing solutions to address controversial issues. We are building up our predation team again and focusing on what is driving predator numbers in the countryside. In recent years we have used GPS tracking and trail cameras to demonstrate the high density at which foxes can occur and determine habitat use (see *Review of 2017*, pages 14-17), and to quantify the impact of predators on declining waders (see pages 66-67). There is now much speculation, though very little evidence, that released gamebirds are supporting increased numbers of some predators. As part of our work on drivers of predator numbers, we initiated a PhD study with Bournemouth University in autumn 2021 employing genetic and stable-isotope techniques to examine fox population dynamics.

*We are looking to quantify the impact of predators on declining waders, such as curlews. © Mike Short/GWCT*

Blended finance from developers will become a key part of funding future environmental delivery. © Peter Thompson

# Natural Capital Advisory – a new GWCT initiative

Roger Draycott, Director of Advisory & Education

- GWCT Advisory has set up a subsidiary company – Natural Capital Advisory.
- Activity includes biodiversity offsetting projects, nutrient offsetting and, in the future, carbon sequestration projects.

The GWCT Advisory Service has provided conservation advice to the farming and land management community for generations. In the early days, the habitat that was created and managed by farmers to support game and wildlife was entirely privately funded by the farmers and landowners themselves. Since the introduction of public sector support for habitats through agri-environment schemes, much of our advice has been to help farmers utilise these schemes to provide maximum benefit for wildlife. Many of the options in agri-environment schemes supporting wildlife are based on GWCT research, including beetle banks, wild bird cover, late winter supplementary feeding and conservation headlands, and our advisors have worked with farmers to maximise the benefits of these options for wildlife. Looking to the future, in England the Environmental Land Management Scheme (ELMS), which will replace Countryside Stewardship, will provide financial support for individual farmers and groups of farmers working together at the landscape-scale to continue to provide wildlife habitat on farmland. The devolved nations have not yet made clear the extent or nature of their agri-environment climate schemes, but some public payment for environmental goods and services delivery seems likely.

Although it is widely accepted that the phasing out of direct support for the farming sector through the withdrawal of the Basic Payment Scheme will significantly negatively impact the finances of the majority of farms, we believe there are significant opportunities for farmers to access private sector funding to help finance habitat provision and management through 'natural capital' initiatives. There are three potential areas of interest for the farming sector: biodiversity offsetting; carbon trading; and nutrient offsetting. The Advisory Service has launched a new subsidiary, Natural Capital Advisory (NCA) which will be working closely with Recce Rural (an independent rural surveying company) to offer a comprehensive service of advice and trading in natural capital markets. Blended finance models will be a key part of funding future environmental delivery. By blended finance we mean a combination of Government finance through ELMS and private finance from large corporates, water companies and developers which are becoming known as environmental trades. These environmental trades are an opportunity for farmers to deliver biodiversity net gain, nutrient reduction and/or carbon sequestration and be rewarded by the market place. For example, developers will need to offset the biodiversity that is lost by building on an area of land and show a minimum 10% biodiversity net gain in the offset; a developer

who wishes to link a new property to the sewage system within a catchment that has a high level of phosphate in the river water, needs to be able to demonstrate that the new phosphate load can be offset (often by means of a reed bed).

Our new subsidiary will be managed by the GWCT's Advisory team. They are already delivering work for clients by undertaking baseline biodiversity audits for business planning purposes and helping in the formation and running of an exciting new farming co-operative, the Environmental Farmers Group (EFG). The EFG is working collectively to seek new funding opportunities through biodiversity credits, carbon trading and nutrient (phosphate and nitrate) offsetting. The Advisory Service remains committed to continuing to offer specialist conservation advice to the farming and game management sector and this exciting new area of activity has the potential to deliver fantastic opportunities for the natural environment and farm businesses.

For further details please contact advisory@gwct.org.uk.

*Our advisors are already helping clients improve biodiversity on their farms (above) and undertaking audits to record species such as birds and butterflies on specially created habitats such as beetle banks (below). © Peter Thompson*

## GWCT BIODIVERSITY ASSESSMENTS

The GWCT's experienced and respected team of advisors offer bespoke Shoot Biodiversity Assessments providing an independent expert report on best practice and biodiversity gain on individual shoots. For more information please see gwct.org.uk/shootbiodiversity or contact the advisory team on 01425 651013.

# Is there a storm brewing in the uplands?

In northern England, rotational burning has been stopped by Natural England (NE) on designated blanket bog sites where peat depth exceeds **40** centimetres.

Dave Baines looks at the pressures facing the uplands including increasing regulation and extreme weather

Reading our 30-year trends in red grouse article on page 30 of this *Review*, you would ask what could be wrong in the grouse world. Why the despondency among grouse managers? In northern England, grouse counts, while showing evidence of five-yearly cycles, were stable but then dramatically increased following the big turn to 'new' medicated grit in 2007. The Scottish picture is not dissimilar but with lower densities, longer quasi-cyclical fluctuations and less marked grit-related responses. So why such doom and gloom?

What is clear is that most moorland gamekeepers are good at producing red grouse, but they are becoming increasingly restricted by others in their capacity to do so. Outside pressures are being imposed on each of the three legs of the grouse management stool, (heather) habitat, predation and parasites. Taking heather first, in northern England, rotational burning has been stopped by Natural England (NE) on designated blanket bog sites where peat depth exceeds 40 centimetres. Applications can still be made for burning licences, but receiving one is difficult, even for scientific research purposes. Seemingly NE consider no further knowledge is needed. Intriguingly, will NE grant itself a licence at Moor House NNR to enable the next set of burns in the ongoing 70-year burning-grazing experiment that it hosts? If managing peatlands by fire has ended, what's next? Answer, it is cutting. Now tractor-mounted flails cut and remove the very *Sphagnum* hummock topography that NE wanted to protect from burning. Not having the same weather restraints and being readily done by outside contractors, subsequent cutting rates have been very high, perhaps reflecting expectations that this too will be 'effectively banned' soon. So how does this impact grouse? GWCT research has shown massive benefits of burning to some ground-nesting birds that like short vegetation, but those benefits applied more to waders than to grouse. Our concerns about cutting include the relative lack of heather regeneration from seed, the thick layer of cut heather mulch that may swamp vegetation recovery post-cutting, and the effects of nutrient enrichment from mulch within an otherwise nutrient poor habitat.

"Outside pressures are being imposed on each of the three legs of the grouse management stool, (heather) habitat, predation and parasites"

Moving to predators, harriers are being actively encouraged, while buzzards are now plentiful. Restrictions were placed on corvid control, ironically especially in relation to designated sites, including those for ground-nesting birds. Licences from NE are now required to control large gulls such as lesser black-backed gulls and

Dave Baines, Director of Upland Research

*GWCT research has shown huge benefits of burning heather to some ground-nesting birds that like short vegetation, but those benefits applied more to waders than to grouse. © Laurie Campbell*

*(Top L-R) Licences are now required from NE to control large gulls such as lesser black-backed gulls; red grouse have had low breeding success in four of the last seven years, often corresponding to extreme weather. © Laurie Campbell*

## NEW RESEARCH

**A new GWCT study which started in 2022 will explore how parasites, food quality and weather interact to determine maternal conditions in grouse and how hen health may, together with insect abundance, determine chick survival.**

seem almost impossible to obtain, requiring evidence of predator impact which, by definition, means the damage has already been done. Several of our notable studies, eg. Salisbury Plain for partridge, Upland Predation Experiment (Otterburn) for waders, and Langholm for red grouse have quantified the benefits to prey species of legally removing a suite of generalist predators. However, few studies have quantified the effects of individual predator species on prey, hence questions are now being asked about the legitimacy of killing those species. Jackdaw, rook and some gulls are case examples, but what about others such as stoats? Although plentiful in the English uplands and arguably top of the kill bags of most gamekeepers, what would happen if stoat control was stopped? Grouse would doubtless suffer, but so would black grouse, grey partridge and curlew among others. Will it happen? It is probably a question of when, not if.

Finally, regarding parasites our Figure 4 on page 32 in this *Review* clearly shows the huge contribution anthelmintics in medicated grit have made to grouse numbers, especially in northern England. So successful was it that, for several years, we struggled to find strongyle worms in autumn-shot grouse, especially among young birds. Better control of worms was linked to a reduced risk of population crashes through increasing grouse survival. This in turn led to higher shooting bags, but also to banking, ie. sparing birds from shooting and instead saving them for the next year in a dubious competitive pursuit of high day and annual bags. To achieve these unsustainable highs, medicated grit was often used as an annual insurance against worms rather than being used when most needed. This appears to have had several repercussions. First, density-dependent diseases such as respiratory cryptosporidiosis emerged, taking the cream off grouse productivity, survival and bags. Veterinary practices required greater evidence of problem levels of worms before prescribing medication. Greater awareness of the wide use of free-access drugs across UK moors by anti-grouse moor campaigners brought subsequent research on the presence of flubendazole and its breakdown residues in moorland substrates, soil, water and possible impacts on soil mesofauna. Recently several practitioners have claimed that medication no longer works effectively. The last point is unproven, but unsurprising given how quickly drug resistance developed among similar parasitic worms amongst domestic livestock. Is it now happening with flubendazole in medicated grit and the grouse's strongyle worm?

### So, what does the future hold?

It's likely that statutory bodies will increasingly regulate the capacity of grouse keepers to manage the heather habitat. A largely unrestricted assemblage of predators may reduce breeding success and survival among several groups of ground-nesting birds, including grouse. Should sufficiently high densities of grouse remain, then parasite-induced population cycles may resume once medication is either banned or rendered ineffective through parasite resistance.

Finally, despite being a sub-species of the willow grouse, a hardy bird with a circumpolar distribution, red grouse can be vulnerable to unseasonal cold weather. Scrutiny of Figure 3 on page 31 shows low breeding success in four of the last seven years, often corresponding to extreme weather including the 'Beast from the East' in 2018 and the spring freeze of 2021. If, as predicted, these events become commonplace, they could dictate not only red grouse trends, but could threaten the regional or national retention of rarer gamebirds, notably black grouse, capercaillie and hill-fringe grey partridge. Some busy and anxious years may lie ahead.

## UPLAND RESEARCH FUNDING

**We urge our supporters to fund studies that improve our understanding of quantifying the impacts of individual predator species on clutches of red-listed ground-nesting birds. We also need to understand whether the unpredictable performance of medicated grit may be due to parasitic worms developing resistance to the worming drug flubendazole and require funding for a study to find out. If you can help us extend our research, please donate at gwct.org.uk/uplands. Thank you for your support.**

# Humbled by your incredible support - thank you

Jeremy Payne, Director of Fundraising and Rory Kennedy, Director Scotland

*(Above clockwise) The well attended Sussex shoot walk; enjoying the many competitive clay shoots; the GCUSA assembly at the Mashomack Preserve Club; Lady Martha Sitwell and Christopher Lawrence Price enjoying the 41st London Ball in the stunning setting of the V&A.*
*© Verity Johnson/Noah Goodrich*

England & Wales
- Major donor income at £1.19 million.
- £260,000 from the New York auction (subject to exchange rate).
- County committees projected at £500,000.
- London events at £130,000.

The fundraising department including the US committee and all the county committees worked very hard to deliver these numbers (above) in the long shadow of the Covid-19 virus. To have delivered once again our best ever number for Major Donors is testament to this group's generosity and recognition of both our contribution and our need.

The major donor total includes a good proportion of fundraising on our behalf as support for the Challenge Fund and last year's Special Appeal carried on and rippled outwards with trustees and others putting their shoulders to the wheel. Late in the year we had our first donation from the President's Club led by Lord Salisbury.

The New York auction had only one substantial UK lot, so the £260,000 represented extraordinary generosity from our US trustees, once again led and encouraged by Ron Beck and Robyn Hatch.

County committees had to stay flexible with many events planned but then scuppered by the virus. Some clay days and gala events went ahead despite the uncertainty – our particular thanks to these counties who managed the uncertainties so elegantly. We have learnt from various lockdowns, and an increasing number of physical auctions now have an online dimension, allowing more people to bid.

The only London event we held was the 41st annual Ball at the V&A led by our chairman, The Duke of Roxburghe. In addition to dinner, dancing and fine wine, guests had the opportunity to see the extraordinary Fabergé collection.

On behalf of all at the GWCT, sincere thanks to all of you who did whatever you could in 2021.

Scotland

- Major donor income of £243,000.
- Scottish online auction income of £100,994.
- Northern online auction income of £55,478.
- Dumfriesshire High Four raffle raised £34,442.
- Perthshire High Four raffle raised £35,373.
- Edinburgh & SE Scotland clay day raised £3,186.
- West Tayside 'Birdies & Bunkers' event raised £19,236.
- Edinburgh & SE Scotland Drinks Party raised £5,106.

During 2021 we began our response to the Werrity report and to fund an enhanced workload, we asked a number of individuals to help us. Inspired by one very keen and committed supporter who galvanised support from his friends, we raised a substantial sum which allowed us to increase our policy work and enhance research into mountain hares. General support from donors continued to be generous and forthcoming with people understanding the need for funds for a number of projects.

As in 2020, the regular regional events were affected by restrictions on gatherings, so most of the early year activity remained online. There was a very successful Northern Auction, amalgamating the usual Highland & Grampian events, which raised a higher joint total than we would usually budget for the two individual events. The Scottish Auction was again held online with the added option of ordering a set menu to be delivered to your home so you could enjoy the meal that would have been served at the live event. We also ran two further big/high four raffles starting with one in Dumfriesshire which sold out all 350 tickets and one in Perthshire later in the year which sold 90% of the tickets. In the latter part of the year we managed to run a few live events. The Edinburgh & SE Scotland committee ran two, starting with a small simulated clay event south of Edinburgh and finishing off with a Christmas drinks party at Oxenfood Castle in late November, both of which helped raise funds. Finally there was the relatively new West Tayside's inaugural event, having been cancelled in 2020, which was a golf and clay day at the Gleneagles Hotel. It was a resounding success and surpassed our expectations. Thank you once again to everyone for their fantastic and generous support over 2021.

*(Above) Campbell Pitt's winning team at the Gleneagles golf and clay day.*

*(Above & below) The lucky Dumfriesshire Fantastic Four Team enjoying their day.*

# Partridge & Biometrics

### JOIN THE PCS

The country's wild grey partridges need more land managers, especially those with only a few grey partridges, to join the Partridge Count Scheme. Find out more at **gwct.org.uk/pcs**.

## Partridge Count Scheme

*More second broods were seen in 2021, possibly owing to bad weather in June. © Michal Pesata*

### KEY FINDINGS

- The average density of grey partridge pairs increased from 3.9 pairs per 100ha in 2020 to 4.3 in 2021.
- Productivity, recorded as young-to-old ratio, was lower in 2021 compared with 2020 in the south and east of England, but higher elsewhere.
- National autumn density averaged 19.2 birds per 100ha in 2021, a decrease of 4% from 2020.

Neville Kingdon
Julie Ewald

In spring 2021, Partridge Count Scheme (PCS) members returned 527 spring count forms to the scheme, yielding a total of 7,072 pairs of grey partridges counted, 398 pairs (+6%) more than in 2020. Just over half (56%) of all the pairs recorded in the PCS were found on the 28% of sites in eastern England. Northern England recorded over one-fifth (22%) of the spring pairs counted, across 18% of PCS sites, while Scotland recorded 10% of the total pairs on 15% of PCS sites. National grey partridge spring pair density increased again from 3.9 pairs per 100 hectares in 2020 to 4.3 in 2021 (+10%). Regionally, average pair densities in all areas either remained stable or recorded increases in spring density, except in southern England (-18%). Meanwhile the northern region achieved the highest average density, 6.6 pairs/100ha, an increase of 31% compared with 2020.

Nationally, the average 2020/21 over-winter survival rate of 54% (calculated as the ratio of 2021 spring birds to 2020 autumn birds for sites that returned both counts) was unchanged to that of the previous winter. It is encouraging for this value to have remained above 50%, but it means that nearly half of the UK grey partridge stock recorded by the PCS is 'lost' between autumn and spring, which may still be misleadingly positive compared with non-PCS farms and shoots across the rest of the UK.

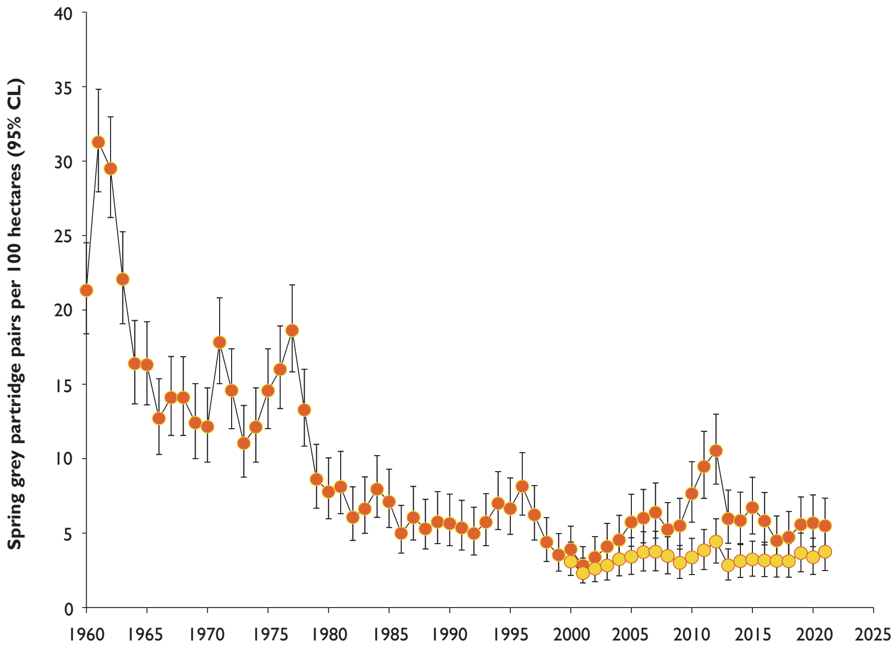
Long-term PCS sites – many of which maintain a strong game management and habitat focus – recorded an average national spring pair density of 5.5 pairs/100ha, representing a 3% decline on 2020 (see Figure 1). New sites (joining since 1999) recorded a positive 11% increase to achieve an average density of 3.8 pairs/100ha, a level last achieved in 2012.

Although summer 2021 was slightly warmer than average across the UK, southern and south-eastern counties of England were barely above average and particularly wet,

### Figure 1

Trends in the grey partridge spring pair density, controlling for variation in different count areas






### ACKNOWLEDGEMENTS

We are extremely grateful to GCUSA for its ongoing support of our grey partridge work.

TABLE 1

**Grey partridge counts**

*Densities of grey partridge pairs in spring and autumn 2020 and 2021, from contributors to our Partridge Count Scheme*

| | Number of sites (spring) | | Spring pair density (pairs per 100ha) | | | Number of sites (autumn) | | Young-to-old ratio (autumn) | | Autumn density (birds per 100ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Region** | 2020 | **2021** | 2020 | **2021** | **Change (%)** | 2020 | **2021** | 2020 | **2021** | 2020 | **2021** | **Change (%)** |
| South | 88 | 88 | 2.2 | 1.8 | -18 | 91 | 87 | 2.5 | 2.1 | 11.9 | 20.1 | 69 |
| East | 151 | 151 | 5.2 | 5.3 | 2 | 146 | 127 | 2.4 | 1.9 | 19.7 | 18.1 | -8 |
| Midlands | 92 | 87 | 2.6 | 3.1 | 19 | 85 | 70 | 2.1 | 3.0 | 14.2 | 21.6 | 52 |
| Wales | 2 | 3 | 1.5 | 1.7 | 13 | 2 | 2 | 1.5 | 2.3 | 7.3 | 11.9 | 63 |
| North | 128 | 115 | 5.1 | 6.6 | 29 | 118 | 76 | 3.0 | 3.1 | 34.3 | 22.7 | -34 |
| Scotland | 73 | 80 | 2.4 | 2.6 | 8 | 70 | 72 | 2.9 | 3.1 | 14.2 | 14.4 | 1 |
| N Ireland | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | - |
| **Overall** | **534** | **524** | **4.1** | **4.0** | **10** | **512** | **434** | **2.6** | **2.3** | **19.9** | **19.2** | **-4** |

*Small sample size. The number of sites includes all that returned information, including zero bird counts. The young-to-old ratio is calculated where at least one adult grey partridge was counted. Autumn density was calculated from sites that reported the area counted.*

while the northern half of the country was much drier than average. June rainfall was below average in most areas, but much of southern and south-east England received around double the average, especially in the latter half of the month following grey partridge hatching. Many areas were also wet in July, and only western and northernmost areas were drier than average, with localised heavy thundery rain events occurring regularly on other areas. Anecdotally, but also noticeably, we received more comments on autumn count forms that noted seeing larger and younger late or second broods than in recent years; we found a similar pattern during our own counts on our Sussex Study area.

Following this disappointing summer, 434 autumn counts were returned in 2021 (see Table 1). The area counted declined by 16%, from 166,630ha in 2020 to 139,260ha. Nationally, bird densities decreased from an average of 19.9 to 19.2 birds per 100ha, driven by declines recorded in eastern (-8%) and especially northern England (-34%). Elsewhere, densities remained stable (Scotland) or increased (South, Midlands, Wales).

Young-to-old ratio (YtO), an easy measure of summer breeding success, declined nationally by 15% from 2.6 to 2.3 young birds for every adult. Declines were seen in eastern and southern England, with small increases in other regions. Nationwide YtO remained above the threshold level of 1.6 needed to cover adult losses into next year.

Despite a difficult summer for first broods in southerly counties, due to wet weather after peak hatch of mid-June, there were many younger birds in second broods, highlighting the grey partridge's strong urge to produce young. Chick survival, which is contingent on the provision of small slow-moving, soft insect larvae and the habitats to support them, remains low. This continues to be a major obstacle preventing grey partridge recovery, and must be addressed before substantial improvement in autumn densities can be expected.

## BACKGROUND

Partridge counts can offer valuable insight into how well your partridges breed, survive and benefit from your habitat and management provision throughout the year. Each count (spring and autumn) is easy to carry out and helps assess the previous six months without the need for continual monitoring.

How to count:

- Spring: Ensure winter coveys have broken up and breeding pairs have formed – typically in February and March. Record all pairs and any single birds.
- Autumn: Wait until most of the harvest has finished – ideally between mid-August and mid-September. Record adult males, adult females and young birds in each covey separately. Don't assume a covey is two adults and some young.
- Use a high 4WD to cover more area in less time. Drive each field perimeter and then criss-cross using tramlines to minimise crop damage. Binoculars help when examining each pair or covey.

www.gwct.org.uk/pcs.

*Successful brood-rearing cover is needed on many more farms to improve summer chick survival.* © Peter Thompson

# Increasing farmland biodiversity at Balgonie

*A block of PARTRIDGE mix at Balgonie, sown in 2021. © Fiona Torrance/GWCT*

## BACKGROUND

Balgonie Estate, situated near Glenrothes in Fife, has been working with the GWCT to conserve its initially modest stock of grey partridges since 2014. Together, we created various habitats for the benefit of partridges and other farmland wildlife. This has involved mostly growing wild bird seed mixes, but also establishing habitat for pollinators, improving hedge management and introducing winter feeding. Since 2016, the farm has been a demonstration site for the PARTRIDGE project, which aims to showcase how farmland biodiversity can be increased by improving agri-environment schemes (see PARTRIDGE, Interreg VB North Sea Region Programme).

Despite Covid-19 restrictions, the Scottish PARTRIDGE team (ourselves and the farm) have worked hard throughout the year to ensure that monitoring activities and good habitat management continued. At the beginning of the year, in addition to the provision of supplementary food in feeders, hare surveys and partridge playback surveys, we reviewed the PARTRIDGE seed mixes that had been sown in 2018. These were designed to provide nesting, brood-rearing and winter cover for partridges (as well as other farmland wildlife) and although they were delivering, we felt that they could be improved.

The main area for improvement was the density of the mixes. Although they were sown at the recommended rate of 20 kilogrammes per hectare (kg/ha), we found that they were too dense in places. Density of brood-rearing cover is important, as dense patches prevent partridges from foraging within them. Cutting 'sweeps' into the blocks in 2020 helped with this, but we felt they could be better. As a result, we decided to resow some plots during 2021 and used this opportunity to improve the mix in other ways.

Although the mixes had provided ample foraging for pollinators during their first year, many of the annual plants had disappeared and some of the other species such as perennial rye and sweet fennel had become too dominant. Working with Kings Crops, additional perennial flowers were introduced into the mix and the species that had become dominant were reduced (see Table 1). We also reduced the sowing rate to 15kg/ha in the hope of enabling partridges and their chicks to forage through the mixes freely.

Our plan to resow some of the PARTRIDGE mix in spring was scuppered owing to one of the driest seasons in recent times. This meant delaying until late June (when partridge chicks start hatching), and we held our breath to see if rain would come and if the late sowing would influence chick survival rate. Fortunately, rain eventually arrived and the mixes grew well.

### Figure 1

**Spring pair density (search area 495-688ha) and autumn density (search area 348-688ha) of grey partridges at Balgonie, 2014-2021. Spring pair counts were not possible in 2017 and 2020***

**Search area variable owing to changing ground conditions*

Spring pairs

Autumn stock

TABLE 1

**Comparison of Balgonie PARTRIDGE mix sown in 2018 and 2021**

| Year 2018 | Year 2021 |
|---|---|
| Brown mustard | **Black knapweed** |
| Chicory | Brown mustard |
| Coleor kale | Chicory |
| Fodder radish | Coleor kale |
| Gold of pleasure | Fodder radish |
| Linseed | Gold of pleasure |
| Perennial rye | Linseed |
| Phacelia | **Oxeye daisy** |
| Sweet clover | Perennial rye |
| Sweet fennel | Phacelia |
| Triticale | **Red clover** |
| | Sweet clover |
| | Sweet fennel |
| | Triticale |
| | **Wild carrot** |

*(Bold species added in 2021)*

During March, we conducted our partridge spring pair counts to estimate the breeding population. Unfortunately, they showed that our 2021 spring pair density was at its lowest level ever at 3.8 pairs per 100 hectares (ha), although it is not clear why. The dry weather until June meant that harvest was around two weeks earlier than normal, so we started our autumn partridge counts in August. We were delighted to find that our autumn density had increased by 22% on the previous year to its highest level of 40.5 birds per 100ha (Y:0 2.51), indicating that up to six pairs had not been visible during the spring count. It is likely that this was a result of a combination of weather and refreshed habitat.

Our farmer engagement work was severely impacted in 2021. Attracting farmers to our events has always been a challenge, but with restrictions in place, it was incredibly difficult to communicate what we were trying to achieve. Now that things are returning to normal, we are planning our first events in two years.

Coincidently, the Scottish Government recently announced the extension of the Agri-Environment and Climate Scheme from 2022 to 2024. Although it is widely accepted that the scheme could be improved, this is a positive measure for biodiversity in the short term. Long-term, it is almost certain that farming for biodiversity will become standard practice, and we hope to help policymakers and farmers make the transition as smooth as possible.

## KEY FINDINGS

- Grey partridge autumn densities have increased by 187% since 2014.
- The estate has created 40ha of new or improved habitat since the GWCT became involved.
- Balgonie is a PARTRIDGE demonstration site used to communicate with policymakers and other interested stakeholders.

Fiona Torrance
Dave Parish
Elizabeth Fitzpatrick
Tamara Spivey

## ACKNOWLEDGEMENTS

Thanks to Balgonie Estates Ltd for allowing use of the site in the project and to Kingdom Farming for establishing the various measures. We thank Kings Crops for its advice and support, and Scottish Agronomy for its advice and assistance with communication activities. Finally, thanks also to our colleagues Francis Buner, Julie Ewald, Cameron Hubbard and Hugo Straker for their help, our other Scottish colleagues and volunteers who have assisted with surveys and to the Interreg NSR programme for funding.

*Balgonie also has other high-quality habitats, including strips of pollinator mix. © Fiona Torrance/GWCT*



# Proposed afforestation and mountain hare

*Extending woodland planting in the Cairngorms would affect mountain hare distribution. © Laurie Campbell*

Afforestation is widely promoted as a nature-based solution (NBS) to address climate change and biodiversity loss. New woodlands can benefit wildlife, store carbon and provide other benefits such as reduced flood risk. However, new woodlands will replace other habitats with potentially negative effects on the species reliant on them. In response to this, the UK Government and devolved administrations have developed ambitious afforestation targets. Areas that are most likely to be targeted for woodland expansion are those that are suitable for tree growth, avoiding deep peat soils and areas of high conservation value, and are of low agricultural value, such as upland moorland. We need to better understand the biodiversity trade-offs associated with woodland expansion on these habitats.

We used the Cairngorm National Park (CNP) and mountain hares as a case study to understand how afforestation might affect open habitat species such as the mountain hare. We chose the CNP as a study area because the Park's Forest Strategy, which categorises areas of the Park as 'unsuitable', 'preferred' (550$km^2$), 'potential, with known sensitivities' (1,322$km^2$) and 'potential montane' (526$km^2$) for afforestation, is detailed enough to enable us to construct baseline and possible scenarios of future woodland expansion. In addition, previous research, involving local land managers, provided good data on the distribution of mountain hares within the park and shows that the CNP is the core area for mountain hares in the UK. We used a species distribution model (SDM) to combine mountain hare occurrence records and bioclimatic and management data (eg. elevation, climate, landcover) to explore the effect of different woodland expansion scenarios on mountain hare distribution. Mountain hares are strongly associated with open moorland habitats, especially areas managed for recreational shooting of red grouse. Therefore, as well as land cover change, our model considered changes in moorland management and assumed that moorland management would cease if moorland cover in any one-kilometre (km) square declined below 67%, as evidenced in earlier research on Scottish moors.

Woodland currently covers around 17% of the 4,528$km^2$ of the CNP. On that basis, the initial model predicted that mountain hare would occur in 63% of one-km

## BACKGROUND

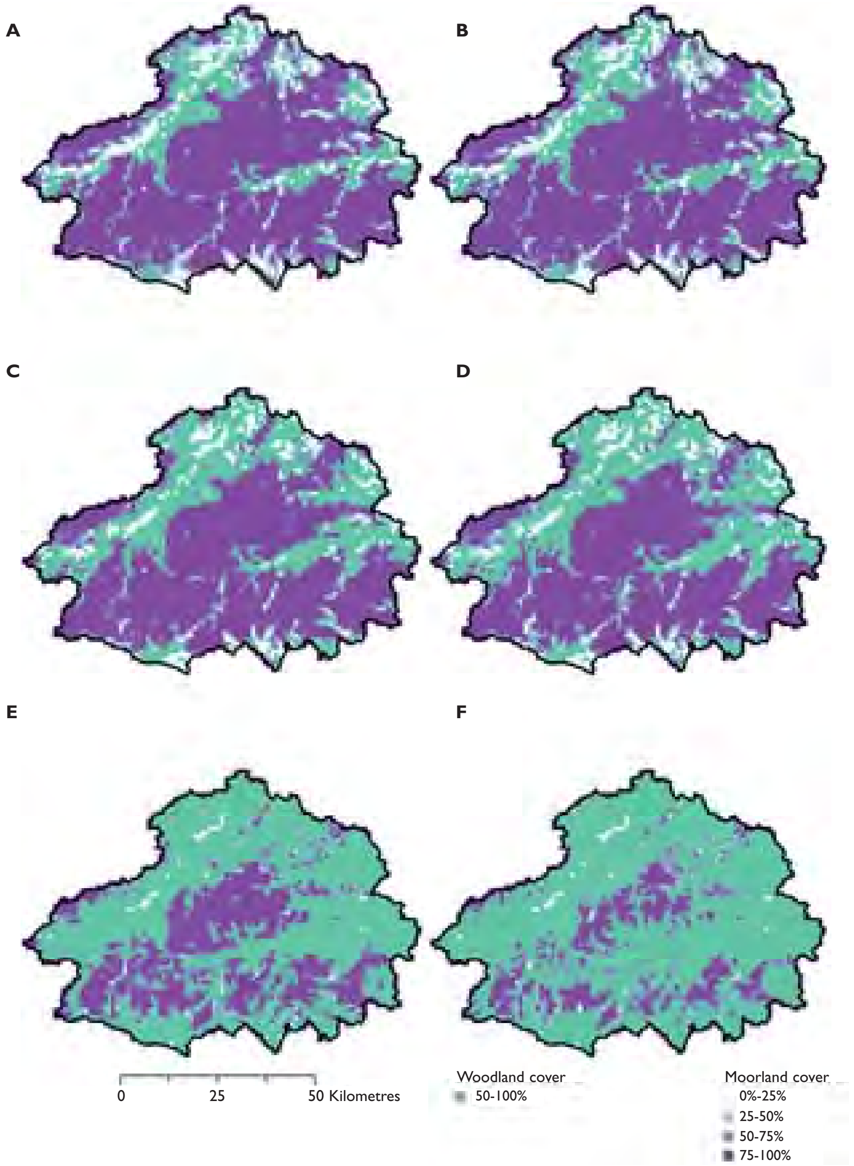
Afforestation is proposed as a means of carbon sequestration, habitat restoration and increasing resilience (eg. flood reduction). Species associated with open moorland habitats, such as the mountain hare, may lose out in this proposed land-cover change. The Cairngorms National Park has published afforestation plans (see *CNP 2018 Forest Strategy and the draft National Park Partnership Plan 2022-27*) which we have used, in combination with a previous survey of mountain hare distribution (*GWCT Review of 2007*, pp56-57) in an attempt to forecast the effects of afforestation on this species.

### TABLE 1

**Projected scenarios of woodland expansion across the Cairngorms National Park (4,528$km^2$ in size), and modelled effects on mountain hare distribution**

| Scenarios | Woodland area | Managed moorland | Mountain hare distribution | |
|---|---|---|---|---|
| Baseline (2015) | 789$km^2$ (17% of CNP) | 1,520$km^2$ (34% of CNP) | 3,343$km^2$ (70% of CNP) | Cumulative change |
| By 2022 | +50$km^2$ | -20$km^2$ | -32$km^2$ (-1%) | (-1%) |
| Additional 350$km^2$ by 2045 | +373$km^2$* | -301$km^2$ | -274$km^2$ (-8%) | (-9%) |
| Preferred area | + 156$km^2$ | -194$km^2$ | -97$km^2$ (-3%) | (-12%) |
| Potential area | + 1,322$km^2$ | -630$km^2$ | -654$km^2$ (-20%) | (-32%) |
| Potential montane woodland | +526$km^2$ | -189$km^2$ | -246 $km^2$ (-7%) | (-39%) |

**Buffering of previous area resulted in slightly over 350$km^2$, for this scenario.*




## Figure 1

A graphical representation of the levels of moorland and woodland across the study area through the additive expansion scenarios created from the CNP Forest Strategy and the draft National Park Partnership Plan 2022-27; (A) Base (2015) scenario,(B) Expansion 1a – made up of 'existing' and 50km² of 'preferred' areas, (C) Expansion 1b – incorporating 'existing' and 400km² of 'preferred' areas, (D) Expansion 1c – afforestation complete afforestation of 'preferred' areas in addition to 'existing' areas, (E) Expansion 2 – afforestation – complete afforestation of 'potential areas' added to Expansion 1, (F) Expansion 3 – with all target areas fully afforested

squares within the CNP (see Figure 1A). The CNP Forest Strategy and proposals include plans for 50km² of new woodland cover by 2022 (see Figure 1B), and proposals for 350km² of new woodland by 2045 (see Figure 1C). Our SDM predicted that afforestation of 50km² within 'preferred' areas would result in the loss of 20km² of managed moorland and a 1% decline in the occurrence of mountain hares. The proposed additional 350km² of woodland cover, also within the 'preferred' areas, would lead to the loss of 301km² of moorland and a further 8% decline in the occurrence of mountain hares (see Table 1). The complete afforestation of the whole of the preferred afforestation zone resulted in an additional 156km² of woodland, a loss of 194km² of managed moorland and the cumulative loss of 12% of mountain hare distribution. Simulating the total afforestation of all 1,322km² of 'potential woodland expansion' area, resulted in a further reduction of 630km² of managed moorland and loss of hares from an additional 654km², with an overall decline in hare distribution of 32%. Finally, for completeness, afforestation of the potential montane woodland area would lead to the loss of 189km² of managed moorland and an overall 39% reduction in the distribution of mountain hare. However, there is no current proposal to completely afforest all these areas, the target areas are indicative only. Any increase in woodland cover includes all types of woodland and scrub, and the CNPA woodland strategy clearly calls for a sensitive approach.

A reduction of 9% of mountain hare range produced by all of the afforestation planned over the next 25 years in the CNP is probably an acceptable trade-off, though GWCT research has shown that the CNP is the stronghold for mountain hare in Scotland and there may be consequences beyond the predictions of our model. Extending woodland planting beyond the plans for 2045 would significantly increase the potential impact on mountain hare distribution and on the landscapes of the Cairngorms.

## KEY FINDINGS

- Tree planting and afforestation is a proposed solution to climate change and biodiversity loss.
- This may have unforeseen consequences, as new woodland replaces other land cover, affecting how the land is used and managed – with knock-on effects for wildlife.
- Models of proposed afforestation plans predicted a cumulative loss of 9% of the distribution of mountain hare in the Cairngorm National Park, reflecting plans for an expansion of woodland area by 400km² (Figure 1C, 50km² by 2022 plus additional 350km² by 2045, outlined in the draft National Park Partnership Plan 2022-2027). We predict further expansion, as outlined in the CNP Forest Strategy, would result in more significant declines.
- Although afforestation may be a valid method of combating climate change and biodiversity loss, consideration needs to be given to the location, and composition, of novel woodland to minimise its disbenefits.

Cameron Hubbard
Julie Ewald
Scott Newey

# PARTRIDGE habitat mapping

*The diverse wildlife habitats on the Rotherfield demonstration site. © GWCT*

## Habitat provision across the PARTRIDGE project

The PARTRIDGE project aims for a 30% increase in farmland biodiversity by 2023 across its 10, 500-hectare (ha) demonstration sites (two each in England, Scotland, the Netherlands, Belgium and Germany), with each demonstration site paired with a local reference site where habitat improvements have not been made. Habitat provision on the demonstration sites is tailored around the needs of grey partridges – with the thinking that if grey partridges can thrive in an arable landscape so can other farmland flora and fauna. In addition to monitoring wildlife (grey partridges, brown hares, other farmland birds), we also digitally map changes in habitat provision on every site to monitor progress towards a key objective – ensuring that at least 7% of the demonstration areas include high-quality, wildlife-friendly habitat. Habitat must provide suitable areas for nesting, brood-rearing or overwinter survival of grey partridges to qualify as high-quality. Maps are produced twice a year, one recording habitat in the summer and another during the winter, for a total of 240 maps during the lifespan of the project. PARTRIDGE partners record every single hedge, flower block, path and crop, with habitat descriptions following a mapping protocol containing 150 unique habitat types. As a result, our maps record detailed information on what is grown when, how it is managed and what it provides for grey partridges and other farmland wildlife.

All our demonstration sites have exceeded the 7% high-quality habitat target, with an average of 11.7% in our demonstration sites in the summer of 2020. At each demonstration site PARTRIDGE partners have taken a site-specific approach to habitat provision, working within the challenges presented by their country's agri-environment schemes, the funding available to them and the interests of the landowner(s).

## BACKGROUND

The North Sea Region Interreg PARTRIDGE project, running from 2017 to 2023, is a multinational project, led by the GWCT, showing how best practice and novel management solutions can be used to enhance biodiversity in an agricultural landscape. These new management solutions are deployed at 10, 500-hectare demonstration sites across four countries, and their results are compared with 10 reference sites which are indicative of a typical farm in the same region.

## Rotherfield (England)

The Rotherfield demonstration site provides an excellent example of how to provide a diverse range of different high-quality habitat types across an area of roughly 500ha. Overall, 83ha of high-quality habitat has been established, of 23 different habitat types, covering 16% of the site. This exceeds the average of 15 different habitat types across the other demonstration sites. Approximately 15% of Rotherfield is covered by high-quality habitat which provides nesting and brood-rearing habitat for grey partridges, while 7% provides escape and foraging cover through the winter. This enhanced habitat also appeals to a wide variety of other farmland species. The Rotherfield site benefits from being managed by one farmer, reflecting the average size of farms in the UK.

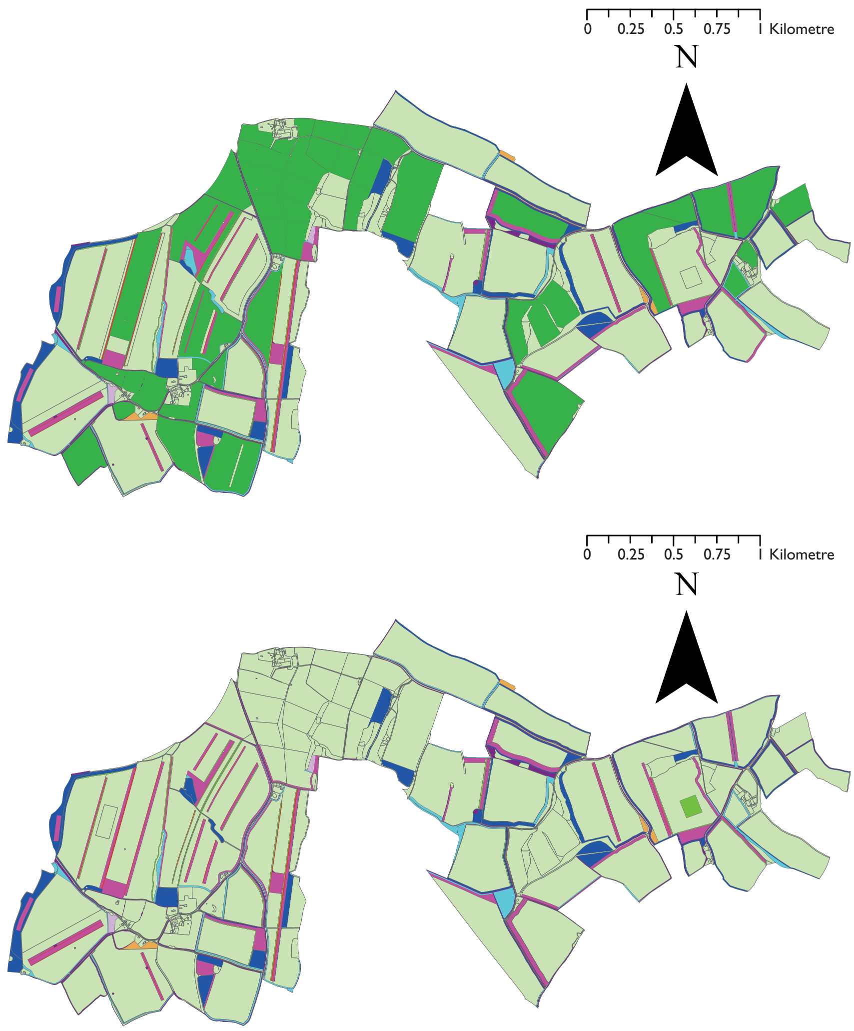



**Figure 1**

The Rotherfield demonstration site in England, pictured in winter 2020 (top) and summer 2021 (bottom). Rotherfield boasts an incredibly diverse range of habitat types and provides the most beneficial habitat out of all of our demonstration sites

*© Crown copyright and database rights 2021 Ordnance Survey 0100031673*

- Beetle banks
- Floristically enhanced features
- High-quality hedges & herbaceous elements
- Pollen & nectar mixes
- Unenhanced grass margins
- Vogelacker or headlands
- Wild bird cover
- Winter stubbles
- Other habitat

### Burghsluis (Netherlands)

PARTRIDGE partners have country-specific options available to them through their agri-environment schemes. One such option available to our Dutch partners is the 'Patrijzenrand' ('partridge border'), illustrated in Figure 2 from the Burghsluis demonstration area. Patrijzenrand is a combination of three different habitats (a flower strip, a grass strip and bare land) arranged in parallel strips. Individually these three habitats may at best provide moderate benefits for grey partridges, but arranged together they provide an all-in-one area for grey partridges to forage, nest and overwinter. Patrijzenrand is one of 15 habitat types present in Burghsluis, accounting for 15% of the high-quality habitat on that site.


**Figure 2**

The Burghsluis demonstration site in Zeeland, the Netherlands. The 'partridge edge' habitat (pictured in yellow) provides everything a grey partridge needs to thrive – food, nesting sites, and overwinter cover

- Partridge edge habitat
- Beneficial habitat

*The Dutch 'patrijzenrand' habitat at the Burghsluis demonstration site. © Suzanne van de Straat*

### Diemarden (Germany)

Many sites in continental Europe cannot practise predation control of the sort that is legally possible in the UK, where it is directed towards reducing predation during grey partridge nesting. This leads to an increase in predation risk, exacerbated by the fact that many of the linear features on our demonstration sites, such as floristically-enhanced grass margins, are used by mammalian predators to travel around the sites. This is the case on the sites managed by our project partners in Germany. Their research has shown that it is possible to mitigate the impact of predators by substantially increasing the width of linear habitats. This reduces the likelihood of a predator stumbling across a grey partridge as it follows the edge of the feature. In Diemarden (see Figure 3), one of the German demonstration sites, thin linear features such as wild bird cover plots have been made 23% wider than the same linear feature in English and Scottish sites where predators are controlled.

### Isabellapolder (Belgium)

Simply establishing good habitat is not enough to improve biodiversity – it then has to be managed correctly to ensure that it continues to provide maximum benefit. This applies to the rotational wild bird cover plots that have been implemented across many of our demonstration sites. These can provide nesting sites, overwinter cover and foraging habitat, even in the first year, depending on when they are sown. However, in the second year onwards the vegetation on the plot can grow too thick, becoming less beneficial for the species we aim to conserve.

Across our demonstration sites this is remedied by re-establishing parts of the plot in rotation each year, creating a mosaic of habitat ages and ensuring the plot never

## KEY FINDINGS

- PARTRIDGE project partners across Europe have established habitats to aid grey partridge conservation and other farmland wildlife, covering at least 8% of their demonstration areas.
- Here we use computer mapping to illustrate how this is accomplished at four demonstration sites, taking into account local considerations.
- Habitat mapping provides both a visual interpretation of the extent of management and precisely quantifies the amounts of each habitat type at each site.

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Julie Ewald
Francis Buner
Ellie Raynor
Suzanne van de Straat
Catherine Vanden Bussche
Nick Van Der Hooft
Lisa Dumpe
Valentin Dienst

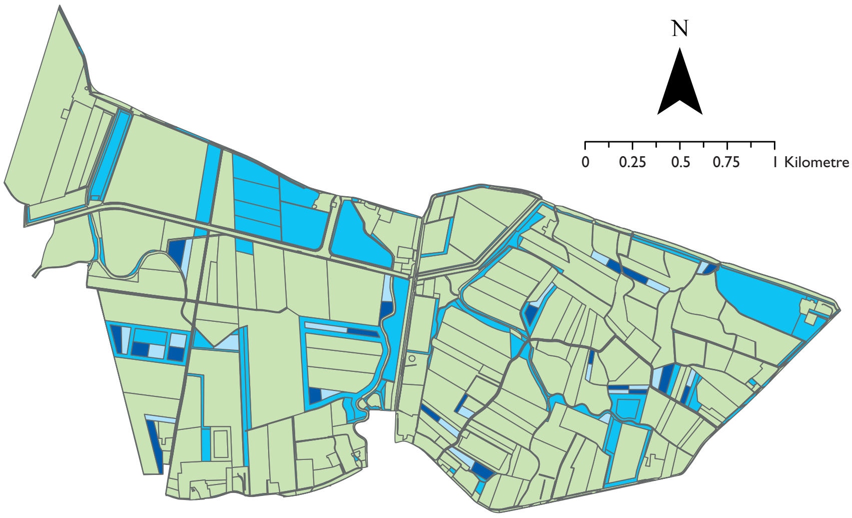
*One of the flower blocks established in our German demonstration sites. © Lisa Dumpe*


## Figure 3

Diemarden, one of our German demonstration sites. To mitigate the impact that predators have on grey partridges across the site many of the features are wider than they would be on a site with lethal predator management. Pictured in dark purple are wide features where grey partridges are better able to avoid predation

Thin features with typical predation risk

Wide features with decreased predation risk




## Figure 4

Isabellapolder, one of two demonstration sites in Belgium. The rotational cutting of wild bird plots to ensure they provide the maximum benefit possible is most apparent here, with newly established plots coloured in light blue, and older plots in dark blue

*Partridge beneficial habitat.*
*© Vlaamse Landmaatschappij, 2022*

First-year wild bird cover

Second-year wild bird cover

Other beneficial habitat

grows so dense as to be unusable. A map of Isabellapolder, one of the demonstration sites managed by our Belgian partners (see Figure 4), provides an example of this. Roughly 3% of this site is occupied by wild bird plots, and the rotational re-establishment is clear to see on the map of the site. The cutting takes place outside the breeding season to ensure that hens and chicks are not disturbed or harmed by the mowing.

*An aerial view highlighting the rotational re-establishment of wild bird cover at Isabellapolder. © Korneel Verslyppe*

## ACKNOWLEDGEMENTS

This project would not be possible without the help of hundreds of supporters. We thank all participating GWCT members of staff (in particular Dave Parish, Fiona Torrance, Chris Stoate, John Szczur, Steve Moreby and Amelia Corvin-Czarnodolski), the PARTRIDGE co-ordinating partner organisations BirdLife NL, the Flemish Land Agency (VLM), INBO, the University of Göttingen and the Danish Hunters Association together with their local PARTRIDGE partner organisations, all the participating farmers, hunters, volunteers, NGOs and Government agencies, the Steering Committee members, and, last but not least, the NSR Interreg Secretariat in Denmark.

# NGC: trends in deer and boar

*After doubling by 2010, numbers of sika deer reported to the NGC have stabilised. © David Mason*

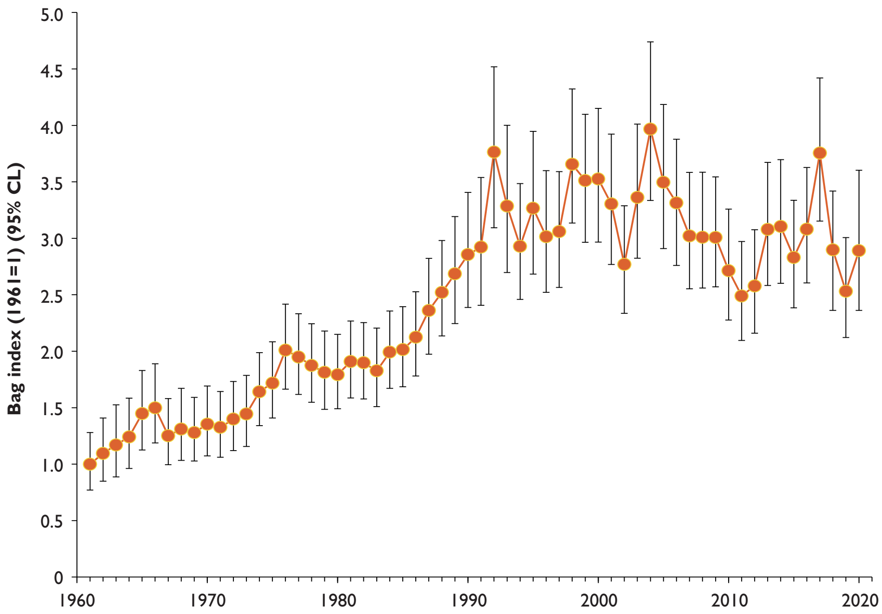
## BACKGROUND

The NGC was established by the GWCT in 1961 to provide a central repository of records from shooting estates in England, Wales, Scotland and Northern Ireland. The records comprise information from shooting and gamekeeping activities on the numbers of each quarry species shot annually ('bag data').

The National Gamebag Census (NGC) collects information on numbers shot of all six species of deer commonly found in the UK, and also wild boar. Only red and roe deer occur naturally here; the others were deliberately introduced (sika, fallow) or escaped from captivity (muntjac, Chinese water deer, wild boar). These ungulate species are shot for sport (stalking), and also to prevent damage to woodland and arable crops. Thanks to the voluntary returns sent in by NGC participants, we are able to evaluate trends in numbers shot. This provides an insight into historical and current changes on a year-to-year basis, which is important for monitoring the status of indigenous species and the population growth of introduced ones. To calculate trends, we need at least five returns per year, so the start year is 1961 for the two naturally-occurring species and varies from 1977 to 2008 for the others, depending on when each species became widespread enough to generate sufficient annual NGC returns in consecutive years. Hence, for the first time, we can generate a trend for Chinese water deer (starting in 2008), but we cannot do so yet for wild boar. Analysis is based on sites that provide deer returns for two or more years, which enables us to calculate the change between years within sites. These measures are adjusted and averaged across sites to produce annual indices of change relative to the start year. This means that in the graphs the first point has a value of 1 and subsequent points show the amount of change since the first year (e.g. a value of 2 indicates a doubling in numbers shot since the first year, one of 0.5 a halving).

**Figure 1**

Index of red deer shot per km² on NGC sites across the UK, 1961-2020



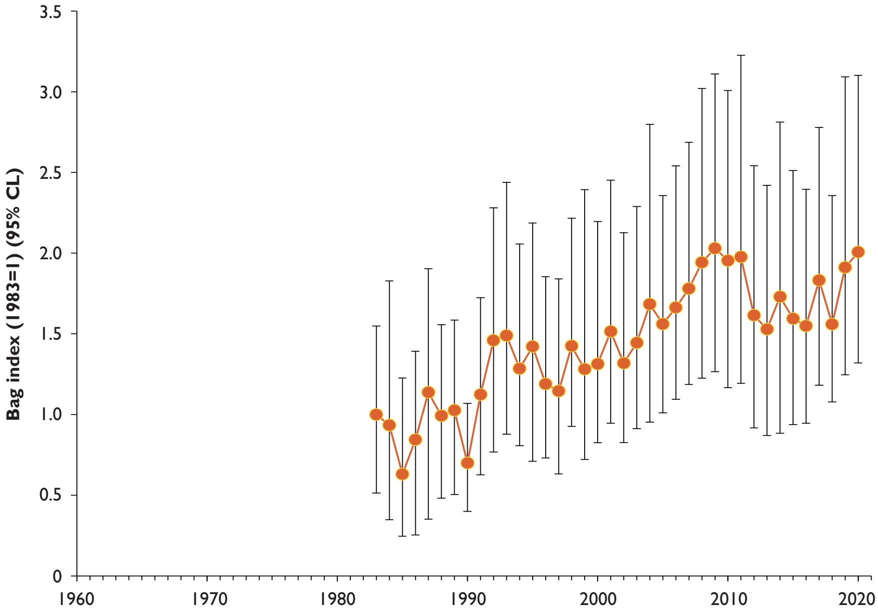



Figure 2

Index of sika deer shot per km² on NGC sites across the UK, 1983-2020

## KEY FINDINGS

- Since 1961, the numbers of red, sika, fallow and roe deer reported to the NGC increased two- to seven-fold, but then stabilised (sika, roe) or even declined (red deer).
- The numbers of muntjac reported increased 25-fold since 1983 as the species grew in range and abundance across England.
- Chinese water deer records are now numerous enough to calculate a trend, showing that from 2008 to 2020 the numbers shot increased 18 times.
- Since 1990, wild boar have been reported present at 26 sites and shot at 16, reflecting their gradual establishment and spread in England, Wales and Scotland.

Nicholas Aebischer

### Red deer (Figure 1)

The red deer is widespread across Scotland, its traditional stronghold, but also in northern and southern England through to East Anglia as well as Northern Ireland. Based on returns from 291 sites, the bag index more than tripled by the early 1990s, remained roughly stable to the mid-2000s, then declined by 15% by 2020. The increase reflects the rising abundance and expanding range of the species, probably helped by insufficient culling of females, better food resources from afforestation, better survival during milder winters and reduced competition with hill sheep. Maturing forestry and intraspecific competition may explain the recent decline.

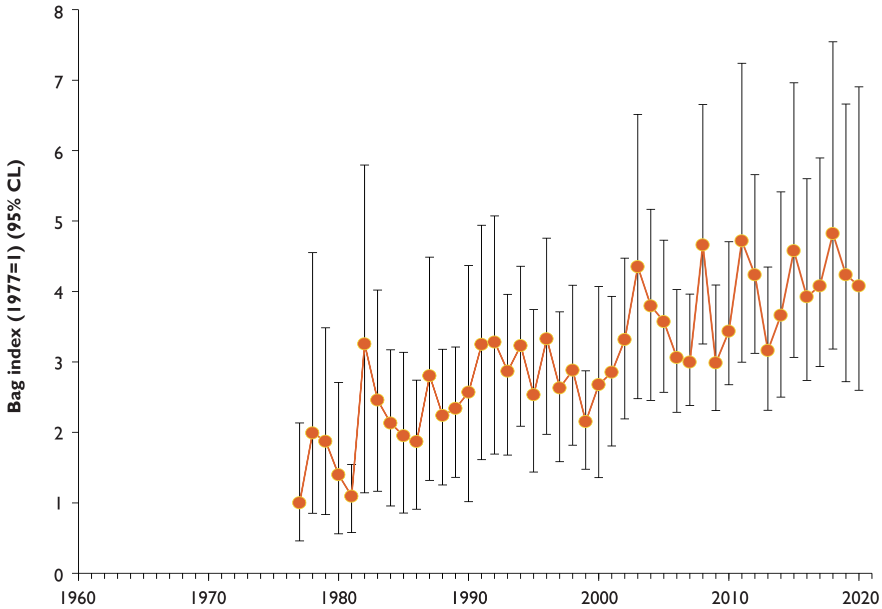
### Sika deer (Figure 2)

Sika deer, originating from Japan, Taiwan and the adjacent Chinese mainland, were introduced into British deer parks from 1860 onwards. Many since escaped and the species is now widespread across northern and western Scotland, the Scottish Borders, Cumbria, Lancashire, Sussex/Hampshire/Dorset and the western part of Northern Ireland. In all 76 NGC sites have reported sika deer, with sufficient records to evaluate trends since 1983. The bag index shows a doubling by 2010, followed by stabilisation. The increase matches what is known about the ongoing range expansion and increasing abundance of sika deer.

*Roe deer went nearly extinct 300 years ago, but since 1961 there has been a seven-fold rise in numbers reported to the NGC. © Laurie Campbell*

Figure 3

Index of fallow deer shot per km² on NGC sites across the UK, 1977-2020




## Fallow deer (Figure 3)

The Normans re-established the fallow deer in England in the 11th century, it having gone extinct in Britain during the last Ice Age. It is currently widespread across most of England and Wales, and occurs in isolated areas of Scotland and Northern Ireland. Sufficient NGC sites are available to evaluate trends from 1977, with 208 sites in total reporting shot fallow deer. The UK bag index increased four-fold by 2020, with scant evidence of stabilisation. The increase is as expected from the species' gradual expansion in range.

## NATIONAL GAMEBAG CENSUS PARTICIPANTS

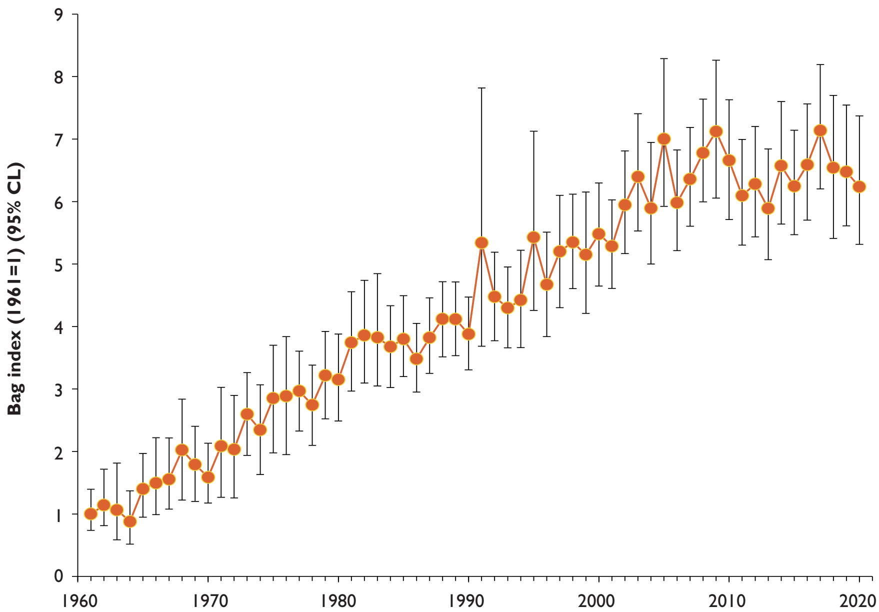
We are always seeking new participants in our National Gamebag Census. If you manage a shoot and do not already contribute to our scheme, please contact Corinne Duggins on 01425 651019 or email **ngc@gwct.org.uk**.

## Roe deer (Figure 4)

The roe deer went nearly extinct 300 years ago. Helped by reintroductions, it has steadily expanded its range and now occupies mainland Scotland, nearly all of England and most of Wales. The calculation of trends is based on returns from 705 sites. Since 1961 there has been a sustained rise amounting to a nearly seven-fold increase by the late 2000s, with apparent stabilisation thereafter. The increase corresponds to a spectacular period of range expansion and increasing abundance, probably linked to a combination of habitat expansion (new forestry plantings) and changes in the law (control by snaring and shotgun drives no longer permitted), that led to greater use of stalking for control and for income.

Figure 4

Index of roe deer shot per km² on NGC sites across the UK, 1961-2020



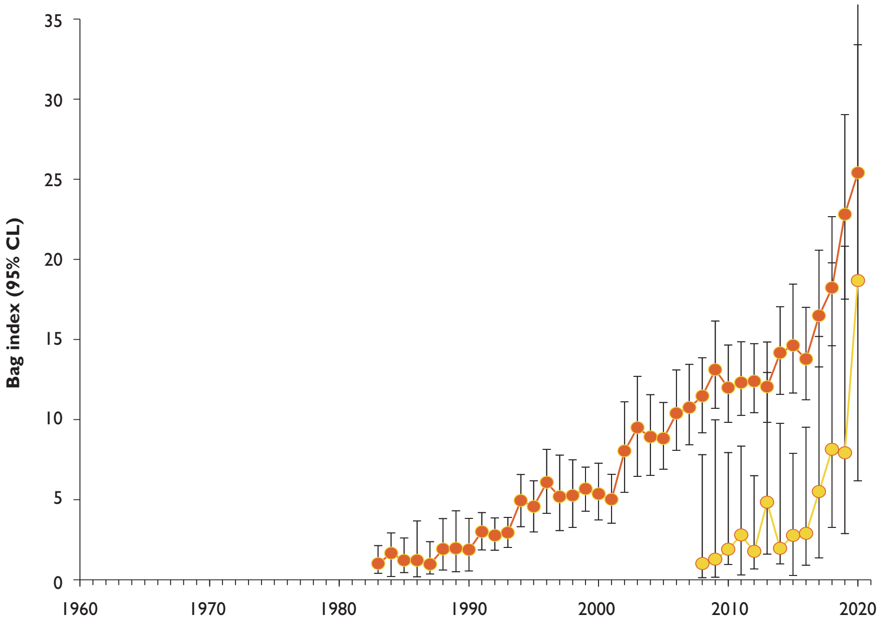



Figure 5

Index of muntjac (1983-2020) and Chinese water deer (2008-2020) shot per km² on NGC sites across the UK

Muntjac (1983=1)

Chinese water deer (2008=1)

## Muntjac (Figure 5)

The muntjac originates from south-east China and Taiwan. Originally introduced to Woburn Park, Bedfordshire, in 1894, further releases and escapes led to it becoming established in the wild. NGC muntjac returns were from southern and eastern England originally, then after 1980 increasingly from the Midlands. The first return from northern England was in 2005, and from Wales in 2014. Based on returns from 249 sites, trends can be evaluated since 1983. They show a spectacular 25-fold increase to 2020, with no evidence of it petering out. The increase matches what is known about the continuing growth in range and abundance of muntjac.

*Muntjac showed a spectacular 25-fold increase between 1983 and 2020. © David Mason*

## Chinese water deer (Figure 5)

Originally from China and Korea, Chinese water deer were introduced to Woburn Park in 1896 and Whipsnade Park in 1929-1930, both in Bedfordshire. Escapes and deliberate releases led to the species becoming established in the wild in south-eastern England. The first NGC record of water deer being shot was from Bedfordshire in 1990. Bags have now been reported from 29 sites: 4 in Bedfordshire, 1 in Buckinghamshire, 1 in Cambridgeshire, 9 in Norfolk, 2 in Suffolk, 1 in Oxfordshire and 1 in Hampshire. The number of returns is sufficient to construct a bag index since 2008: it shows an exponential rise, with an 18-fold increase in numbers shot by 2020.

## Wild boar

Wild boars were native to the British Isles but were hunted to extinction in medieval times. The farming of wild boar for meat began in the 1980s, leading to escaped animals establishing themselves in the wild, initially in Kent and Dorset. By 2000, those counties each provided one site returning the first NGC records of wild boar presence; 13 sites did so in 2001-2010, and 16 in 2011-2020. Overall, presence of wild boar has now been reported from 26 sites: 1 in Devon, 5 in Dorset, 1 in Somerset, 1 in Gloucestershire, 3 in Kent, 2 in Suffolk, 2 in North Yorkshire, 1 in Powys, 1 in Gwent, 1 in Dumfries & Galloway, 6 in Grampian, 1 in Tayside and 1 in Highland; animals were shot on 16 of them.

*Wild boar range is gradually expanding across England, Scotland and Wales. © WildMedia*

# Uplands

© Laurie Campbell

# Uplands monitoring in 2021

## BACKGROUND

Our upland research team conduct annual counts of red grouse in England and the Scottish Highlands to assess their abundance, breeding success and survival, which may change according to *Trichostrongylus tenuis* parasitic worm infestations. We also count black grouse at leks and estimate their breeding success in August. These data enable us to consider any long-term changes so we can recommend appropriate conservation or harvesting strategies. Such information is vitally important if we are to base such decisions on accurate estimates.

### Grouse counts - England

Despite the long-term annual monitoring of red grouse being one of the key tasks undertaken by the upland team, the number of staff equipped with working pointing-dog teams was reduced from four to two. This resulted in the number of grouse counts conducted in northern England being pruned from 54 in 2020 to 41 in 2021. This remaining level of survey only proved possible due to the levels of fitness and dedication shown by veterans David Baines and Philip Warren and their respective hounds, together with coaxing David Newborn from retirement.

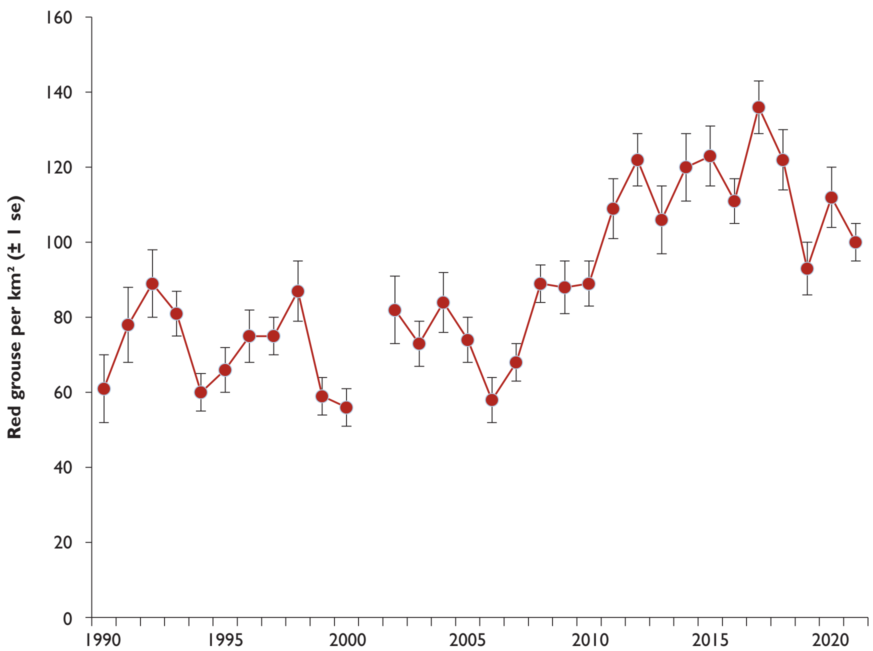
Dropping counts, many of which had valuable time series dating back to the mid-1980s, involved making difficult decisions. Perhaps the hardest was to drop all counts within the Forest of Bowland in Lancashire and the Peak District in Derbyshire. Doing so massively impaired key geographical comparisons, but reduced logistical problems, costs of travel and overnight accommodation, all important considerations within the new-normal Covid-19 era. This allowed us to retain most of the relatively local sites in the North Pennine Dales and the North York Moors.

In this article, we report on changes in annual grouse numbers and breeding success over the last three decades (1990-2021) in northern England. The number of sites counted per annum rose from 17 in 1990 and peaked at 56 sites in 2018. Typically, we count grouse twice per year at each site, first in spring (March or early April) to assess pre-breeding numbers when grouse are in pairs, and second in summer (July or early August) when fledged chicks are in family groups and still distinguishable from the adults. From these two counts we report pre-breeding and post-breeding densities and breeding success (the ratio of young to adult grouse in the July coveys).

The 30-year pattern in spring grouse densities is shown in Figure 1. Mean annual values varied little between 1990 and 2007, at a range of 60-90 grouse (30-45 pairs)

**Figure 1**

Average density of adult red grouse in spring from 17-56 moors in northern England 1990-2021



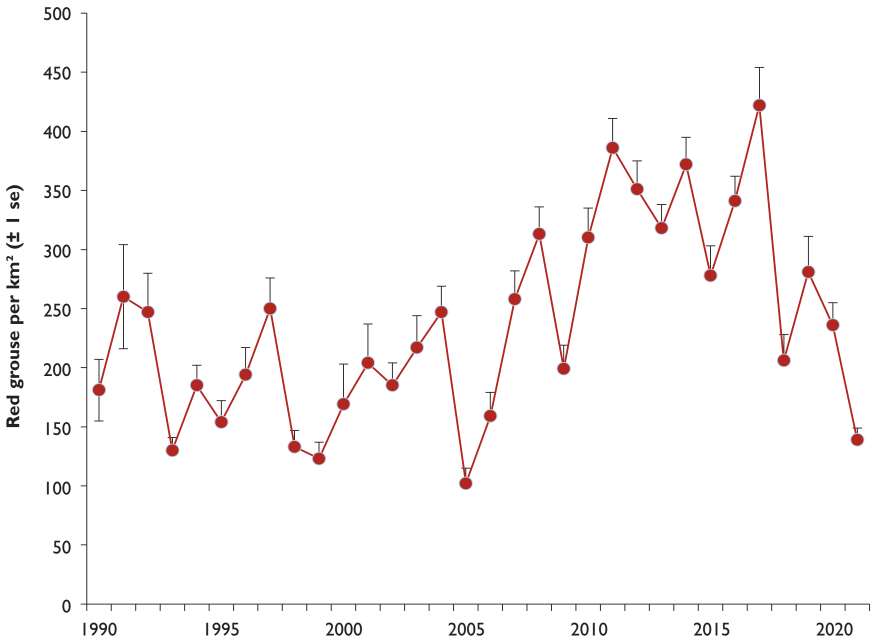



**Figure 2**

Average density of young and adult red grouse in July from 17-56 moors in northern England 1990-2021

per km². However, from 2008 onwards, densities steadily climbed, reaching a peak of almost 140 birds (70 pairs) per km². In the last four years, densities have fallen to an average of just over 100 (50 pairs) birds per km².

This general pattern in grouse pre-breeding densities is repeated when considering post-breeding densities, which showed relative stability until 2008, a tendency for increases in the period 2008-17 and reductions in the last four years (see Figure 2). However, within those trends, post-breeding grouse densities show greater annual variation, ranging from 123-258 birds per km² up to 2007, 200-422 from 2008-17 and 139-281 after 2017.

Average post-breeding counts show greater variation between years than pre-breeding counts for two main reasons. First, they reflect differences between years in grouse breeding success, which is depicted in Figure 3, and second, harvesting (shooting) helps regulate grouse numbers in the autumn and early winter and, together with adjustment for natural mortality through the rest of the winter, should bring numbers back to reflect pre-determined required levels by the following spring. Thus, carefully designed and conducted grouse count schemes can guide shooting programmes to ensure optimal levels of sustained harvesting are met.

So, what has caused these differences in pattern in the three periods pre-2007, 2008-17 and post-2017? Accounting for the rise in grouse numbers after 2007

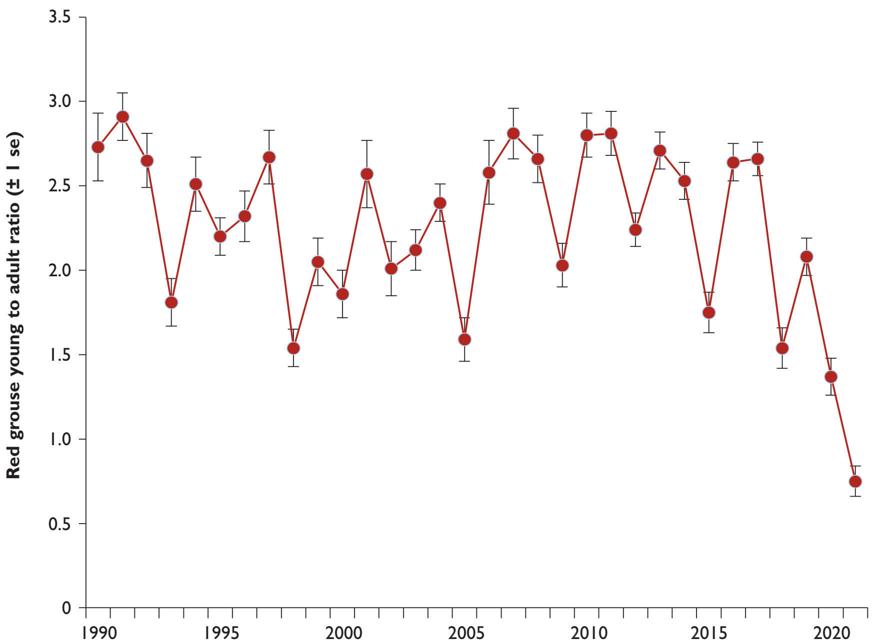
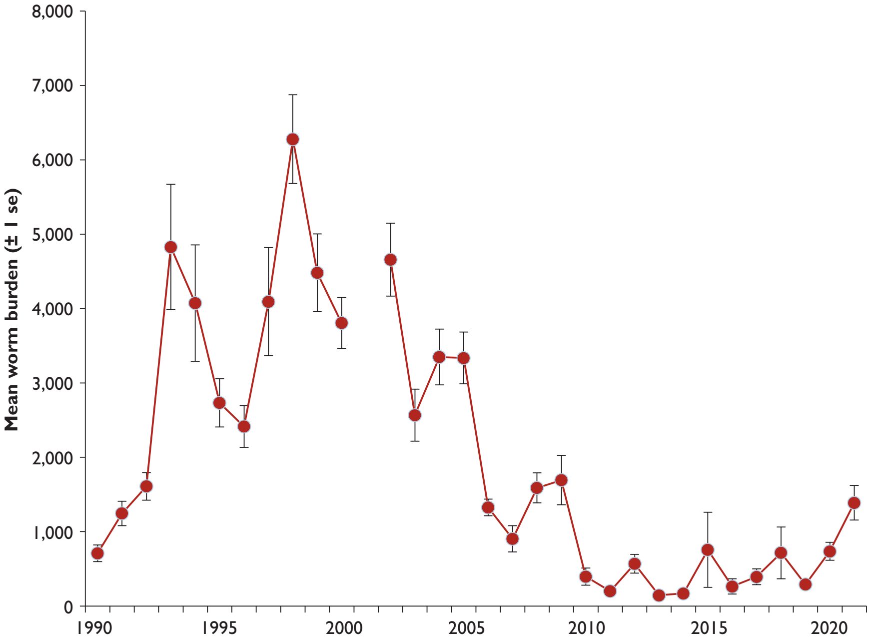



**Figure 3**

Red grouse breeding success in northern England 1990-2021

Figure 4

Average (geometric mean) annual worm burden for autumn-shot adult red grouse from 11-45 moors in northern England 1990-2021




## KEY FINDINGS

- Grouse densities fluctuated over a five-year cycle, but were otherwise stable in northern England from 1990-2008.
- From 2008-2017 densities increased in-line with use of new medicated grit. The mechanism for this being increased adult survival rather than better breeding success.
- Poor breeding in recent years has been associated with poor food quality following heather beetle outbreaks and increased levels of strongyle worms, despite use of medicated grit.
- A new study in 2022 will explore how parasites, food quality and weather interact to determine maternal conditions in grouse and how hen health may, together with insect abundance, determine chick survival.

David Baines
Kathy Fletcher
Sonja Ludwig
Phil Warren

appears straightforward. It is coincident with, and probably caused by, the widespread uptake of the new form of medicated grit ie. flubendazole-based, stearate-coated and served in a removable box or tray. As evidence to support this, strongyle worm infestations in grouse plummeted to sustained low levels following deployment of this improved product and more efficient delivery technique (see Figure 4). The demographic mechanism for this rise in grouse numbers appears not to be improved breeding success, which showed no overall change after 2007, but improved adult grouse survival, both during the breeding season, reflected by the increase in July counts (see Figure 2), and over-winter, the latter despite marked increases in levels of harvesting (not illustrated).

What is harder to explain is why grouse numbers have dropped in the last few years and so much in 2021. Medicated grit was in use, but grouse mortality was high, especially that component caused by the parasitic worm-induced disease strongylosis. Of note is that grouse deaths occurred at much lower worm intensities than those measured pre-2007. The most plausible cause for grouse being more susceptible to parasitic worms was their level of fitness. In the last two years, outbreaks of heather beetle have devastated heather plants, the food of both grouse and beetle. In 2021, post-outbreak recovery of heather was impaired by severe spring frosts and snow, causing prolonged winter browning of heather and delayed increase in its nutrient content. Green nutrient-rich heather was generally not available until after egg formation, with hens producing clutches of few eggs, possibly of low quality. Greening frequently did not occur until after chicks had hatched (and died). Poor-quality heather and delayed emergence of craneflies eaten by chicks both appeared to severely impact chick survival and suppressed grouse breeding success in 2021 (see Figure 3). The recently observed high levels of strongyle-induced mortality among grouse could also in theory be explained by parasitic worms developing genetic resistance to the wormer flubendazole. It has happened already among domestic livestock, why not grouse too?

*The recently observed high levels of strongyle-induced mortality among grouse could also in theory be explained by parasitic worms developing genetic resistance to the wormer flubendazole.* *© Laurie Campbell*

## Future grouse monitoring

Into the future, we hope to fundraise specifically to enable us to test the possibility of wormer resistance. More immediately we intend measuring how seasonal and annual variations in heather nutrient content, early-developing protein-rich foods such as flowers of cotton grass and worm parasites interact to influence grouse maternal condition. In turn, we will also consider how hen condition affects both egg and clutch sizes, and how egg quality, together with the timing of emergence and abundance of craneflies, collectively influence chick survival.

## Grouse counts - Scotland

Grouse counts have also been undertaken in Scotland since 1990, with 18-25 counts each year. Spring grouse densities in Scotland are lower than in northern England with mean values ranging from 35 to 81 birds (17 to 40 pairs) per km² in the last 30 years (see Figure 5). Average post-breeding densities show less pronounced trends than those in northern England, with a peak of 184 birds per km² decreasing to the most recent counts of 59 birds per km² (see Figure 6). The lower densities in Scotland can, at least in part, be explained by lower productivity. This has averaged 1.6 young per adult between 1990 and 2021, with poor breeding for the last four years (0.7–1.3 young per adult). Strongyle worm burdens were again low on average for those estates monitored.

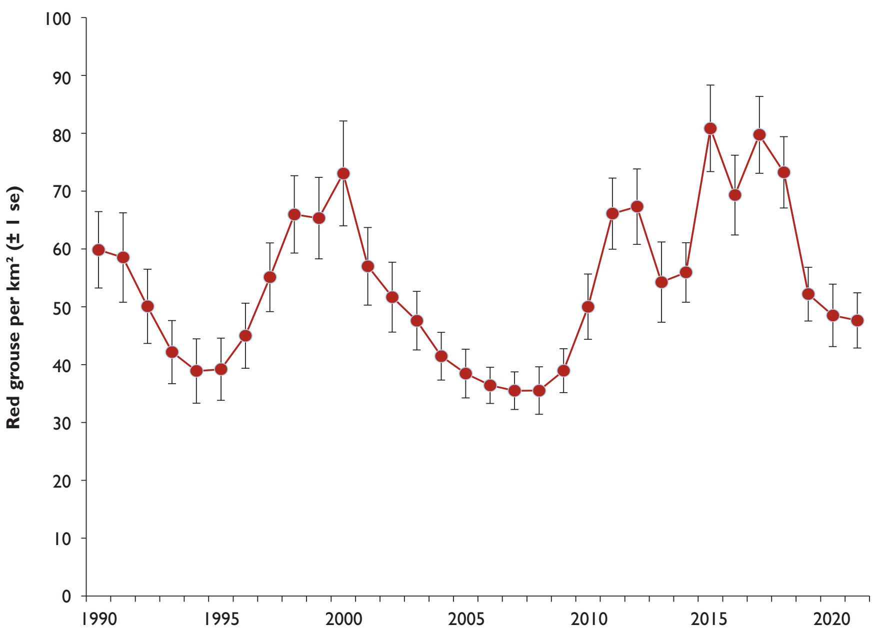



**Figure 5**
Average density of adult red grouse in spring from 18-25 moors in Scotland 1990-2021

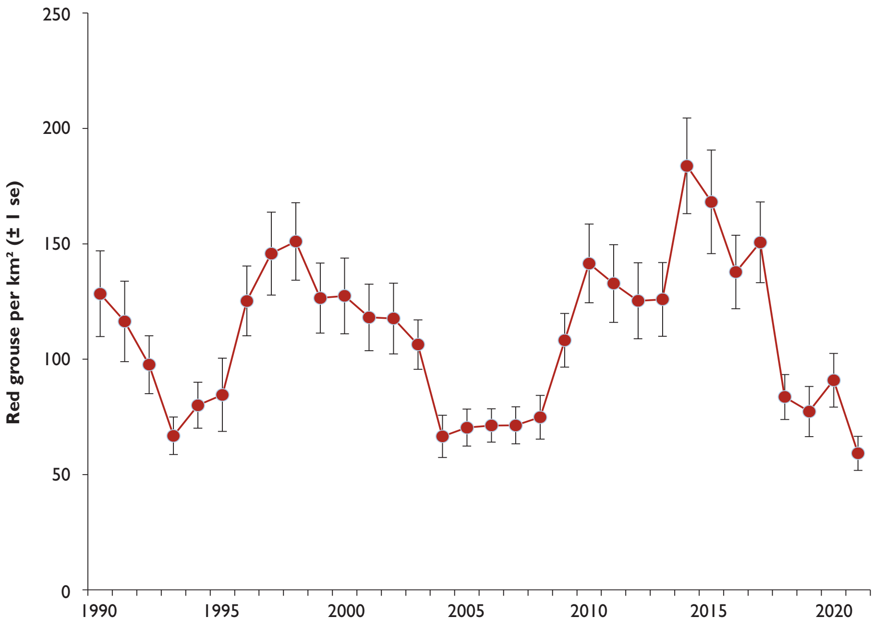



**Figure 6**
Average density of young and adult red grouse in July from 18-25 moors in Scotland 1990-2021

# Merlin Magic - increasing our understanding

*After concerning local declines, merlin were returned to the Red List of Birds of Conservation Concern in 2015. © Dave Baines/GWCT*

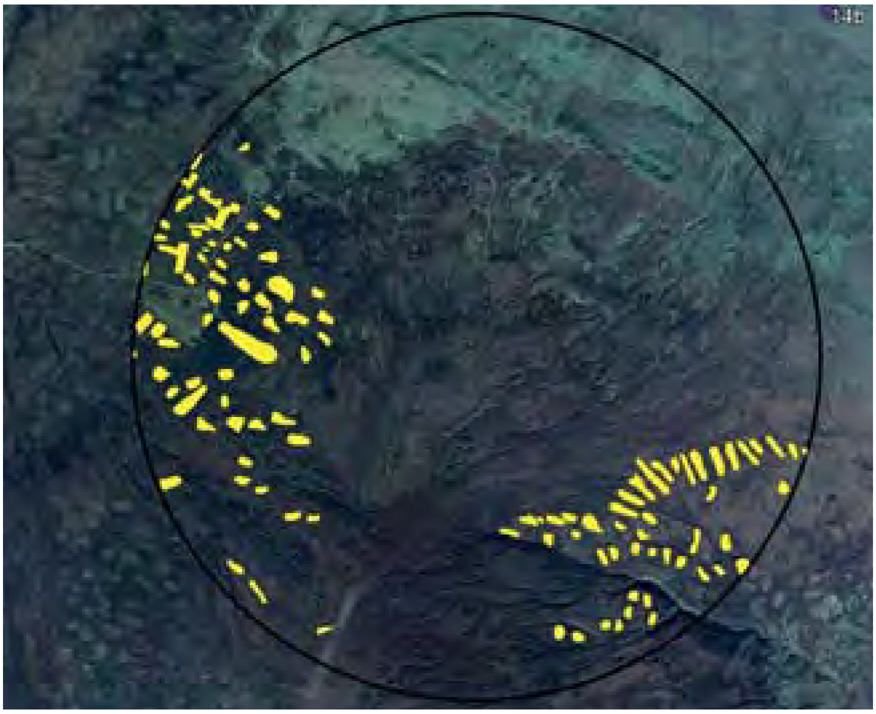
## BACKGROUND

Merlin were upgraded to the Red List of Birds of Conservation Concern in the UK in 2015 as their recovery from a historic decline had faltered. In parts of northern England declines of up to 69% since 1994 had been recorded, but these are contested by grouse-moor managers who feel that numbers remain stable. Increased heather management through burning or cutting on grouse moors has been suggested as a contributor to the decline through reducing the availability of tall heather for nesting and modifying habitats, reducing numbers of meadow pipits and skylarks which are important prey species for merlin.

Merlin Magic is an 18-month project funded by the Government's Green Recovery Challenge Fund, a multi-million-pound boost for green jobs and nature recovery in England. The project focuses on the merlin, a small falcon of long-term conservation concern which breeds on moorland. Merlin have undergone periods of marked population decline, crashing to just 550 pairs in the 1960s owing to organo-chlorine pesticide contamination. Numbers have since recovered, with the most recent survey in 2008 estimating that there were 1,162 pairs in Britain, 301 of which were found in England. Comparisons with data from 1993/4 suggest that overall the population is stable, but with some marked local declines particularly in south-west England where pairs declined by 83% and in northern England, with reported declines of 69% in Northumbria and 47% in the North York Moors and South Pennines. Thus, in 2015 merlin were returned to the UK Red List of Birds of Conservation Concern, meaning they require urgent conservation action.

In northern England, grouse moors provide important refuges for merlin, where they breed in areas of tall heather and feed their young on small birds such as meadow pipits and skylarks. Raptor workers annually visit merlin nests and ring chicks under licence. In 2020, GWCT staff volunteered time to help monitor breeding merlin and ring nearly 50 chicks within the Yorkshire Dales National Park. This provided opportunities to discuss merlin conservation with moorland managers and learn more about their concerns regarding recent population declines and associated likely causes. Recent declines are contested and there is disagreement on the causes. For instance, gamekeepers believe that their management for grouse helps to support merlin and other ground-nesting birds, while others suggest that over-zealous heather burning for grouse reduces merlin nesting habitat and prey abundance.

The causes of merlin decline are not well understood and may act on moorland breeding grounds, on wintering grounds on lowland farms and coastal areas, or on both. To date merlin decline has been associated with pesticide contamination, but has also been linked to loss of moorland habitats planted with commercial forestry or converted to grass moor through overgrazing by sheep. More recently, the intensification of heather management through rotational strip-burning or cutting on remaining moorland, especially that managed for driven red grouse shooting, may have reduced the availability of tall heather for nesting and the numbers of small moorland birds such as meadow pipits and skylarks which are important prey species.



*Aerial photographs are used to map the changes to heather burning (yellow) through time, using three images taken approximately 10 years apart between 2002 and 2021. © GWCT*

The Merlin Magic Project aims to help reconcile opinions by promoting co-operative working between gamekeepers and raptor workers to help locate nests, then ring and tag chicks under licence. GWCT scientists will measure vegetation characteristics at nests and within breeding territories, and assess the abundance of avian prey, to learn more about breeding habitat requirements for merlin. To learn more about chick diet and prey delivery rates we will set up concealed cameras at a sample of merlin nests. We will also fit a sample of fledglings with GPS tags to study movements after the breeding season and mortality timing and rate, and where possible causes of mortality on wintering grounds. The evidence collected will be used to guide landscape-scale management for moorland habitats to benefit merlin, other ground-nesting birds and to improve overall habitat condition on moorland.

As well as conducting field research to collect vital data, the project aims to produce a suite of resources to help people learn about merlin and moorland conservation issues and provide evidence-based information to inform conservation policy. The project hopes to bring the public closer to these birds through streaming nest footage, writing fieldwork blogs and providing regular updates. By doing so the project will communicate best-practice strategies for effective merlin conservation directly to grouse practitioners and upland ecologists working in these areas, as well as promoting public awareness of moorland conservation issues and laying the foundations for further grouse-raptor reconciliation projects.

## PROJECT AIMS

- Provide a better understanding of how merlin use grouse moors and what pressures are affecting merlin numbers.
- Bring together different groups with a shared passion for merlin, but with differing perspectives on how to drive their recovery. Help to reconcile opinions through promoting co-working between gamekeepers and raptor workers to locate nests, then ring and tag chicks under licence.
- Engage with a wider audience – grouse practitioners, raptor workers, conservation workers and the wider public through a range of channels – from peer-reviewed scientific papers to streaming footage of merlin nests.

David Baines
Philip Warren
Georgia Isted
Lucy Marsden
Bethany Tilley
Leah Cloonan

## FUNDING

MERLIN MAGIC

This project is funded by the Government's Green Recovery Challenge Fund. The fund was developed by Defra and its Arm's-Length Bodies. It is being delivered by The National Lottery Heritage Fund in partnership with Natural England, the Environment Agency and Forestry Commission.

Green Recovery Challenge Fund

*Field measurements are taken within merlin territories to understand the types of vegetation present and the structure of heather which is burnt/cut in patches. © GWCT*

# Heather restoration after heather beetle outbreaks

*Heather sward showing areas of grey, dead heather killed by heather beetle attack. © Sarah Grondowski*

## BACKGROUND

The heather beetle (*Lochmaea suturalis*) is a small (about 6mm long) member of the leaf beetle family. Both adults and larvae eat almost exclusively heather, causing damage to the shoots and leaves, which then renders plants vulnerable to drought or frost. The most severe impact occurs between June and August when larvae hatch and feed before pupating in mid- to late-summer. Numbers of heather beetle can fluctuate widely and periodically will increase to outbreak densities that can severely defoliate and kill off large areas of heather. Affected areas are then left vulnerable to replacement by faster growing plant species, particularly grasses, reducing the extent of heather and so having a negative impact on moorland habitats and other heather specialists such as red grouse.

Little meaningful pure or applied research has been conducted on heather beetle, and there is often a lack of knowledge among moorland managers about basic aspects of its ecology. It is perceived that beetle attacks are becoming more frequent and that the recent outbreak in 2019 damaged and killed heather over much greater areas than previously described. On Dutch heaths, beetle damage has been associated with a transition from an ericaceous-dominated plant community to a more grass-dominated one following nutrient enrichment from increased heather decomposition and the accumulation of larval faeces. Damage prevention and damage mitigation managements have become complicated by statutory designations that generally restrict previously favoured, but not proven, practices of moorland draining and sward burning in favour of non-intervention.

Improving our understanding of the drivers of heather beetle outbreaks, and how best to manage the sward following an outbreak, is of particular concern to grouse moor managers owing to the close relationship between grouse abundance and availability of healthy heather. Our own research has highlighted a negative relationship between female grouse abundance and the proportion of dead heather in the sward. Heather quality will also impact on breeding success. Indeed, poor grouse chick survival in 2021 appeared attributable to females being in poor breeding condition partly caused by delayed heather greening among already stressed and weakened plants. Because of the sporadic and unpredictable nature of heather beetle outbreaks, it is difficult to collect empirical data that can be used to identify factors associated with increased risk of outbreak. However, we can more readily consider whether types of post-outbreak management might help the heather recover.

*Heather beetle larvae. © Laurie Campbell*

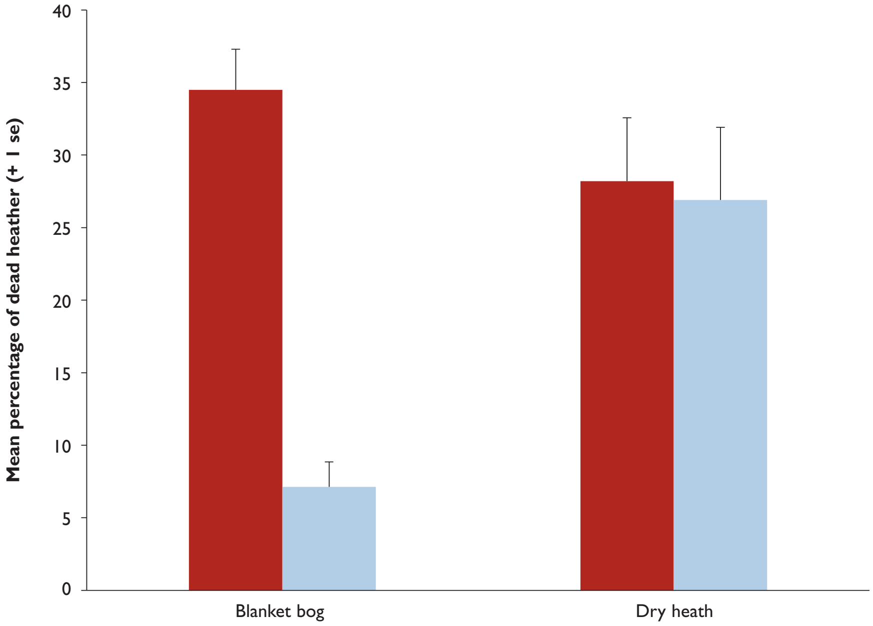



**Figure 1**

Mean percentage of dead heather in six control (no management intervention) plots on each of two sites in March and August 2021

March

August

In 2021 we established an experiment to assess the effectiveness of different heather-management methods in helping to restore heather after a severe beetle outbreak. The study comprises 18 experimental plots, each of 0.02 hectares (ha), on each of two separate moors in Swaledale, North Yorkshire. One moor has deep (>40cm) peat blanket bog, while the second moor is dry heath (<40cm peat). On each moor, we established six randomised replicates of three heather-management treatments (burn, cut or no-treatment control) within areas of heather that had been damaged by heather beetle in the previous year. In March 2021, we collected baseline information on vegetation structure and composition, including quantification of the extent of damaged and dead heather. Data were collected from five 1m² quadrats per plot, in which percentage cover of live, damaged and dead heather was estimated to the nearest 5%. The site's keeper then applied the management treatments in March 2021.

In the first growing season after application of those treatments, it was too soon to detect any meaningful vegetation response on the plots that had been cut or burned, but we went back and re-measured how much dead heather was present on the control plots. On the dry heath site there was no change in the extent of dead heather but on the blanket bog site there was less than a quarter of the dead heather compared with March measurements., (see Figure 1). We will now continue to measure vegetation response in all treatment plots annually.

## KEY FINDINGS

- We established an experiment in 2021 to examine whether active management of heather, after a heather-beetle attack, can accelerate recovery of the sward.
- We set up plots on two moors, where we established experimental burning, mowing and control treatments on areas of heather that had been damaged by heather beetle.
- We collected baseline data in March 2021, with managements undertaken immediately after.
- After one growing season, control plots showed marked recovery of heather sward on one moor, but none on the other.
- We will now collect annual measurements of subsequent vegetation response in all treatment plots.

Siân Whitehead
David Baines

*Poor grouse chick survival in 2021 appeared attributable to females being in poor breeding condition partly caused by delayed heather greening among already stressed and weakened plants. © Coatesy*

# Burning and cutting heather on blanket bog

*Assembling a quadrat ready for vegetation surveys.* *© Siân Whitehead/GWCT*

> **BACKGROUND**
> Burning of heather on blanket peat habitat remains a contentious issue, and its use as a management tool in protected sites is now carefully regulated by Natural England. Conversely, cutting as an alternative heather management technique is now widely practised, despite a general paucity of knowledge of its effects. Our study complements initial findings from the Peatland-ES-UK study (**peatland-es-uk.york.ac.uk/**), led by Andreas Heinemeyer (Stockholm Institute, York University), by collecting data from an additional five sites further north, thus providing a wider range of environmental conditions such as altitude, peat depth and rainfall.

Last year, we reported on a new long-term study to look at the vegetation and hydrological responses of burning and cutting heather over blanket bog. The study covers five experimental sites in northern England at a range of altitudes and peat depths. Each site holds four experimental blocks, each comprising four plots, to each of which we randomly assigned one of the four heather management treatments (burning, cutting and leaving brash, cutting and removing brash, and a control which received no management intervention). Keepers on each site conducted the managements in March 2020. In our study, we are exploring vegetation, hydrological and invertebrate responses to the management. Here we report preliminary vegetation and hydrology findings.

## Vegetation responses

As intended, burning and cutting reduced the amount of heather (see Figure 1) with a 10-fold decrease in cover across both treatments. Subsequent heather recovery was greatest in the cut plots, in which heather had recovered to approximately 20% of baseline values by year two, compared with 6% in burns. In contrast, cotton grass increases were most marked in the burn plots, in which there was three times the amount of cotton grass cover by year two when compared to the baseline.

Management reduced *Sphagnum* moss cover in all three treatments, with the biggest reduction (almost 70%) in the burn plots. By year two, cover was back up to

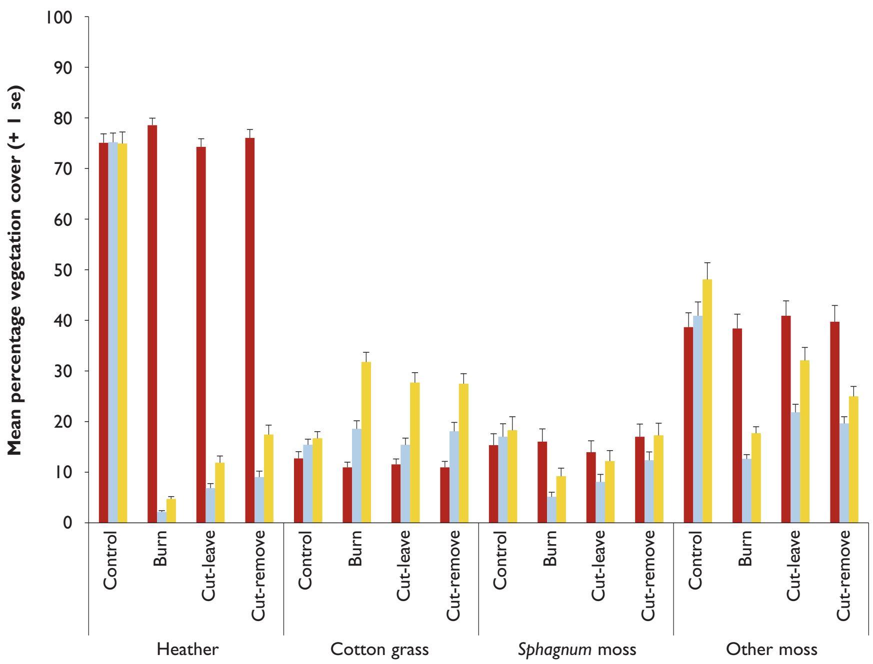
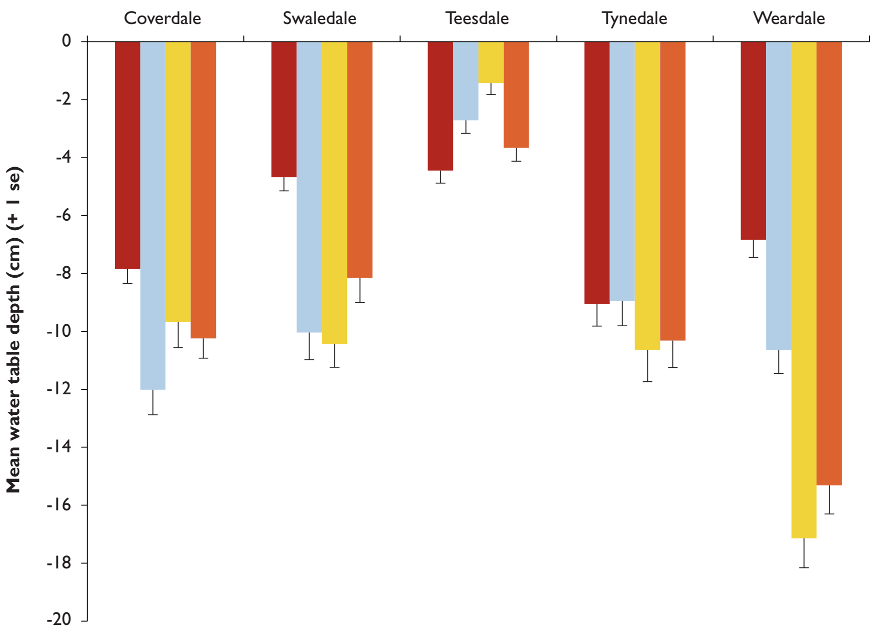



**Figure 1**

Overall mean percentage cover of heather, cotton grass, *Sphagnum* moss and other moss in each of four experimental heather management treatments (control, burn, cut and leave brash, cut and remove brash), in pre-treatment baseline period, and in years one and two after treatment

Baseline
Year 1
Year 2




## Figure 2

Site mean water-table depth in each of four experimental heather management treatments (control, burn, cut and leave brash, cut and remove brash)

- Control
- Burn
- Cut-leave
- Cut-remove

baseline values in the cut-remove treatments, and already over half of the baseline value in burns. In contrast, moss depth was impacted most in the cut treatments with a 60% reduction, compared with 45% in the burns, and little evidence of recovery in any of the treatments by year two.

### Water-table depth and dissolved organic carbon

Water samples are taken from some of the plots and are sent to Manchester University for analyses of colorimetry and carbon content, while water-table depths are recorded in all plots monthly. Water-table depth (WTD) is predictably showing clear seasonal differences on all sites, being nearer the surface when rainfall is higher in winter. Dissolved organic carbon (DOC) also shows a seasonal trend, with an autumn peak as carbon that is released in the upper drier parts of the peat column during warmer, drier summer months is then flushed out of the peat when rainfall increases in the autumn.

Both measures show considerable differences between sites as illustrated by WTD (see Figure 2). There is some effect of treatment, but this is largely due to strong effects in the first couple of months immediately after management. Similarly, the biggest change in DOC levels was in the first couple of months after treatment, but these changes were not consistent across sites: on two sites there was no impact of management at all, on two sites DOC was higher on the burn and cut-remove treatments, and on the fifth site the effect was seen on both cut treatments but not the burn.

We're still trying to understand how much of these short-term impacts on WTD and DOC may have been caused by the cutting or burning, how much may be due to the physical impact of installing the dipwells, and how much might be attributed to an abnormally dry April and May in that year. However, there is also an emerging picture of variation between sites, with responses to management interventions influenced by a complex interaction of weather, altitude, past management and peat state.

## KEY FINDINGS

- Both cutting and burning heather resulted in 10-fold reductions in heather cover.
- Two years after management, heather regrowth was greatest in cut plots, where it was approximately 20% of baseline values by year two.
- Cotton grass cover increased in both cut and burn plots; after two years, it had tripled in cover in burn plots.
- *Sphagnum* cover was reduced in all treatments, with the biggest reduction (almost 70%) in the burn plots but had recovered to over half the baseline values by year two.
- There was a short-term (months one and two) decrease in water-table depth and increase in dissolved organic carbon in some treatments on some sites, but these patterns were not consistent. Seasonal and site differences made general interpretation difficult.
- Variation between sites in vegetation and hydrological responses to heather management will require a tailored approach to prescribing appropriate interventions rather than a 'one-size-fits-all' policy.

Siân Whitehead

Sphagnum *capillifolium.*
*© Siân Whitehead/GWCT*



© Peter Thompson

# Where have all the insects gone?

## BACKGROUND

Having a healthy and varied insect community is critical for the farmed environment and farmland wildlife generally. Insects are an essential component in the diet of most farmland birds, pollinate crops, regulate crop pests and recycle organic matter in the soil. Worryingly, numbers of nearly half of all studied insect groups are falling according to our long-term monitoring of cereal crops in Sussex and this could threaten these vital ecosystem functions. This has come to the attention of the farming community. To better understand the underlying factors influencing this downward trend, we started additional annual monitoring of insect levels on 10 farms across England in 2018, along with the Rotherfield Estate which is part of the PARTRIDGE project. The motivation for many of those in the farming community, and conservationists more broadly, is to understand whether there are sufficient food supplies for grey partridges and other farmland birds, and which habitats provide the highest levels of partridge chick-food insects. We concentrate here on what both the long-term monitoring in Sussex and at our Allerton Project farm in Loddington, and the short-term changes from the wider monitoring, can tell us about changes in grey partridge chick-food and report on first indications on how to reverse insect shortages.

### Long-term trends in grey partridge chick-food insect abundance on the Sussex Study and the Allerton Project

Invertebrate sampling on the Sussex Study began in 1970 and for the Allerton Project at Loddington in 1992, with both continuing to the present day. In both of these long-term monitoring studies, sampling is carried out with a Dvac suction sampler, but the detail of what habitat is sampled varies. In Sussex, the emphasis has always been on grey partridge chicks foraging in the headlands of cereal crops, so sampling has been restricted to those areas. For the Allerton Project, a more comprehensive approach has sampled all crops in both the headlands and the middle of fields. Since 2000, sampling in the boundaries of fields (hedgerow bottoms, grass banks) at the Allerton Project has recorded information in semi-natural habitats as well. Information is currently available from 1970 to 2020 for Sussex and from 1992 to 2011, 2015-2017 and 2019 for the Allerton Project.

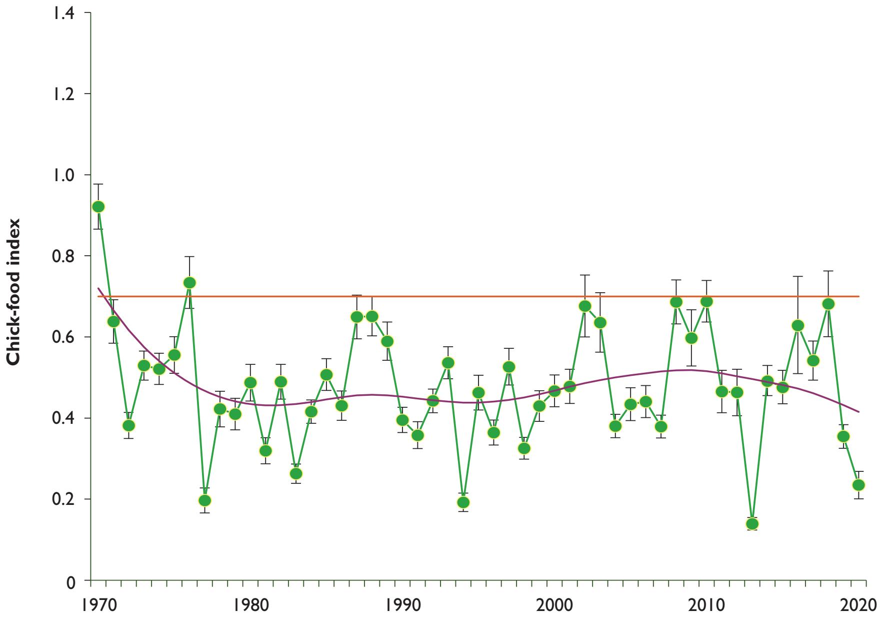
Long-term monitoring in Sussex, across all samples, shows that only in 1970 and 1976 has the average yearly chick-food index exceeded the threshold of 0.7 needed for stable grey partridge numbers (see Figure 1). There is a great deal of year-to-year variation, with the lowest levels of chick-food in 1977, 1994 and 2013. Examining trends in the different types of cereal crops over 51 years finds that spring cereals (mainly spring barley) have higher average chick-food indices than either winter wheat or winter barley/oat crops (see Figure 2). We observed no significant differences between conventional spring cereal crops and conservation headlands in spring cereals, although in 2016-2018 the average chick-food index in conservation headlands exceeded 0.7 (see Figure 3).

In the Allerton Project, the yearly average chick-food index in headlands across all crops was below 0.7 in all years, whereas in the semi-natural habitat surrounding fields (hedges and grass banks) the average chick-food index exceeded 0.7 for 11 of 16 years (see Figure 4). There is a significant positive correlation between the yearly averages in the semi-natural habitat and the respective yearly average from the crop samples at the Allerton Project, indicating that drivers of annual variation are acting in synchrony across the area – possibly linked to weather conditions as we have shown in Sussex – see *Review of 2015,* pages 28-29.

### Chick-food levels across 10 English farms

We sampled nine arable crops across the 10 farms (Yorkshire-1, Northamptonshire-1, Shropshire-1, Norfolk-6, Dorset-1), including both spring- and winter-sown crops, along with permanent pasture, grass leys and a variety of non-crop habitats. To compare findings with the long-term monitoring in Sussex and at the Allerton Project, we used Dvac suction samplers and sampled annually (2018-2020) at the same time (June or early July), when insects are most abundant. This enabled us to calculate the grey partridge chick-food index. Depending on the landowner's interests, we sampled in the headland area of the crop and/or mid-field.

None of the nine arable crops sampled reached the threshold level of 0.7 in the grey partridge chick-food index (see Figure 5). The maximum recorded was 0.42 in the headland area of spring beans, while spring oats and grass leys also had higher

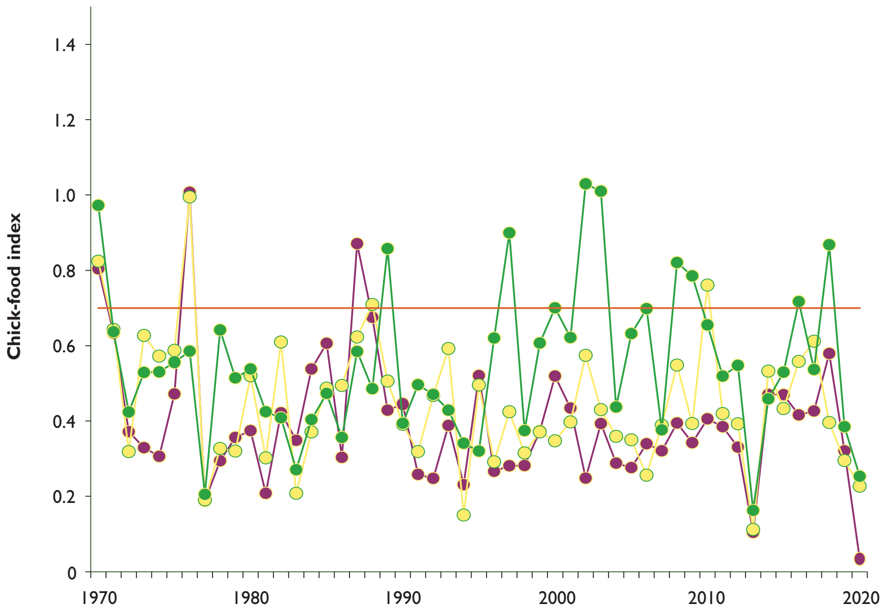



## Figure 1

Long-term trend in the average grey partridge chick-food index in Sussex from all cereal crops

*An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers*

Significant long-term trends




## Figure 2

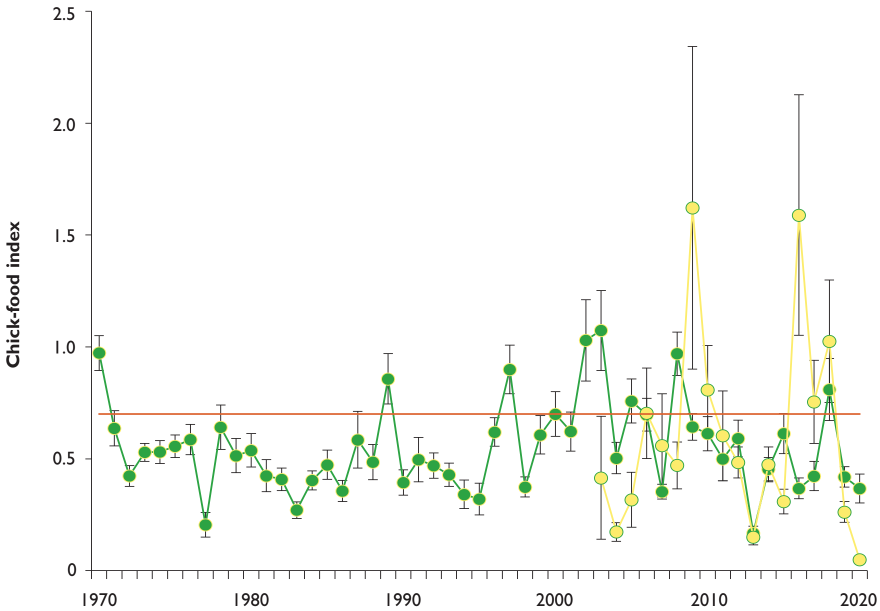
Long-term trends in chick-food index in the three types of cereal crops sampled in the Sussex Study across 51 years

*An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers*

Spring cereal

Winter wheat

Winter barley and oats




## Figure 3

Long-term trends in the chick-food index in spring cereals in Sussex, comparing those in conventional fields with the yearly average in spring cereal conservation headlands

*An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers*

Conventional fields

Conservation headlands

*An uncropped margin at Rotherfield was one of three agri-environment scheme habitats that delivered high insect numbers.* *© Francis Buner/GWCT*

## KEY FINDINGS

- Levels of chick-food insects are extremely low in all sampled arable crops across England, except peas at Rotherfield.
- Spring cereals tend to have higher levels of chick-food than other cereal crops.
- Semi-natural habitats, such as hedgerows and grass banks that surround fields, may hold higher levels of chick-food, with correlation between levels in this habitat and in crops.
- Non-crop agri-environment scheme habitats failed to deliver target levels of chick-food insects except at Rotherfield, where PARTRIDGE wild bird mixes, arable margins and extended overwintered stubbles delivered above target. In Sussex, conservation headlands contained more chick-food insects than conventional crops in some years.

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levels than the other crops. These values are lower than those in conventional spring cereals in the Sussex Study from 2018 to 2020 (0.53 ± 0.14 SE), but similar to those in crops at the Allerton Project in 2015-2017 and 2019 (0.18 ± 0.02), suggesting widespread depletion of insect levels among all crops.

In the non-crop planted conservation habitats (see Figure 6) the chick-food index was also very low; flower strips and the cornfield-annuals mix were the best performing habitats, although these were still below the threshold level.

### Chick-food levels at the Rotherfield PARTRIDGE demonstration site

Sampling started in 2018 and followed the method described above, focusing on the PARTRIDGE agri-environment scheme (AES) habitats (wild bird seed mix, cultivated uncropped margins and extended overwintered stubbles) in comparison with winter wheat and peas. In line with the results across all other farms reported here, winter wheat contained very low insect numbers, yielding an average chick-food index far below 0.7 (0.23 ± 0.04, n = 15). However, contrary to the other 10 English sites, the three AES habitats delivered values above 0.7 (PARTRIDGE mixes: 0.82 ± 0.16, n = 39; cultivated uncropped margins: 0.93 ± 0.30, n = 8; extended overwintered stubbles: 1.40 ± 0.31, n = 6). Peas also harboured high insect numbers (primarily aphids) in two of the three years sampled, thanks to a non-insecticide policy on the outer 24 metres (index = 0.87 ± 0.39, n = 5).

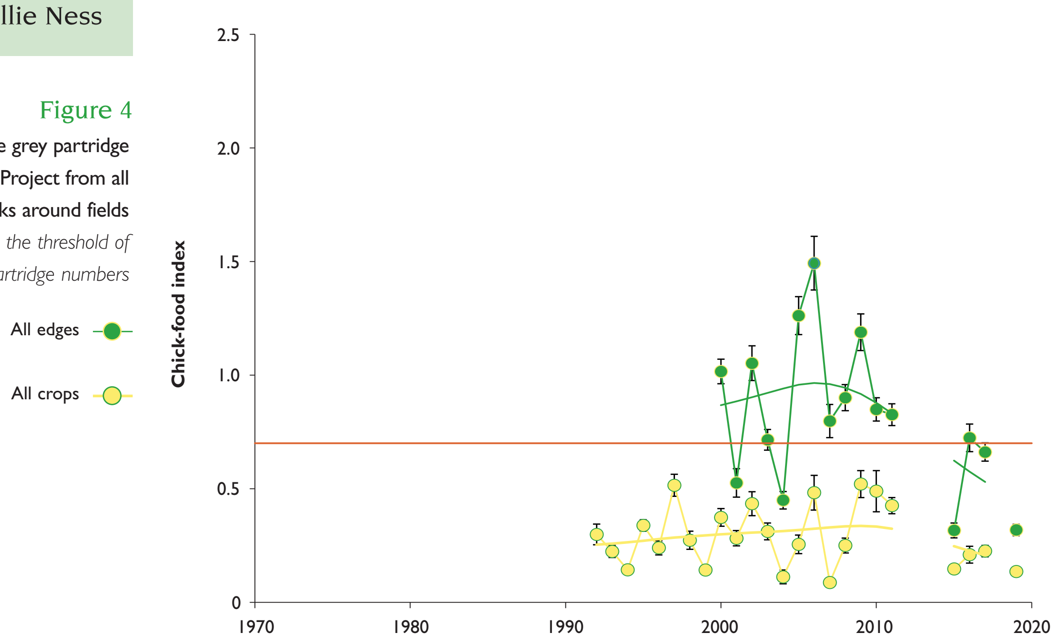
### Conclusions

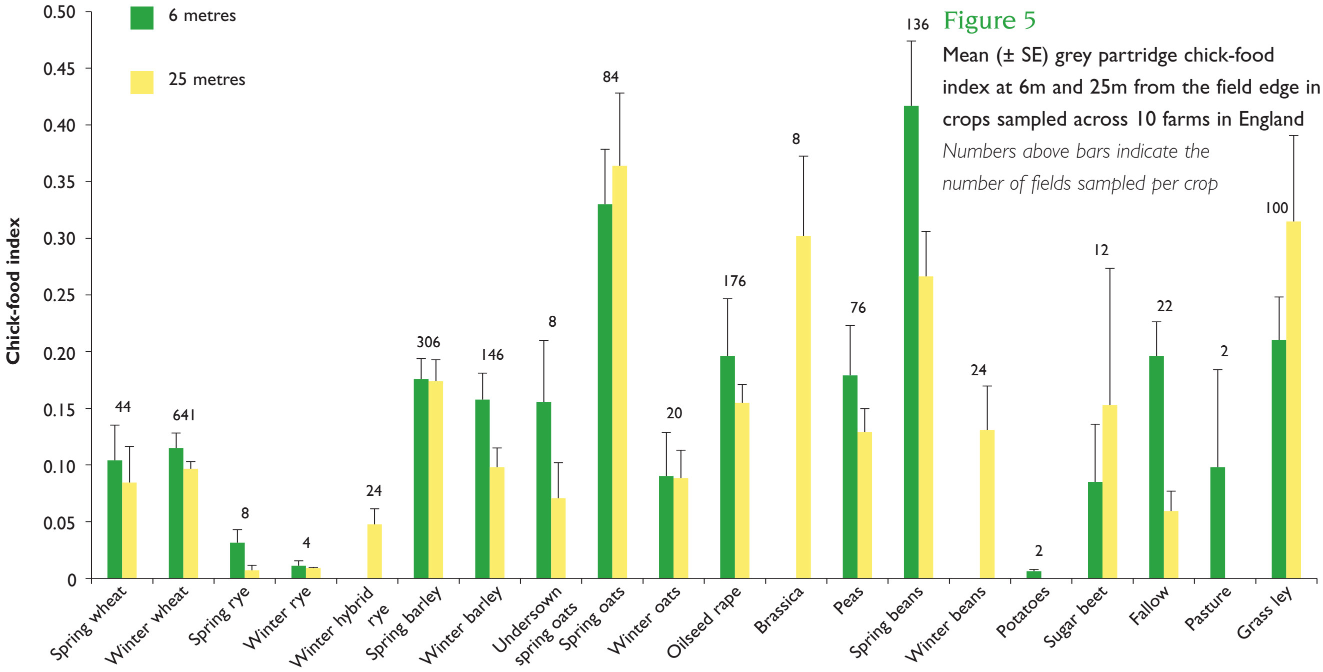
Having such low levels of insects across arable crops generally is of grave concern and backs worldwide reports of a collapse in insect populations. Of added concern is the

### Figure 4

Long-term trend in the average grey partridge chick-food index in the Allerton Project from all crops and in the hedges/grass banks around fields

*An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers*






## Figure 5

Mean (± SE) grey partridge chick-food index at 6m and 25m from the field edge in crops sampled across 10 farms in England

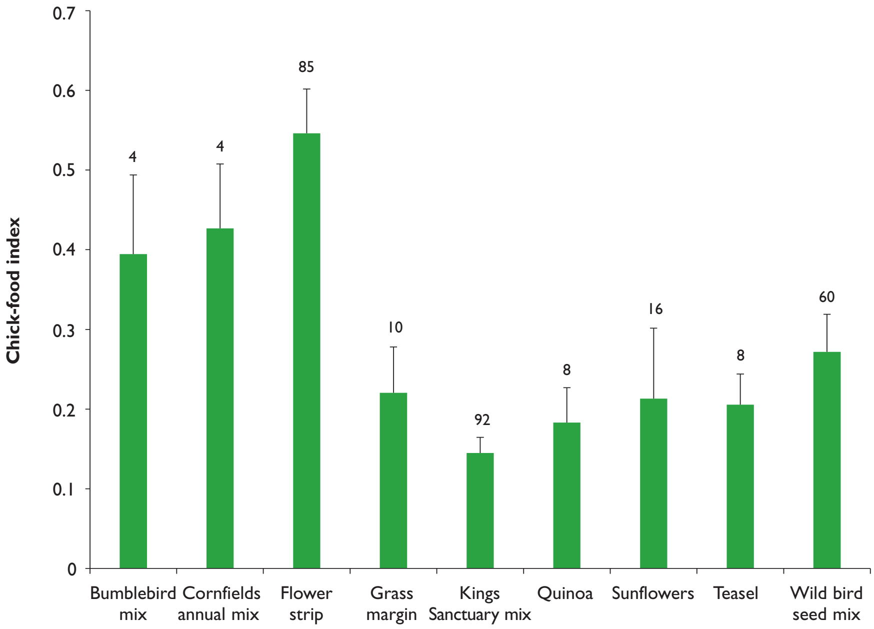
*Numbers above bars indicate the number of fields sampled per crop*

poor number of chick-food insects in the non-crop AES options at the 10 English farms. These low insect levels may explain why many farmland bird species continue to decline or have failed to recover nationally despite the widespread uptake of AES options focused on their recovery. Such insect declines also have far-reaching consequences for food production as they make crops more vulnerable to new pests that may spread with climate warming, there now being potentially fewer natural enemies to regulate them.

Within crops and the studied AES habitats it is mainly the arable plants (weeds) that support the most insects. Hence, floristically diverse conservation headlands such as in Sussex or cultivated uncropped margins like at Rotherfield – where most have been sown with a mix of native rare arable flora – play an important role in restoring insect numbers and diversity. Further successes may be achieved by making existing wild bird seed mixes more species-rich, including native annual and perennial flowers as is the case with the PARTRIDGE mix (available as a wildlife plot option under Defra's Test and Trials Scheme), and by promoting extended overwintered stubbles. The effort required to increase the abundance of chick-food insects is considerable and success is reliant on weather conditions as well as diverse high-quality habitat provision at a landscape-scale.

## ACKNOWLEDGEMENTS

We are most grateful to everyone involved in the studies and for funding from the Sandringham Estate, BASF UK Sustainability Farms, Stubhampton Estate, Millichope Foundation, the Rotherfield Estate and the NSR Interreg programme that funds the PARTRIDGE project. The farmers and land managers on the Sussex Study area have allowed GWCT scientists to sample cereal crops for over half a century, supported by several funders over the years, recently including the Ernest Kleinwort Charitable Trust.




## Figure 6

Mean (± SE) grey partridge chick-food index for seven non-crop habitats across 10 farms in England

*Numbers above bars indicate the number of sites sampled per habitat*

# FRAMEwork: Expanding Farmer Clusters

*We recorded 592 butterflies, representing 22 species including marbled white. © Holly Turner/GWCT*

## BACKGROUND

A 'Farmer Cluster' is a community of farmers, located in the same region, who share knowledge, support and motivate each other to improve biodiversity and the ecological health of their farms. Farmer Clusters have become increasingly popular in the UK, but to date the ability of Farmer Clusters to improve biodiversity at the landscape-scale has not been scientifically tested. This will be addressed through the European FRAMEwork project.

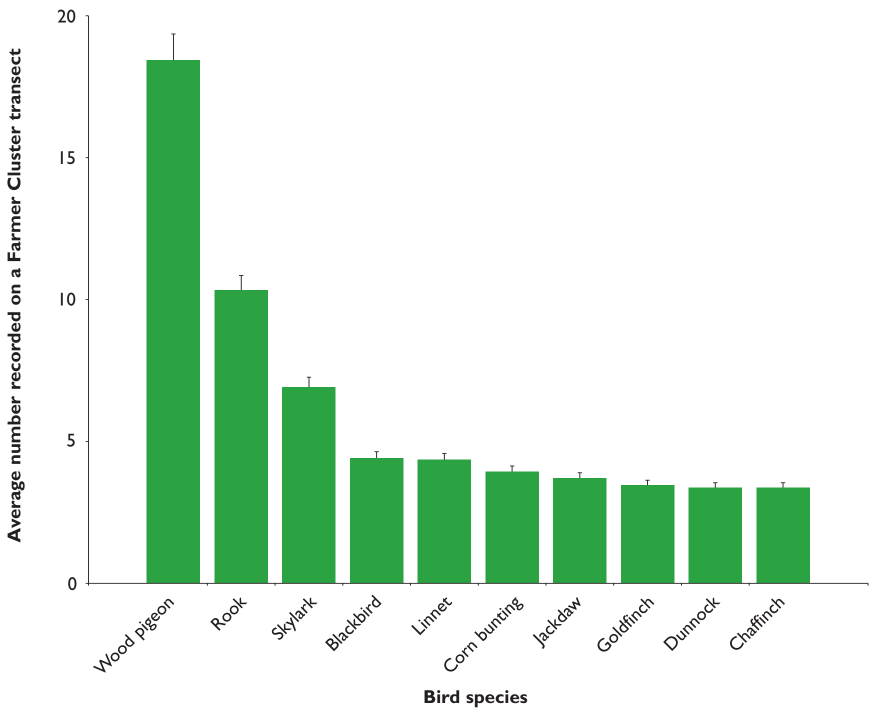
There are currently more than 100 Farmer Clusters in the UK and the FRAMEwork project aims to introduce Farmer Clusters to a further eight European countries. The project will also deliver Advanced Farmer Clusters, in nine countries including England, by providing a new level of technological support in planning, managing, and monitoring the groups to help farmers reach their goals. The Farmer Clusters will be linked with an Information Hub that will facilitate farmer and citizen-based collection and sharing of harmonised, high-quality information on biodiversity and farming. It will also develop engaging activities to amplify awareness and understanding of biodiversity across different stakeholders in Europe.

One key aim is to develop standardised biodiversity monitoring techniques, which can then be applied across all clusters to measure the impact of landscape-scale farm management. These were developed and focused initially on two groups: birds and pollinators (butterflies and bees). In 2021 we applied these techniques to measure numbers of birds and pollinators on England's pilot Advanced Farmer Cluster, the Cranborne Chase Farmer Cluster. The group comprises 18 farms and covers 8,400 hectares of the Cranborne Chase Area of Outstanding Natural Beauty (AONB).

To monitor farmland birds, we superimposed a 1-km² grid over the cluster and selected all squares that fell entirely within the cluster boundary for surveys, resulting in 24 survey areas. Within these squares 1-km transect routes were selected that ran roughly north-south or east-west, the majority of transects followed field boundary features. We conducted two surveys along each transect in early April to mid-May and again in mid-May to late June. Surveys began one hour after sunrise to avoid peak activity

**Figure 1**

The 10 most commonly occurring bird species recorded on the Cranborne Chase Farmer Cluster



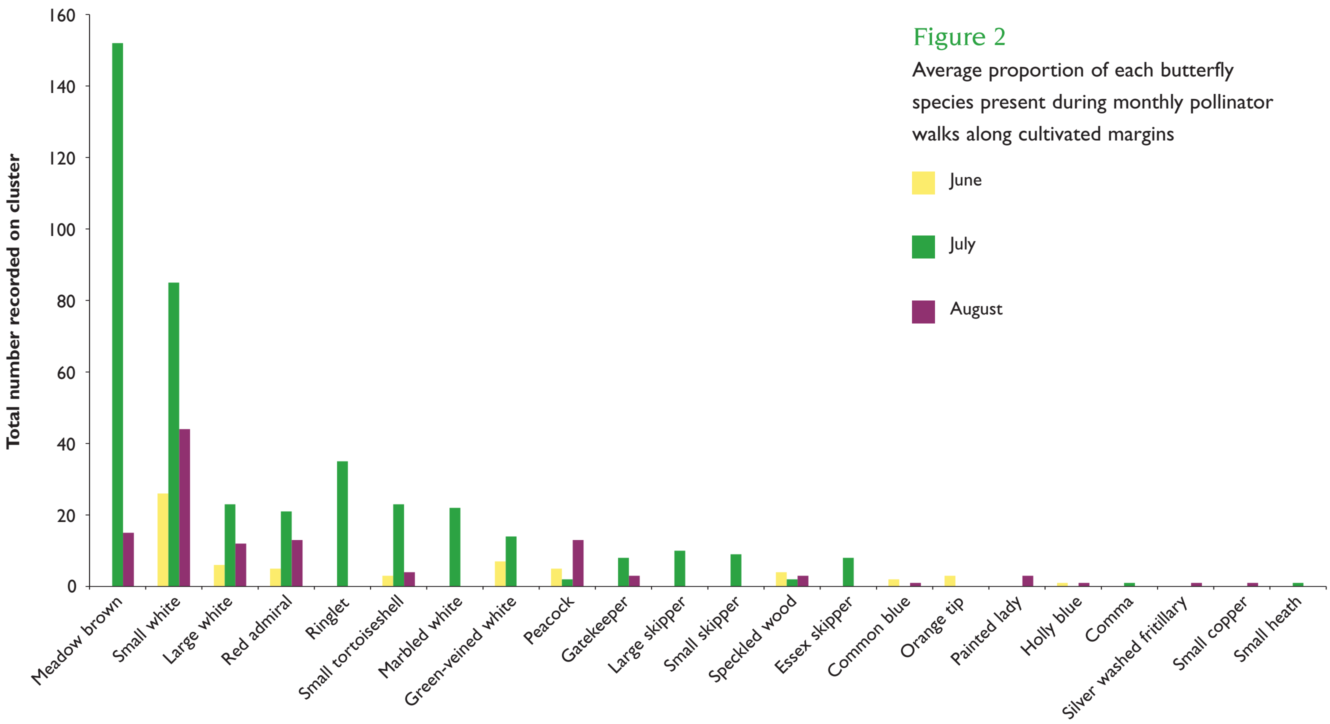



Figure 2

Average proportion of each butterfly species present during monthly pollinator walks along cultivated margins

of birds and finished by mid-morning (approximately 10-11am in the UK depending on the month). Surveys were not conducted in heavy rain, poor visibility or strong wind. All birds seen or heard were recorded, along with any evidence of breeding activity. Birds were recorded in three distance bands 0-25 metres (m), 25-100m and 100 to 300m. In total we recorded 76 bird species (see Figure 1); among the 10 most common species were declining farmland bird species including skylark (179 in survey 1, 153 in survey 2), linnet (135, 74) and corn bunting (73, 116). The corn bunting is of particular interest to the group because it is red-listed in the UK, having suffered a steep decline in abundance between the mid-1970s and 1980s and local extinctions across its former range.

Pollinator monitoring took place within 13 of the 24 farmland bird monitoring squares, along the same 1km transects as the bird surveys, however, for pollinator surveying the transects were split into 20 50m survey sections. The selected survey squares were evenly spread across the cluster to ensure a broad geographical spread. Pollinator surveys took place during optimal weather conditions for bumblebees and butterflies ie. on a sunny day with no rain, at wind speeds of less than five on the Beaufort scale and at a minimum temperature of 13°C. Transects were surveyed once a month, between 1 June and 30 August, leaving at least a two-week gap between two successive walks of the same transect. Transects were walked at a steady and constant pace, counting all the individuals of each (bumblebee or butterfly) species seen within a fixed virtual detection box. The virtual detection box was smaller for bumblebees (2m either side, 4m ahead and 4m above) than for butterflies (2.5m either side, 5m ahead and 5m above), this meant that bumblebee and butterflies could not be surveyed simultaneously.

Overall, we recorded 14 bumblebee species during surveys; the most commonly recorded taxa were the buff/white-tailed bumblebee (78 recorded in June, 251 in July and 43 in August), followed by the common carder (25, 129, 215), red-tailed bumblebee (78, 69, 25), early bumblebee (24, 42, 1), garden bumblebee (1, 23, 3), southern cuckoo (1, 14, 0), heath bumblebee (0, 0, 3) and Barbut's cuckoo (0, 6, 0). We recorded single observations of forest cuckoo, gypsy cuckoo, moss carder, red-tailed cuckoo and tree bumblebee. We recorded a total of 592 butterflies, representing 22 species (see Figure 2), the majority of which were seen in July (416). Meadow browns occurred most commonly in the survey squares (167) followed by small white (155). Populations of some common butterfly species have declined in recent years, so it is encouraging to have recorded some of these species in our initial survey (eg. gatekeeper – 11 records, Essex skipper – eight records).

Annual monitoring of birds and pollinators will take place until 2025 to determine if, through working as a collective and at a landscape-scale, farmers can improve the biodiversity value of their land by working together as a Farmer Cluster. This work will be the first scientific measure of the impact of Farmer Clusters on farmland biodiversity.

## KEY FINDINGS

- Baseline surveying of farmland birds and pollinators took place on the Cranborne Chase Farmer Cluster in 2021.
- Seventy-six bird species, 14 bumblebee species and 22 butterfly species were recorded.

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## ACKNOWLEDGEMENTS

We would like to thank the Cranborne Chase Farmer Cluster and their facilitator Clare Buckerfield for their participation in this project, which is supported by Horizon 2020 funding.

# The Owl Box Initiative

*We checked 140 nest boxes and found 26.4% occupied by barn owls (all box checks and bird ringing were done under licence). © Megan Lock/GWCT*

The Owl Box Initiative is helping to provide and maintain nest boxes for barn owls, and by monitoring active nests, measures breeding success. Through this monitoring, we hope to identify which farmland habitats are most important to owls and how this relates to food abundance. This information should help farmers make more effective decisions when providing conservation habitats and may aid the development of owl-friendly habitats within future agri-environment schemes.

With the help of volunteer ornithologists, we collected information on barn owl box occupancy and breeding success across six Farmer Clusters in Hampshire/Wiltshire/Dorset (Martin Down, Allenford, Cranborne Chase, Avon Valley, Marlborough Downs, Pewsey Downs). In 2021, we checked 140 nest boxes, 26.4% of which were occupied by barn owls, with occupancy rates between Farmer Clusters ranging from 16.2% to 44.4%. We recorded several other species using the nest boxes, including kestrel, jackdaw and stock dove. Kestrel and stock dove are amber-listed birds of conservation concern, so we were pleased to see the boxes supporting these species too.

## BACKGROUND

Through The Owl Box Initiative we are working with 100 farms in six Farmer Clusters across Hampshire/Wiltshire/Dorset, to help monitor and conserve barn owls in southern England. Monitoring barn owl breeding success provides an indication of wider farmland biodiversity health because, as a top predator, they are reliant on a network of other species.

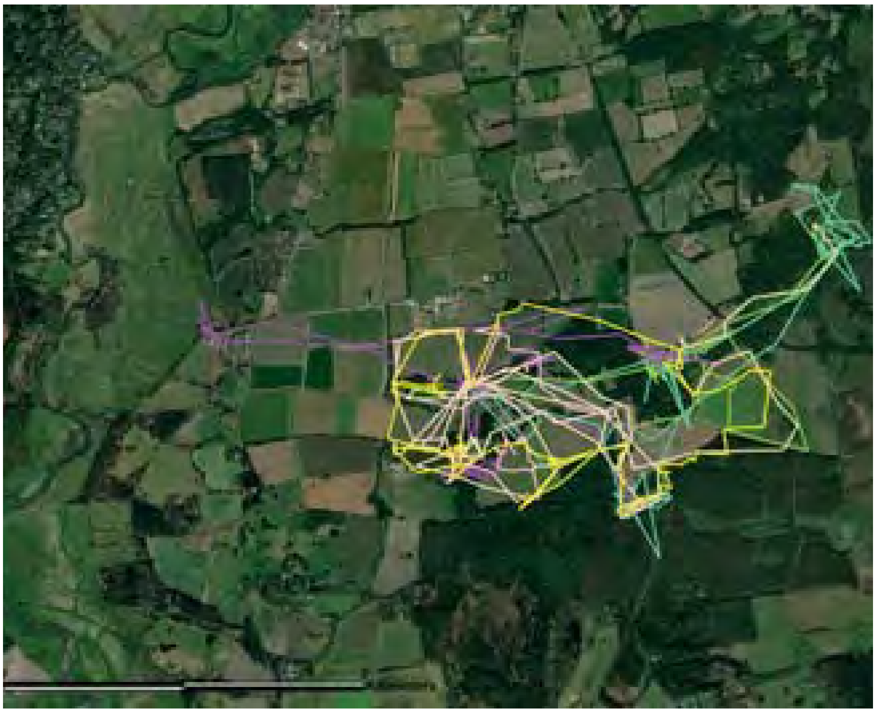

Figure 1

GPS tracking data from a female barn owl tagged on the Avon Valley Farmer Cluster. Each coloured line represents a different night of tracking data

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To understand the relationship between barn owl box occupancy, breeding success and habitat in greater detail, we are using GPS tags to identify the habitats that hunting owls visit while feeding young chicks. Twelve GPS tags were deployed in June-August 2021, of which nine collected data we could analyse. We usually chose females for GPS tagging (10 out of 12 owls) as the data from the tag are downloaded remotely via a base-station, which needs to be relatively close to the GPS tag. Female barn owls remain at the nest longer than males when rearing chicks, so tagging females provides more opportunities for the base-station to receive data transmissions.

GPS tags were programmed to record one-minute fixes each night between 10pm and midnight, the period when owls spend the most time hunting. One female tagged in early July was recorded foraging up to 2.2 kilometres (km) from her nest box and even visited a neighbouring barn that contained a separate brood of barn owl chicks (see Figure 1). A male owl tagged on the Marlborough Downs Nature Improvement Area held a territory that spanned 6.1km from north to south. He spent a large proportion of his time on land belonging to the neighbouring Pewsey Downs Farmer Group. This further highlights the need for landscape-scale collaboration when working to conserve farmland wildlife (see Figure 2).

We are also monitoring the abundance and distribution of owl prey species (small mammals such as voles and mice), using ink tracking tunnels. The tunnels are black plastic triangles with a plastic insert. A4 sheets of white paper are paperclipped to either end of the insert and ink is painted on masking tape either side of a centrally placed bowl of bait. In 2021, 140 tunnels, 10 per 100 hectares spread across 14 sites, were monitored in June and July, when adult barn owls are foraging to feed their chicks. Tunnels were placed at the boundary between two habitats eg. between arable fields and margin habitats or tree lines and margin habitats. We checked tunnels daily for five consecutive days and noted the presence of small mammal tracks for a total of 700 trap-nights over the survey period. Small mammal detection rates were similar between the main habitats studied but small mammals were most likely to be recorded in tunnels located beside a grass margin (27% of trap-nights, 48% of trapping locations, n=18 margins), then arable fields (22%, 43%, n=74), grassland (20%, 50%, n=32), hedgerows (18%, 41%, n=66) and flower-rich margins (13%, 25%, n=12).

In 2022, we plan to continue our barn owl nest box monitoring programme across the project clusters and explore alternative small mammal monitoring methods. We also hope to GPS tag a further 15 birds and conduct detailed analysis relating bird movements to habitat distribution and availability.

## KEY FINDINGS

- Barn owls occupied 26% of 140 nest boxes across 100 farms in Hampshire/Wiltshire/Dorset in 2021.
- The detection rates of voles and mice, a barn owl's main prey, were highest in locations close to a grass margin.

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*We are monitoring the abundance and distribution of owl prey species, such as voles, using ink tracking tunnels. © Niamh McHugh/GWCT*

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**Figure 2**

A male owl tagged on the Marlborough Downs Nature Improvement Area held a territory that spanned 6.1km from north to south. He spent a large proportion of his time on land belonging to the neighbouring Pewsey Downs Farmer Group. Each coloured line represents a different night of tracking data

## ACKNOWLEDGEMENTS

Thanks to the landowners who allowed us to conduct fieldwork on their land and to Matt Prior, Simon Lane, Simon Smart and Alan Masterton who voluntarily gave time to assist the project. This project is supported by the Green Recovery Challenge Fund.

# Allerton Project: game and songbirds

> **BACKGROUND**
>
> Game and songbird numbers have been monitored annually at the Allerton Project at Loddington since it began in 1992, providing an insight into how both have been influenced by changes of management over this period. In particular, they have provided valuable information on the effects of predator control and winter feeding. The farm has been managed as a released-pheasant shoot since 2011, following nine years of no game management. This was preceded by nine years of wild game management. The current regime continues to include habitat management and winter feeding. The level of predator control is intermediate between that in the wild game management phase of the project and that of a conventional released-bird shoot as our previous research has demonstrated the benefits of predator control to some songbird species.

We have reported the resulting recent changes in gamebirds and hares in previous annual *Reviews*. Songbird numbers are monitored annually using 11.5km of transect counts across the farm four times during the breeding season, enabling us to track overall numbers of songbirds in relation to the changes we have made to our game management system.

The songbird transects reveal that overall numbers are 91% above the 1992 baseline (see Figure 1). The annual transect data give us a valuable insight into changes in bird numbers but, except for the most abundant species, don't provide an accurate measure for individual species. Therefore, we systematically map the breeding territories of all species every five or six years. 2021 was one of those years.

The transect data suggest that Biodiversity Action Plan (BAP) species (those that have declined nationally since 1970) are 46% more abundant than in the baseline year of 1992. There is considerable variation between species though. Spotted flycatcher numbers increased dramatically when predators were controlled but, along with skylark, marsh tit, willow tit, tree sparrow and yellowhammer, their numbers in 2021 were similar to those in 1992 (see Table 1). Tree sparrow numbers had increased in the early 2000s in response to the provision of nest boxes but subsequently declined, while yellowhammer numbers have held up against a continuing national population decline.

Numbers of dunnocks, song thrushes, linnets, bullfinches and reed buntings have increased substantially, benefiting from the combination of habitat provision, winter food sources such

**TABLE 1**

**Number of breeding territories for Biodiversity Action Plan species**

| | 1992 | 1998 | 2001 | 2006 | 2010 | 2015 | 2021 |
|---|---|---|---|---|---|---|---|
| **Management** | | | | | | | |
| Habitat management | | X | X | X | X | X | X |
| Predator control | | X | X | | | X | X |
| Winter feeding | | X | X | X | | X | X |
| **Changes in species abundance** | | | | | | | |
| Skylark | 36 | 36 | 37 | 33 | 26 | 37 | 35 |
| Yellow wagtail | 3 | 5 | 3 | 1 | 2 | 6 | 1 |
| Dunnock | 46 | 86 | 144 | 97 | 51 | 135 | 111 |
| Song thrush | 14 | 48 | 64 | 34 | 15 | 44 | 60 |
| Willow warbler | 28 | 47 | 45 | 25 | 12 | 4 | 1 |
| Spotted flycatcher | 8 | 11 | 14 | 6 | 1 | 10 | 6 |
| Marsh tit | 4 | 4 | 7 | 3 | no data | 8 | 6 |
| Willow tit | 1 | 1 | 1 | 1 | 1 | 2 | 0 |
| Tree sparrow | 3 | 0 | 7 | 18 | 12 | 7 | 2 |
| Linnet | 10 | 21 | 25 | 17 | 15 | 22 | 23 |
| Bullfinch | 6 | 11 | 12 | 6 | 12 | 18 | 20 |
| Yellowhammer | 57 | 55 | 54 | 46 | 41 | 44 | 55 |
| Reed bunting | 3 | 3 | 3 | 5 | 8 | 5 | 13 |

*Colours of species' names indicate their listing according to the latest UK Birds of Conservation Concern assessment.*

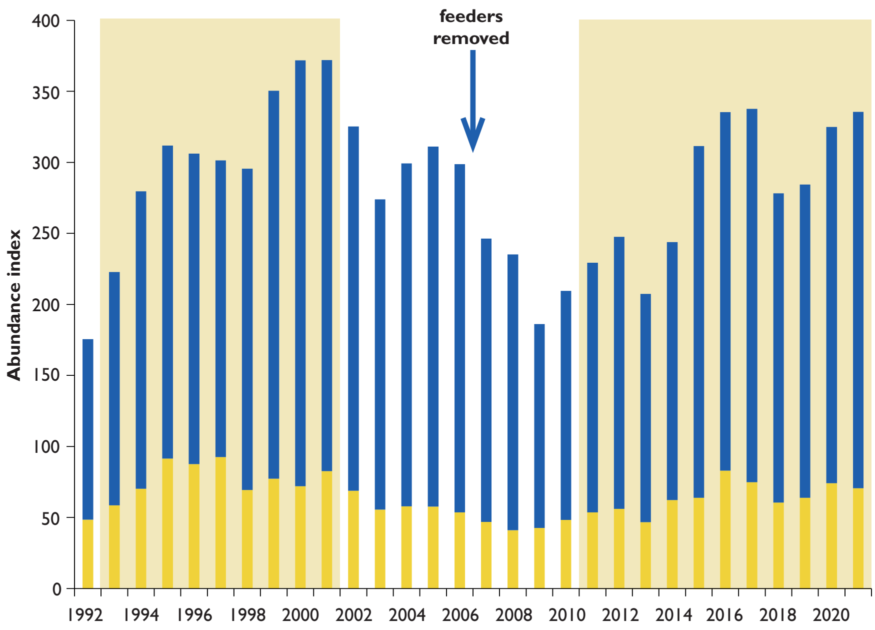



Figure 1
Songbird abundance

Biodiversity Action Plan species
Others
Keepered periods

as wild bird seed crops and supplementary winter feeding, and predator control. Overall, our territory mapping revealed a 76% increase in BAP species abundance since 1992.

Willow warblers are an exception among the BAP species, in that their numbers have declined dramatically and steadily during the period of the project. This is a marked contrast to the trend for the ecologically similar chiffchaff whose numbers have increased (see Figure 2). These differences are explained by migration strategies. Climate change is increasingly enabling chiffchaffs to winter in northern Europe, whereas willow warblers winter in sub-tropical areas of sub-Saharan Africa.

Garden warbler and blackcap are also ecologically similar species. Blackcap was less common than garden warbler a century ago, but this species has undergone a national increase of more than 300% since 1970, while garden warblers declined by 11%. Again, blackcaps have been increasingly wintering in northern Europe while garden warblers winter in Africa. Blackcaps now outnumber garden warblers at Loddington by 20 to 1.

Chaffinch and greenfinch are ecologically similar species that increased by 70% and 313% respectively between 1992 and 2001. But both have subsequently declined in line with the national population trend due to the increased national incidence of *Trichomoniasis*, a parasitic disease which has caused widespread mortality since 2006. Songbird species will always differ in the way their numbers change at Loddington, not just because of the management carried out, but because of conditions operating at regional, national or global scales.

## KEY FINDINGS

- Transect counts revealed 91% higher overall songbird abundance in 2021 than in 1992, and 46% higher abundance of BAP species.
- Detailed territory mapping identified 76% higher BAP species abundance than in 1992.
- Some species have increased in response to the game management system.
- Some species have declined as a result of factors operating at national or international scales.

Chris Stoate
John Szczur
Matthew Coupe

## ACKNOWLEDGEMENTS

Thank you to Kings Crops who supply the seed and provide agronomy support to the Allerton Project.

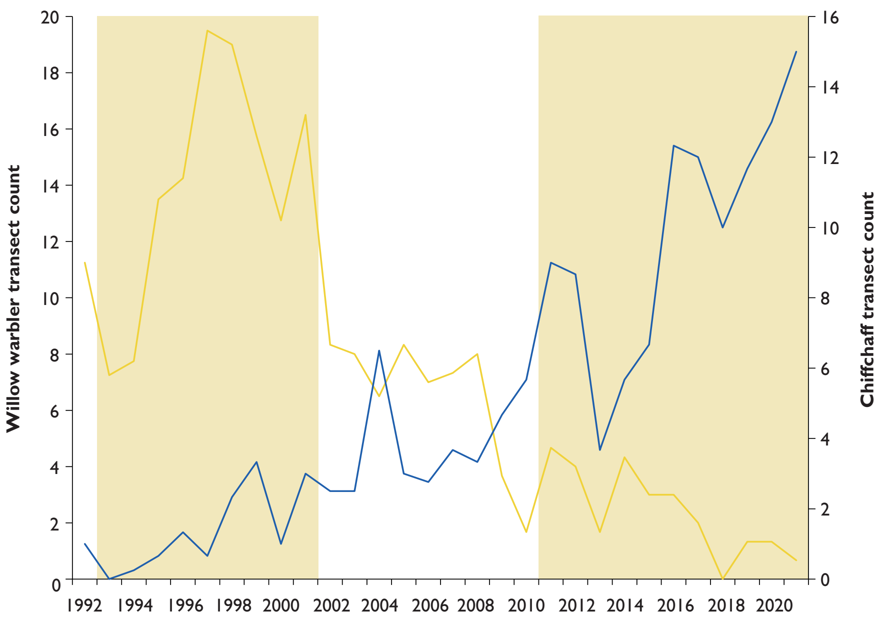



Figure 2
Willow warbler and chiffchaff transects

Chiffchaff
Willow warbler

# The farming year at the Allerton Project

*Recent years have demonstrated that climate change has an increasing impact on our ability to farm. © Joe Stanley/GWCT*

2021 was another challenging year for farmers across much of the country. After a late summer storm shook 40% of our oat grains onto the ground in 2020, a second consecutive torrential autumn and winter – with rainfall totals around double the historic average from 1980 – saw a second year of extensive disruption to the planned cropping rotation at Loddington on our heavy grade 3 clay soils and steep slopes. With 'delayed drilling' into October now the norm for many arable farms to help suppress competitive and increasingly herbicide-resistant grass weeds, our winter wheat plantings were particularly affected, further exacerbated by a carpet of now germinated volunteer oats. This demonstrates why doing the 'right thing' from an Integrated Crop Management (ICM) perspective in reducing reliance on synthetic inputs is not always the easy or profitable thing to do, with weather catching out the best-laid plans.

As is now becoming a worryingly familiar pattern, spring 2021 then lurched directly into drought with the driest April since 1980; it was also relatively cold. These conditions were far from perfect for our large area of spring cropping, which included wheat, barley and beans.

Finally, summer was the 'driest wet harvest' that most could remember, with low wind speeds and high cloud cover – often depositing spoiling, intermittent showers – leading to a very on-off harvest, the lack of a grain drier forcing us to wait until cereal moisture levels were below 17%.

All in all, this led to another disappointing cropping year. Yields were mostly well below our 10-year average, not helped by another year of extreme cabbage stem flea

TABLE 1

**Arable gross margins (£/hectare) at the Allerton Project 2010-2021**

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Winter wheat* | 673 | 783 | 255 | 567 | 590 | 457 | 442 | 766 | 780 | 837 | 568 | 551 |
| *Winter oilseed rape* | 799 | 1,082 | 490 | 162 | 414 | 533 | 524 | 713 | 377 | 528 | - | 485 |
| *Spring beans* | 512 | 507 | 817 | 580 | 646* | 396* | 289* | 436* | 176* | 459* | 301 | 460 |
| *Winter oats* | 808 | 873 | 676 | 570 | 354 | 507 | 156** | - | - | 386 | 324 | 380 |
| *Winter barley* | | | | | | | | 367 | 733 | 423 | 630 | 558 |
| *Spring wheat* | | | | | | | | 367 | 733 | 423 | 630 | 531 |
| *Spring barley* | | | | | | | | 367 | 733 | 423 | 630 | 390 |

*No single/basic farm payment included * winter beans, **spring oats*

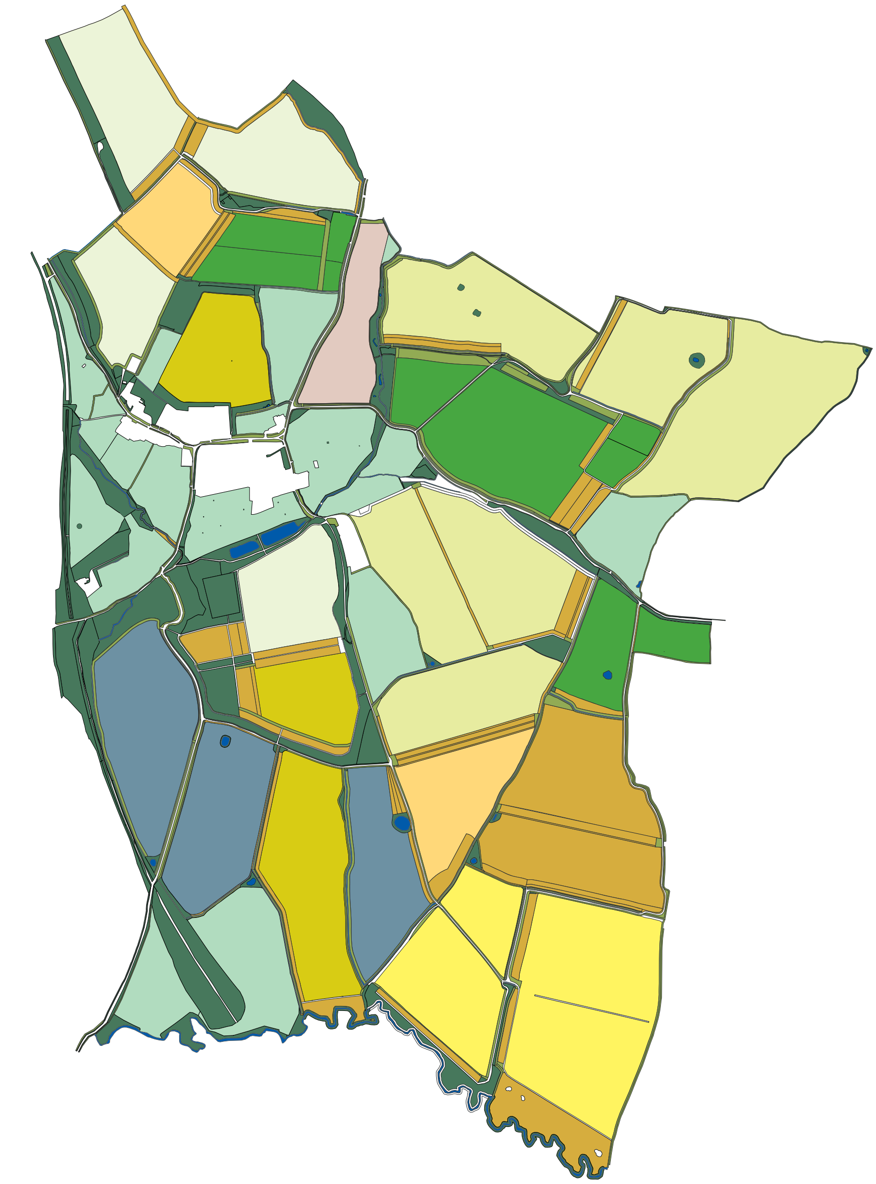


**Figure 1**

Allerton Project cropping 2020/21

- Woodland
- Permanent pasture
- Spring wheat
- Winter oilseed rape
- Winter barley
- Winter oats
- Red clover & lucerne
- Spring beans
- Spring barley
- Stewardship and shoot cover
- Hedgerow/verge

beetle pressure in our oilseed rape. However, autumn 2021 was thankfully relatively kind, with winter crops establishing well heading into Christmas. Spring cropping will remain a key element of the rotation for some years to come, in large part to help combat those pernicious grass weeds, as well as accruing environmental benefits such as enabling the use of over-wintered cover crops and offering a reduced carbon footprint.

Recent years have demonstrated that climate change has an increasing impact on our ability, even in the UK, to produce food in the way we have done for generations. Farmers the world over are on the front line of the unfolding climate crisis, and we must do more to build greater resilience into our farming systems – quite apart from the imperative to play our part in the decarbonisation of the wider economy by reducing agricultural emissions, currently some 10% of the national share. The National Farmers' Union aims for British farmers to be net zero by 2040, and this will involve agriculture's almost unique ability not only to reduce its own emissions, but to absorb those from the rest of the economy by sequestering them in our soils and crops. The Allerton Project is at the forefront of research into these areas.

Our turn towards soil-preserving 'conservation agriculture' in the last decade will also see us in good stead; reduced tillage has seen work rates double versus our old plough-based system, meaning smaller weather windows can be exploited more effectively. However, the extremes of 2019-2020 slammed even these windows shut. In addition, our complex field trials will always reduce work rates from the ideal.

2021 has seen us move away from our longstanding joint venture with a neighbouring farm to invest once again in our own equipment, with the arrival of a second-

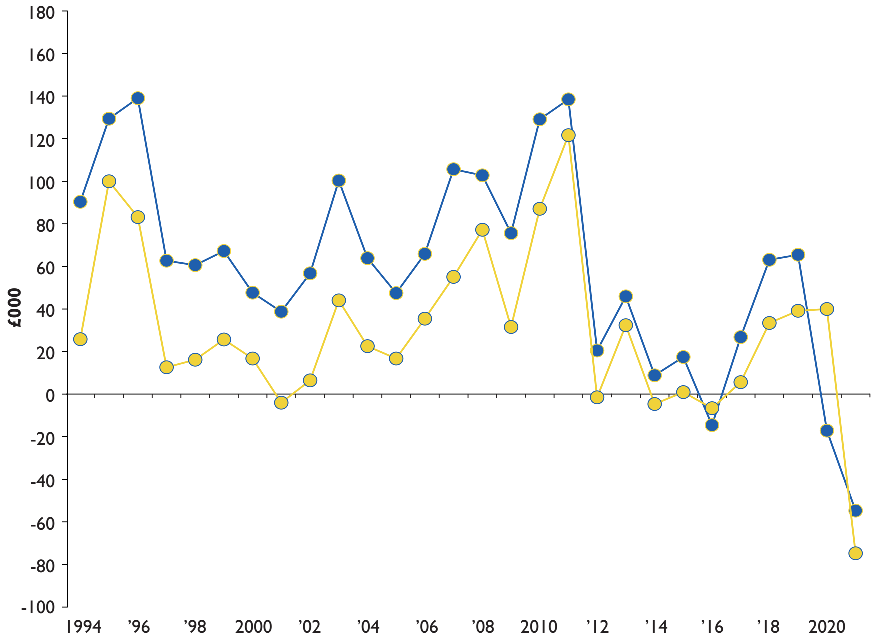
## BACKGROUND

The Allerton Project is based around a 333-hectare (822 acres) estate in Leicestershire. The estate was left to the GWCT by the late Lord and Lady Allerton in 1992 and the Project's objectives are to research ways in which highly productive agriculture and protection of the environment can be reconciled. In 2022, it celebrates its 30th anniversary.

Figure 2

Gross profit* and farm profit at the Allerton Project 1994-2021

*Gross profit = farm profit plus profit foregone to research, education and conservation*




## KEY FINDINGS

- Climate change continues to detrimentally impact farming operations nationwide.
- Agricultural inflation and reduction in Government financial support are applying pressure to farm margins.
- New opportunities are afforded by entering a new five-year Countryside Stewardship Mid-Tier agreement.

Joe Stanley
Oliver Carrick
Alastair Leake
Phil Jarvis

hand Chafer 3500-litre trailed sprayer and a new topper. In addition, we have been fortunate to secure the loan of a reconditioned Claydon direct drill to trial alongside our existing Dale Ecodrill, plus a brand new tracked Claas 670 Lexion combine thanks to the help of our Allerton chairman, Jeremy Finnis. The use of the combine especially, with its 30-foot header, was vital in the timely completion of harvest before crop quality deteriorated.

2021 was also a year of change, with long-serving farm manager, Phil Jarvis, leaving for pastures new. Phil had served 29 years at the Allerton Project, arriving at its inception in 1992. His role on the farm has been taken on by Oliver Carrick, previously assistant farm manager. Phil's extensive responsibilities in the wider Allerton Project have been handed to Joe Stanley, now our head of training and partnerships, who joined us in the summer having previously been farming in his own right since 2009.

2021 also saw us leave our Higher-Level Stewardship (HLS) scheme after 10 years and enter a new Mid-Tier Countryside Stewardship (CS) agreement, with the income from agri-environment engagement expected to double. We are now looking at more whole-field options under CS, with areas put down to overwintered cover

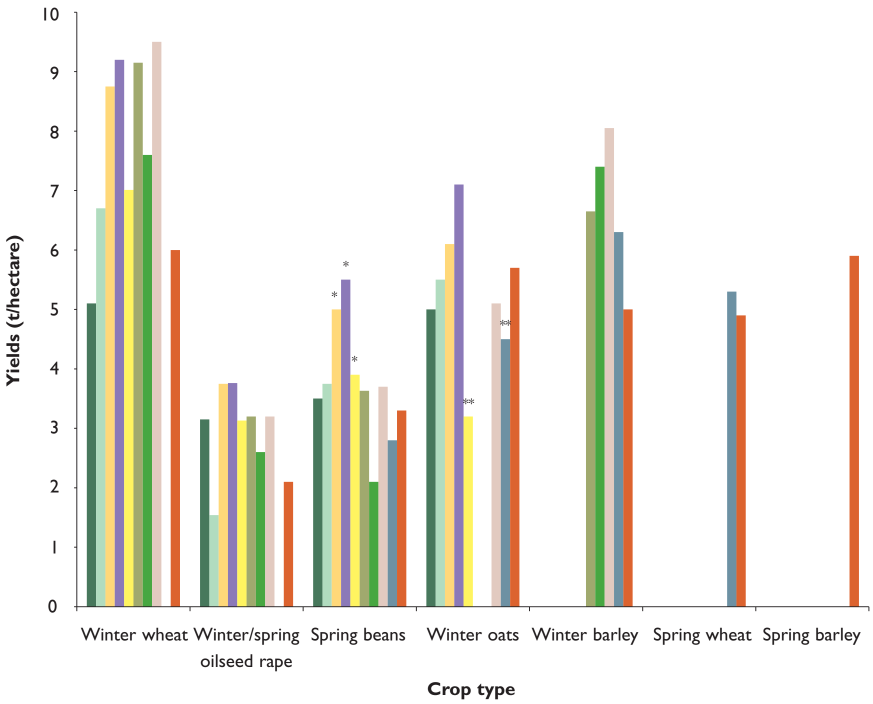

*2021 saw us move away from our longstanding joint venture with a neighbouring farm and invest in our own equipment including the loan of a new combine with a 30-foot header from Claas Eastern. © Joe Stanley/GWCT*

*A winter wild bird seed strip (moir mix, from Kings Crops) beside some spring barley. © Joe Stanley/ GWCT*

crops, two-year legume fallows and legume and herb-rich swards on which we shall be able to graze livestock, primarily sheep from a neighbouring farm on a commercial agreement. These options will benefit the arable rotation by reducing our autumn workload and carbon footprint, increasing cultural controls and Integrated Pest Management (IPM), and benefiting soil health by introducing more organic matter to the land, while sequestering carbon. It is a long-term game, but the benefits should be visible in the years to come.

Changes to farm support payments with our exit from the EU and Common Agricultural Policy (CAP) will impact on the Project, with 2021 seeing the first reduction in the Basic Payment Scheme (BPS). Income from CS will, in the short term, help to cushion this shortfall, but the coming Agricultural Transition Period which will see BPS removed entirely and the introduction of Environmental Land Management schemes will be a challenging time for most in the farming industry. In the short term, this has been exacerbated by agricultural inflation running at 22% in September 2020-21. Although partially offset by higher commodity prices, spiralling costs (and limited availability of key inputs) have put added pressure on farm income.

Whether around climate change, commodity prices or Government policy, building resilience and diversification at Loddington will be key in the coming years.




## Figure 3

**Crop yields at the Allerton Project 2012-2021**

*Spring oilseed rape was sown in 2013, *spring beans, **spring oats*

# Deep-rooting grasses to deliver societal benefits

*Some deep-rooting grass cultivars can contribute to societal objectives for water infiltration so long as management of the sward does not restrict root growth.* *© Chris Stoate/GWCT*

## BACKGROUND

Grass leys have the potential to improve water infiltration (improving catchment-scale water quality and reducing flood risk) and to sequester carbon in the soil. Deep-rooting cultivars are likely to improve these soil functions.

## ACKNOWLEDGEMENTS

This research was part of the EU H2020 SoilCare project. Jeremy Clarke was supervised by Dr Kelly Redeker (University of York).

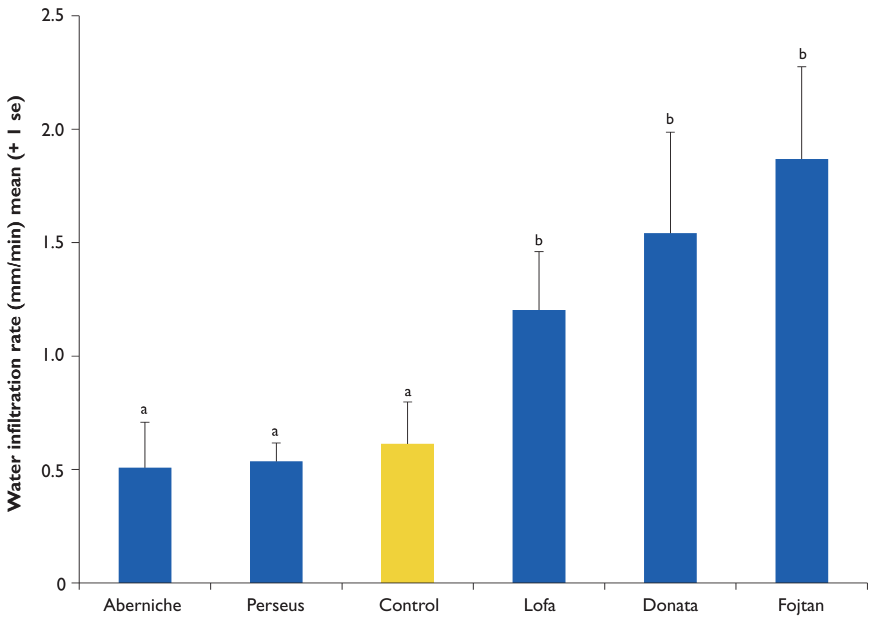
We explored the potential of grass leys to improve water infiltration and to sequester carbon in the soil by using four modern *Festulolium* cultivars (ryegrass x fescue hybrids) and a cock's-foot cultivar compared to control plots containing a standard ryegrass mix. In September 2015, we created three randomised replicates of each treatment in adjacent blocks, eight metres wide and 200 metres in length. Data collection included annual late winter assessment of water infiltration rates (using a double-ring infiltrometer (see Figure 1)), and root volume and soil carbon at 15, 40 and 70 centimetre (cm) depths in the soil profile in Years three and four. We collected soil and root samples by digging a one-metre-deep trench into the plots and using a soil augur into the exposed soil face.

Water infiltration rates were significantly higher in plots containing the *Festulolium* cultivars Fojtan and Lofa, and the cock's-foot Donata, in the first year (2016, see Figure 1). Infiltration rates in Fojtan plots were three times higher than the control, demonstrating potential benefits for meeting catchment-management objectives for flood-risk management. However, this was not repeated in the following year. Our results, combined with direct observation of the plots, caused us to think that a combination of harvesting for silage, grazing sheep and associated soil compaction, could have direct and indirect effects on subsequent water infiltration rates. We know, for example that harvesting above-ground biomass restricts root volume. As a result, a section of the plots was fenced off to exclude harvesting for silage or grazing in years three and four to provide a comparison with the adjacent section of the plots where both these activities continued.

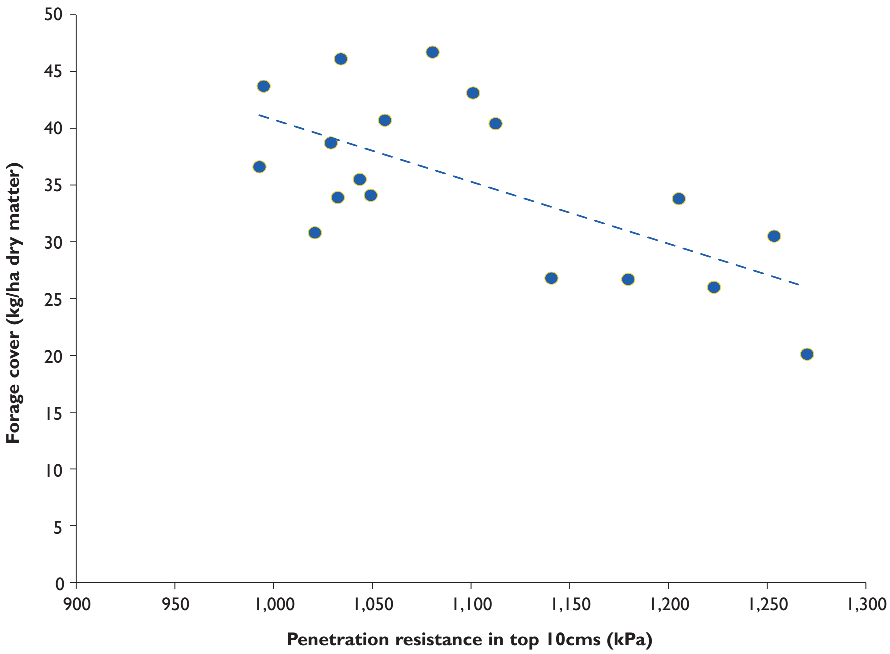
Data collection in Year three in the fenced and unfenced areas was confined to Donata, Fojtan and control plots. Compaction, as measured by penetration resistance, was higher in the unfenced cut and grazed areas than in the fenced areas, confirming our suspicion that grazing and silage cutting were causing compaction. In the unharvested areas, Fojtan had significantly higher root volume at 70cm depth. In Year four, root volume was measured in all plots. Four of the five test cultivars had higher root volume in the fenced off area than in the cut and grazed area, with Fojtan being the cultivar with highest root volume at 70cm depth (62% greater than the control in fenced areas), although this difference was not statistically significant. Above-ground

### Figure 1

Water infiltration rates in year one in plots containing the *Festulolium* cultivars Aberniche, Perseus, Lofa and Fojtan, and the cock's-foot Donata, relative to control plots with a standard ryegrass mix (three plots per treatment). Different letters above bars indicate a statistical difference in mean values






## Figure 2

Relationship between sward volume and soil compaction, as measured by penetration resistance

## KEY FINDINGS

- The deepest-rooting grass had highest water infiltration rates in the first year.
- Soil compaction inhibits grass growth and water infiltration rates.
- Active carbon declined with depth, but stable forms are equally abundant at depth.

Chris Stoate
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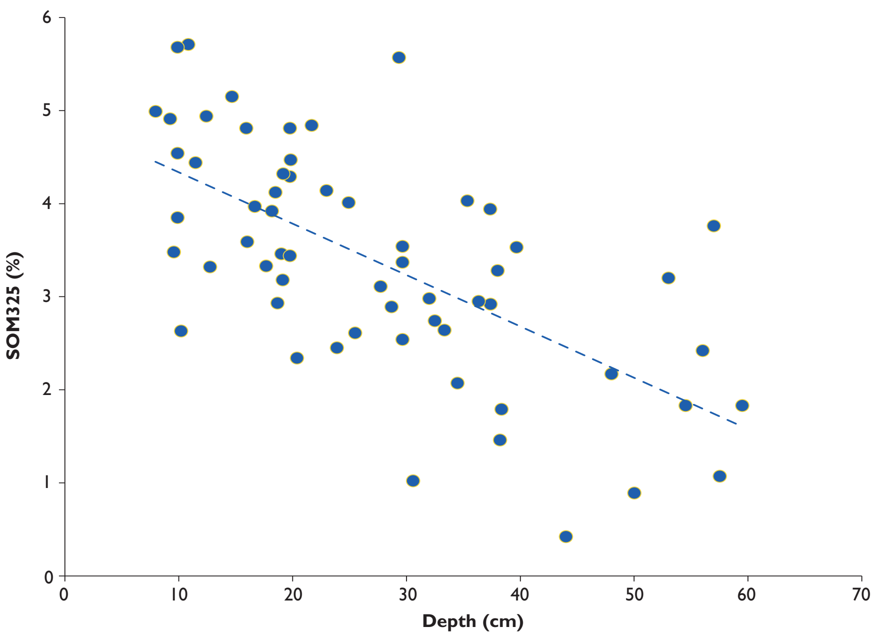
Jeremy Clarke

sward volume was also limited by compaction in the unharvested sections of the plots, limiting the forage available to livestock (see Figure 2).

Soil organic carbon (measured using loss on ignition at a range of temperatures) did not differ between treatments but was significantly higher at 15cm and 40cm depths than at 70cm. The proportion of recalcitrant (stable) and labile (active) forms of carbon influences the extent to which soil organic carbon contributes to genuine sequestration. Labile carbon is important for microbial activity and associated nutrient cycling and crop performance, but recalcitrant forms are necessary for sequestration. Carbon sequestered in soil through the adoption of grass leys and other management practices can easily be lost again when the land is returned to arable cropping unless it is stored below the plough layer (around 30cm depth). We found that labile carbon declined with depth, but recalcitrant carbon was found consistently through the soil profile and therefore offers an opportunity for sequestration. We are investigating this further in relation to the various cultivars.

Our research suggests that some deep-rooting grass cultivars can contribute to societal objectives for water infiltration so long as management of the sward does not restrict root growth. The presence of stable carbon below the plough layer suggests that they may also have a role in carbon sequestration. To be realised, these societal benefits may be dependent on careful management of grazing conditions and harvesting intensity.

*Double ring infiltrometer in use in an arable field.*
*© Chris Stoate/GWCT*




## Figure 3

The negative relationship between the amount of active carbon and depth in the soil profile. SOC325 is a measure of soil carbon based on ignition at 325°C

# Soil Biology and Soil Health

*Collembola play an important role in the decomposer food web, consuming decaying plant material and other organisms, and have a large effect on soil structure and composition and the release of nutrients. © Henrik Larsson*

## BACKGROUND

The five-year Soil Biology and Soil Health Partnership is a cross-sector programme of research and knowledge exchange. The programme is designed to help farmers and growers maintain and improve the productivity of UK agricultural and horticultural systems, through better understanding of soil biology and soil health.

The Allerton Project's contribution to the Soil Biology and Soil Health Partnership has been an ecological comparison of ploughed and direct-drilled plots. We ploughed out three nine-metre-wide mid-field strips in a field that had been direct-drilled for seven years in 2017. We then repeated the ploughing in the two subsequent years while continuing with the direct drilling in the other three plots. After three years, we found a higher VESS score (poorer structure) in the ploughed plots. Soil organic matter was 0.5% higher in the direct-drilled plots.

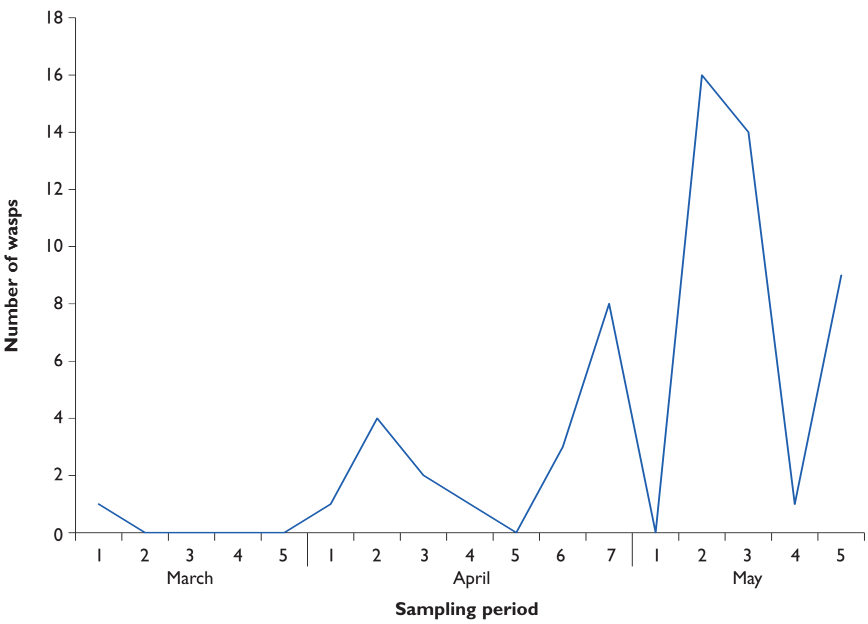
In Year three of the experiment, we used an emergence trap ($0.36m^2$) in each plot to record the invertebrates emerging from the soil from March to May, emptying traps at four to five day intervals. The traps contained an integral collecting bottle in the top and a pitfall trap in the ground. We found no difference in abundance of carabid or staphylinid beetles between ploughed and direct-drilled plots. Abundance of Diptera (mainly Chironomidae (non-biting midges) and Sciaridae (dark-winged fungus gnats)) was significantly higher in the direct-drilled plots (see Figure 2). Abundance of parasitic wasps, many of which are parasitoids of aphids, did not differ between ploughed and direct-drilled plots. Their emergence occurred from late April to late May, a period in which aphids can be actively colonising and feeding on crops (see Figure 1).

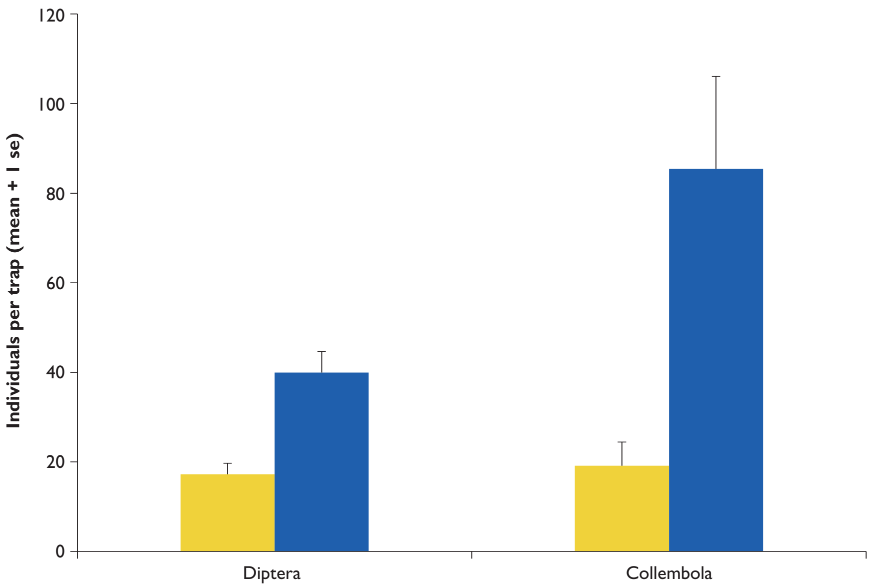
Soil-dwelling collembola (springtails) were significantly more abundant in direct-drilled plots through March and early April (see Figure 2). Although collembola are small, they play an important role in the decomposer food web, consuming decaying plant material and other organisms. As a result, they have a large effect on soil structure and composition and the release of nutrients through microbial action on their faecal material.

We used a MicroRespTM test in the laboratory to measure the ability of the soil microbial community from the plots to effectively metabolise a range of soil

### Figure 1

Parasitic wasp emergence into emergence traps by trapping periods (four to five day intervals) from March to May, 2020






## Figure 2

Numbers of Diptera (early March-late May) and collembola (early March-early April) caught in emergence traps

Plough

Direct drill

substrates, to provide a measure of microbial activity and functional diversity. We also collected data on $CO_2$ and $N_2O$ emissions from the same sites as the soil samples (five amalgamated sub-samples to 15cm depth) were taken, and at the same sampling times to capture in-field data on emissions using a Gasmet gas analyser. $CO_2$ emissions provided a measure of microbial activity.

Microbial functional diversity was 382% higher in direct-drilled plots than ploughed plots, while microbial activity was 300% higher in the direct-drilled plots. Both microbial diversity and microbial activity increased from April to July, declining again in September. $N_2O$ flux was extremely low in both treatments, with no significant difference between them. This is important given that our earlier work on compacted direct-drilled soils showed that $N_2O$ emissions were higher than in ploughed plots (*Review of 2019*, pp26-27). Our results suggest that, given time, the restructuring of the direct-drilled soil through biological activity creates aerobic conditions that are less conducive to the bacterial denitrification that releases $N_2O$.

$N_2O$ flux decreased significantly with microbial functional diversity, but higher functional diversity was also associated with higher $CO_2$ flux. There was a similar response for microbial activity, but with only a weak trend for $N_2O$. There was a positive relationship between organic matter and both microbial activity and diversity. Given the importance of the microbial community in nutrient cycling, this suggests that availability of nutrients to crops may be higher in direct-drilled plots, with higher efficiency and resilience to environmental shocks associated with the enhanced functional diversity.

## KEY FINDINGS

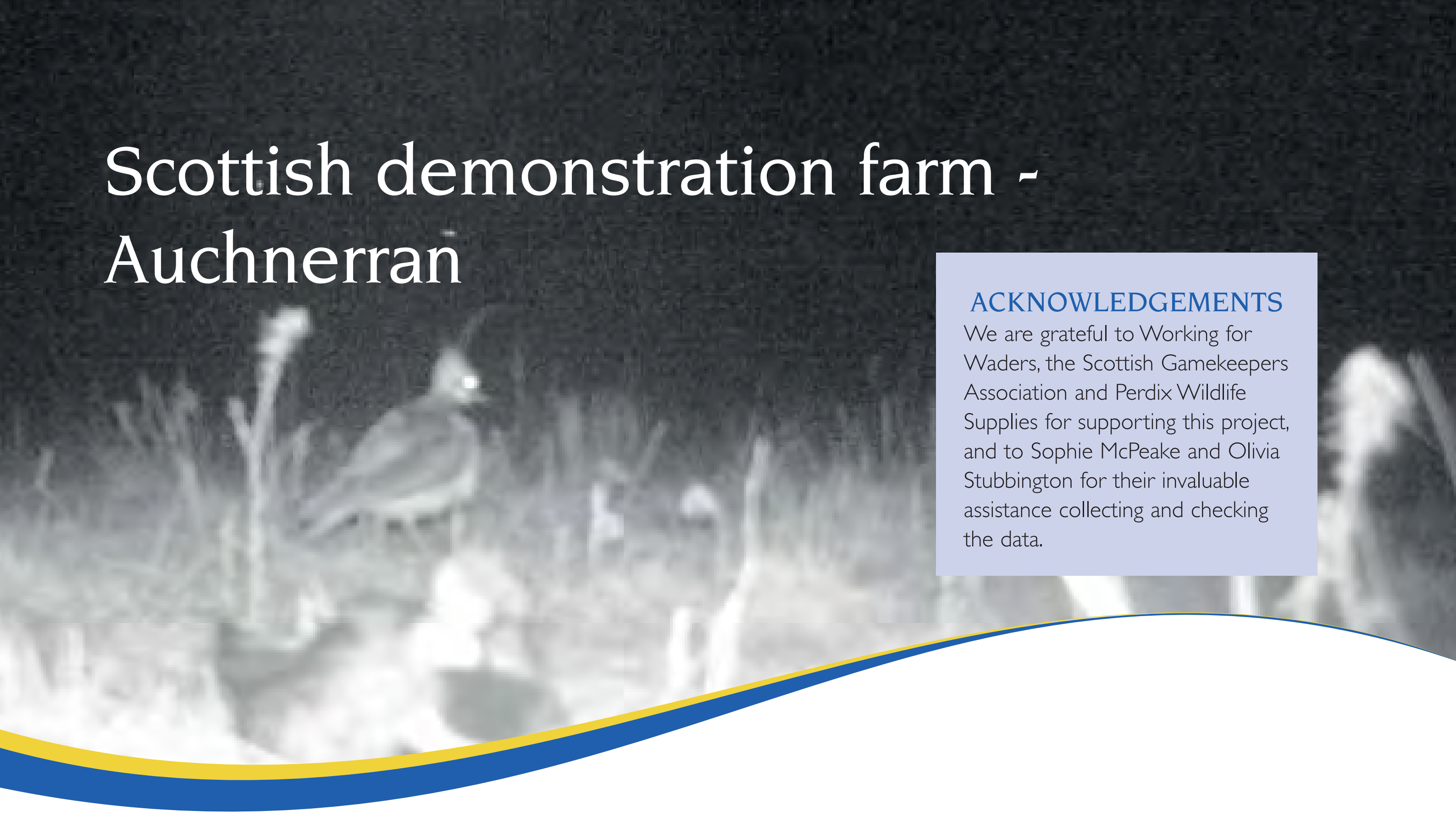
- Diptera and Collembola were respectively 132% and 347% more abundant in direct-drilled than ploughed plots.
- Direct-drilled plots had better structured soils with 300% higher microbial activity and 382% higher functional diversity.
- In contrast to our findings from compacted soils, nitrous oxide emissions were very low from both ploughed and non-compacted direct-drilled plots.

Chris Stoate
Jenny Bussell
Gemma Fox
John Szczur

## ACKNOWLEDGEMENTS

The Soil Biology and Soil Health project was funded by AHDB.

*Availability of nutrients to crops may be higher in direct-drilled plots, with higher efficiency and resilience to environmental shocks associated with the enhanced functional diversity. © Joe Stanley/GWCT*



# Scottish demonstration farm - Auchnerran


### ACKNOWLEDGEMENTS

We are grateful to Working for Waders, the Scottish Gamekeepers Association and Perdix Wildlife Supplies for supporting this project, and to Sophie McPeake and Olivia Stubbington for their invaluable assistance collecting and checking the data.


## Auchnerran: wader counts

*Lapwing pair at the nest – the female is incubating in the foreground; the male is behind. © GWCT*

### BACKGROUND

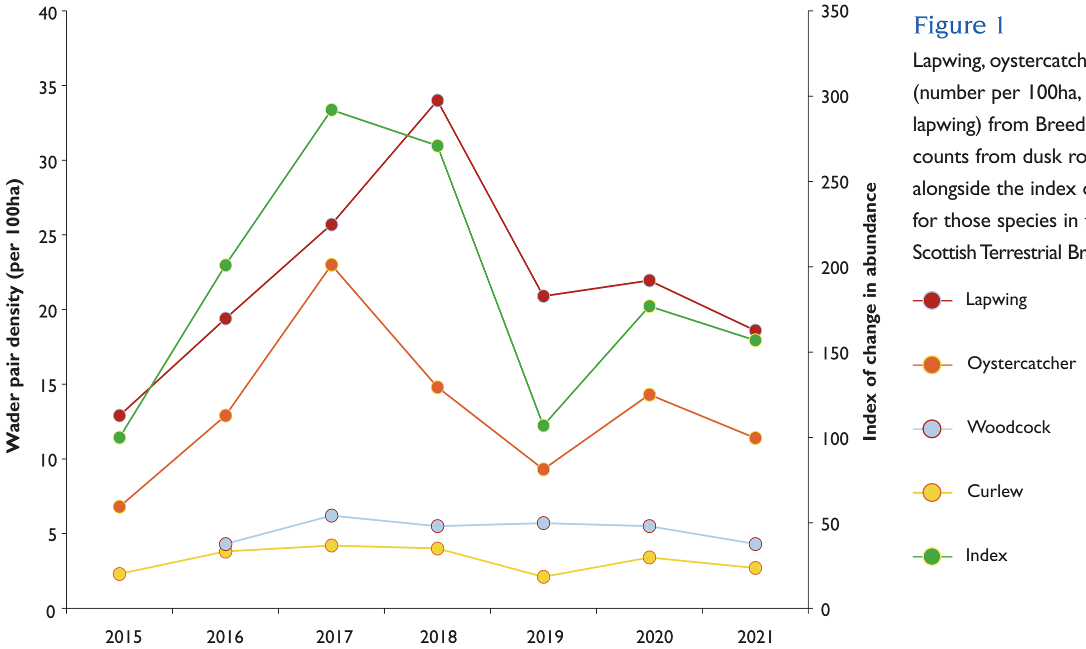
We took on the management of our Game & Wildlife Scottish Demonstration farm, Auchnerran at the end of 2014 and began a two-year baseline survey of biodiversity to quantify the abundance and diversity of wildlife present. Some surveys continued annually to monitor long-term trends and highlight farm activities which might impact biodiversity. The main groups monitored are: game, breeding birds (farmland birds with additional focus on waders and raptors, for which we try to record productivity too), rabbits, foxes, corvids, sheep tick and fluke (with help from the Moredun Research Institute). Only the bird data are described here. More details can be found in our annual reports gwct.org.uk/auchnerran.

The great thing about annual biodiversity monitoring – recording observations on the same species in the same place in successive years – is that you get a detailed understanding of what might be influencing the numbers or productivity of the species in question. Monitoring in 2021 proved to be particularly insightful and quite surprising.

Bird numbers on the farm declined slightly this year. The index of change in abundance for those species present on the farm which contribute to the Scottish Terrestrial Breeding Birds (farmland) index, was down 12% compared with 2020 (see Figure 1). This index is used by the Scottish Government to monitor the long-term population trends of typical farmland species. The fall in the index was reflected in the waders we monitor, which overall declined by 20% compared with 2020 (see Figure 1), which was perhaps associated with the prolonged very cold period in spring that produced significant snow in May. Unfortunately, the 2021 decline means that the marginal recovery we recorded after the major fall in numbers between 2018-19 has stalled.

Auchnerran adjoins a grouse moor whose keepers manage predator numbers across Auchnerran. This is likely to be the main reason why waders breeding at Auchnerran usually have high rates of hatching success (the probability of a clutch producing at least one chick). In 2021, however, hatching success calculated from an estimate of nest exposure declined for lapwing, oystercatcher and curlew (the species we are able to monitor) by 77% relative to the previous year, with lapwing hatching success, for example, down by 83% to just 11% (95% CL 7-21%).

*A badger homes-in on a lapwing nest just before eating the contents. © GWCT*




## Figure 1

Lapwing, oystercatcher and curlew pair density (number per 100ha, assuming monogamy for lapwing) from Breeding Bird Surveys, woodcock counts from dusk roding-male surveys, 2015-21, alongside the index of change in abundance for those species in the Scottish Government's Scottish Terrestrial Breeding Birds (farmland) index

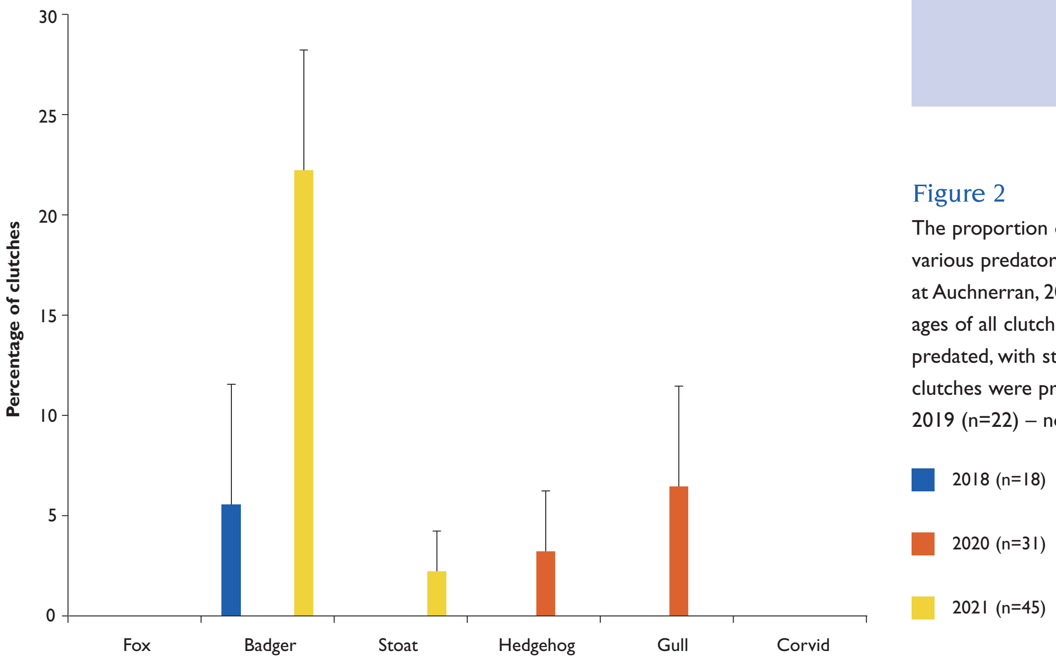
We monitor many of our nests with trail cameras, which provide details regarding the fate of clutches that can be hard to come by using traditional fieldcraft, though the monitored sample of nests is biased towards those more likely to be successful. This revealed a spike in the predation of lapwing eggs in 2021, with badgers the main culprit, taking 22% (± 6% SE) of all 45 lapwing clutches monitored (see Figure 2). Stoats took 2%, and the remainder were lost to agricultural practices (destroyed by sheep or machinery; 7%), abandonment (2%) or unknown predators (7%). The proportion of clutches taken by badgers determined by other means where cameras were not used was similar (20 ± 6%). Clutch loss to badgers has been relatively rare in the past, so why we had this peak in 2021 is not clear. We have no active main setts on the farm and do not often record badgers when surveying or via cameras monitoring other things.

We are currently searching for setts in the wider landscape around Auchnerran with help from neighbours and hope to use hair samples collected from the wider landscape to build up a picture of badger numbers and movements over the next year or so. We will also be keeping a close eye on our waders next year and hope to raise funds for a wider study of predation on the clutches of waders and other ground-nesting birds, by the full suite of potential predators.

## KEY FINDINGS

- Breeding bird abundance was down by 12% this year relative to 2020, perhaps related to the cold weather at Auchnerran in late spring.
- Hatching success of those wader species we monitored was also down, by 77% overall. That for lapwing was down 83%, with only 11% of lapwing clutches producing at least one chick.
- Trail cameras indicated that the single greatest cause of lapwing clutch failure was predation by badgers, which took 22% of all the lapwing clutches monitored.

**Dave Parish**
**Marlies Nicolai**




## Figure 2

The proportion of lapwing clutches taken by various predators identified by trail cameras at Auchnerran, 2018-21. Data are percentages of all clutches monitored, not just those predated, with standard errors. No monitored clutches were predated by foxes or corvids. 2019 (n=22) – no predation recorded

# The farming year at Auchnerran

*Snow in May affected lamb production with early losses. © Marlies Nicolai/GWCT*

This year the Scottish weather threw us a bit of a curveball, with very cold weather extending into late spring. In fact, we had significant snowfall in the second week of May. This was followed by a pretty good summer period which was mostly warm and dry, although more rain would have helped the grass grow more than it did. This resulted in a reduced crop of silage (see Table 1), but we are confident that the 600 bales, along with 18.5 hectares of forage crops, will provide ample supplementary forage over winter.

The weather also affected lamb production, with early losses above average due to the snowy conditions. This reinforces how crucial the timing of lambing is. We already aim to lamb relatively late in the season (from about 1 May) to avoid the worst of the late winter weather: if we advanced lambing we would run the risk of higher losses on a regular basis. In the end, 126% of ewes produced lambs that reached weaning age in

## BACKGROUND

Auchnerran is a hill-edge farm in east Aberdeenshire, bordering the Cairngorms. The main body of the farm extends to 417ha, with another 65ha shared with a neighbour. About 70% of the land is grass with some woodland, fodder crops and game cover. The soils are mostly acidic and sandy in nature. The principal commodity on the farm is the sheep flock, which also serves to mop up ticks on the adjacent grouse moor where the sheep graze from around April to November. More information about Auchnerran, including our annual reports, can be found at gwct.org.uk/auchnerran.

### TABLE 1

**Flock size and productivity (percentage of ewes with weaned lambs) at Auchnerran, along with annual silage production**

| | Ewes | % weaned | Silage bales per year | Bales per hectare |
|---|---|---|---|---|
| 2015 | 1,440 | 60% | 730 | 17 |
| 2016 | 1,205 | 97% | 717 | 20 |
| 2017 | 1,126 | 120% | 1,100 | 25 |
| 2018 | 1,000 | 126% | 460 | 12 |
| 2019 | 986 | 124% | 986 | 23 |
| 2020 | 1,400 | 129% | 830 | 24 |
| 2021 | 1,430 | 126% | 600 | 20 |

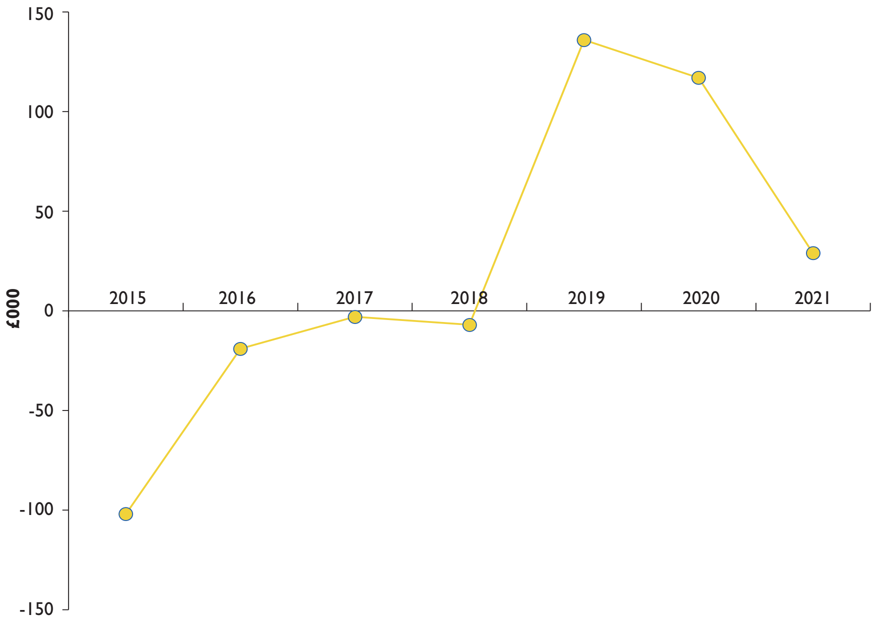



**Figure 1**

Auchnerran farm profit, 2015-2021 (figures for 2021 are provisional)

Farm profit

2021 – not bad at all given the challenging conditions and testament to Allan Wright's hard work.

We have maintained the optimum flock size in 2021, with 1,430 ewes in late November, though 50 of these are simply maintained as tick mops and not bred from. This is about the maximum number that can be supported on the farm and managed by a single person, and is appropriate for tick control on the adjacent grouse moor where the sheep graze in the summer. Flock size declined significantly in the early years at Auchnerran (see Table 1) as we improved the age structure and health of the flock by replacing the old, sick animals, so that we could increase productivity to viable levels.

As we reported last year, we have begun work on both carbon and natural capital audits at Auchnerran, like many farmers are being encouraged to. This process is still ongoing. The carbon audit was extended to include 2018-2020, but unfortunately the AgreCalc carbon calculator being used still does not include a soil sequestration element – especially important for a farm like Auchnerran which has so much pasture of one kind or another. Despite our early optimism, it seems that our emissions, which emanate largely from the sheep themselves, are not fully countered by the farm woods. In 2020, for example, we produced net around 319 tonnes of $CO_2$ equivalent. Although this is still an incomplete picture, it has been a useful exercise which has highlighted the key sources of greenhouse gases. We hope to fill in the blanks soon when we can include soil sequestration in the model. Our natural capital assessment has progressed well but has highlighted the difficulties in valuing the more indefinable elements of the farmed environment, like the species that inhabit it.

## KEY FINDINGS

- Despite challenging weather, the farm performed well in 2021. In all, 126% of ewes produced lambs that reached weaning age and we produced an average of 20 bales of silage per hectare.
- We have maintained the overall flock size around its optimum with 1,380 breeding ewes this year plus 50 ewes simply managed as tick-mops.
- Our updated carbon audit shows Auchnerran is a net emitter of greenhouse gases, but the calculation does not yet include potential soil sequestration.
- Our natural capital assessment is ongoing but has highlighted the difficulties in quantifying the value of some elements like biodiversity.

Dave Parish
Allan Wright
Ross MacLeod

*We aim to lamb relatively late in the season (from about 1 May) to avoid the worst of the late winter weather. © Marlies Nicolai/GWCT*

# Farm improvements and breeding lapwing

*Auchnerran was rich in wildlife especially waders but the farm needed extensive improvements. © Olivia Stubbington/GWCT*

A fundamental aim at Auchnerran is to demonstrate how a typical hill-edge farm can be managed to enhance wildlife and ecosystem services, without compromising productivity and economic viability. After all, what farmer will seriously consider concessions to conservation if they harm the business? So, when we took on Auchnerran and found it needed extensive work but was also rich in wildlife, we knew we were faced with an unusual challenge.

From the outset we have monitored a suite of species on the farm annually to highlight any impacts that management changes might have and to help inform future decisions. Chief among them are the breeding waders. Here we describe preliminary data on the impact that changes on the farm have had on breeding lapwing.

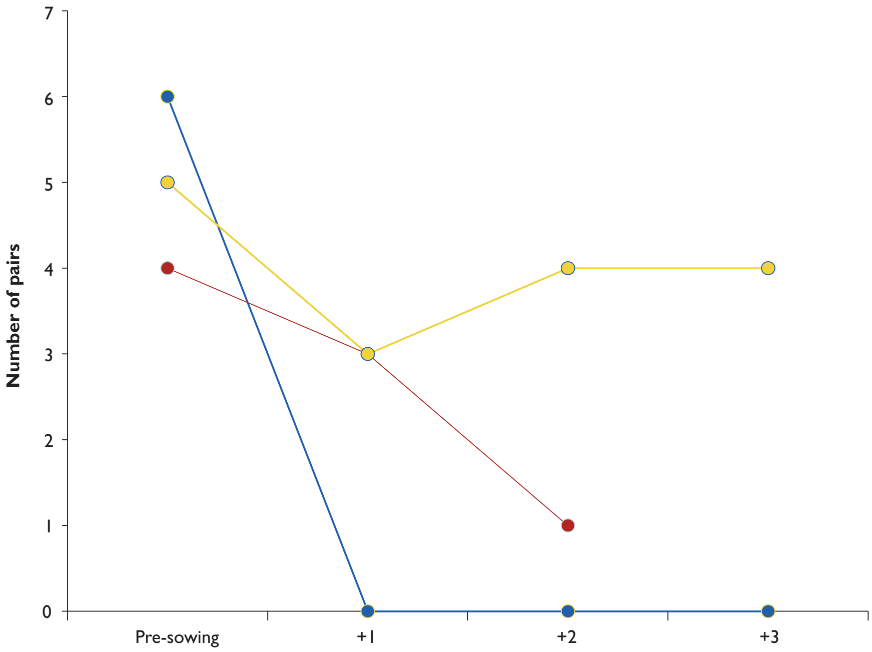
The main relevant alterations to farm management were the introduction of a basic crop rotation that included fodder crops, the reseeding of grass fields and the use of artificial inputs (eg. fertiliser and lime). Reseeding at Auchnerran has established a mix of fast-growing ryegrass and clover for silage and improved grazing, and fodder crops such as brassicas and stubble turnips, both of which provide an important supplement to sheep diet over winter. Often the ryegrass/clover mix would be sown after a fodder crop, with the latter following a variety of crop types. Few alterations to field use were made in any one year. Fertiliser and lime were routinely added to fodder crops and reseeded grass fields to help establishment, and lime and sometimes fertilisers were also added to some older pastures to enhance grass growth.

It was recently suggested that lapwing breeding on a Scottish hill farm benefited from the conversion of grass to stubble turnips for a few years before reverting to grass, with a 52% increase in numbers reported in the first year after the change was made (McCallum et al. 2018). Numbers then declined steadily, but higher lapwing densities were maintained for up to seven years after fodder crop establishment, including in the following grass crop. The initial increase was thought to reflect a more attractive habitat for nesting lapwing but was probably maintained in subsequent years partly through an increase in earthworm abundance (although this wasn't measured), as the conversion involved liming and worms prefer non-acid soils. Therefore, this routine farming practice might be a win-win for sheep farmers and breeding waders. Auchnerran employs a similar system, so provides an opportunity to investigate this suggestion.

There were five occasions at Auchnerran where a grass/clover mix was established and four where turnips were introduced, for which we also have records of breeding lapwing. The average number of lapwing pairs before sowing with the grass/clover mix

## BACKGROUND

The GWCT took over the lease at Auchnerran Farm at the end of 2014, at which time it needed significant improvements to infrastructure (fencing, drainage and buildings), grass quality (nutritional value and growth rate) and sheep health, crucial for the farm business. However, the farm also supported a healthy wildlife community, with the diversity and number of breeding waders particularly noteworthy. Thus, there was the potential for farm improvements to impact on biodiversity.




## Figure 1

The change in number of lapwing pairs in three fields converted to grass, in relation to the time from conversion

Field 1
Field 2
Field 3

was 4.4 (±0.5 standard error). The following year it was 2.6 (±1.0), a 41% reduction. The number of pairs before a field was converted to turnips averaged 2.0 (±0.6) but increased 25% after to 2.5 (±0.9). Although these differences are not statistically significant, they suggest a biologically important decline in the number of pairs after resowing with grass and that turnips might be attractive to breeding lapwing. Looking at the 34 parcels of land which were not resown between 2018 and 2021 (when these changes occurred) the number of pairs was 50, 48, 50 and 41 respectively, suggesting reasonable stability. The 18% drop between 2020 and 2021 almost certainly reflects the very cold weather that extended late into spring, which presumably dissuaded some birds from breeding.

Assuming that the decline in breeding pairs after resowing with grass is genuine, how long does it persist? We have three fields that were converted to grass and were then monitored for two or three years (see Figure 1). Changes in pair numbers in

*Grass fields were reseeded with a mix of fast-growing ryegrass and clover. © Marlies Nicolai/GWCT*

## KEY FINDINGS

- Improvements to Auchnerran Farm include the introduction of rotational fodder crops, resowing of grass fields with a faster-growing, more nutritious grass/clover mix, and the addition of fertiliser and lime.
- Resowing with the faster-growing grass mix resulted in a non-significant 41% decline in the number of lapwing pairs on average, while switching to turnips resulted in a non-significant 25% increase. At the same time the number of pairs in unchanged fields across the farm was relatively stable.
- The addition of lime to a group of five fields resulted in a 32% decline in lapwing pairs over a five-year period.
- Similar trends were noted for pre-breeding lapwing in February and March.
- Introducing the faster-growing grass mix has probably had a detrimental impact on the number of lapwing breeding at Auchnerran, though turnips may provide an attractive habitat.

Dave Parish
Marlies Nicolai

*Lime was applied to some older pastures to raise the pH of the soil and enhance grass growth. © Marlies Nicolai/GWCT*

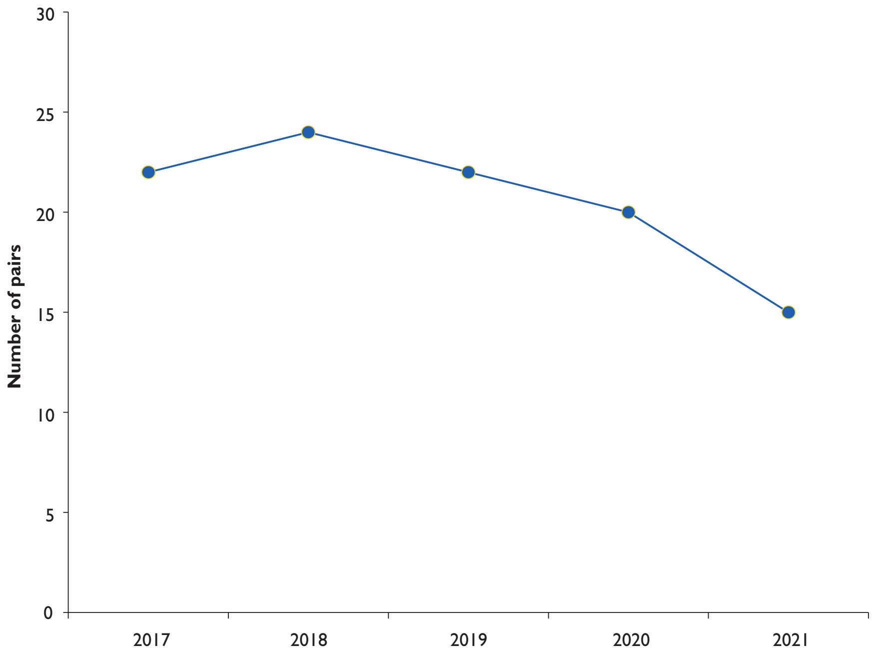
these fields suggest that the impact of field-use change can be long-lasting (at least over the time frame considered here). A change to a field of this sort has multiple consequences, including for the way in which it is then utilised by the farm. For example, stocking densities or the period over which a field is grazed might increase after the change, which may also affect lapwing numbers. As a result, exactly what is behind the differences noted between these three fields is not yet clear.

The other major agricultural improvement that has been applied at Auchnerran is the addition of lime to pasture. This raises the pH of the soil, improving conditions for grass growth. At Auchnerran we have five adjoining fields that were all limed in September 2017 at five tonnes per hectare (the same rate as in McCallum et al. 2018), which also comprise one of our lapwing hotspots. The number of pairs across the five fields declined slowly by 32% over the period (see Figure 2). This mirrors the trend in lapwing numbers for the whole farm, raising the question whether the changes to this hotspot were contributing to the overall trend, or whether the change in numbers at the hotspot reflects a larger scale process affecting the entire farm. Given the relative stability in pair numbers noted above in unchanged fields, it seems most likely that the former explanation is correct.

Although the changes to fields discussed here don't seem to benefit breeding lapwing, especially the resowing of grass, they might have positive effects on lapwings

**Figure 2**

The change in the number of lapwing pairs over time in five adjoining pastures all limed in 2017



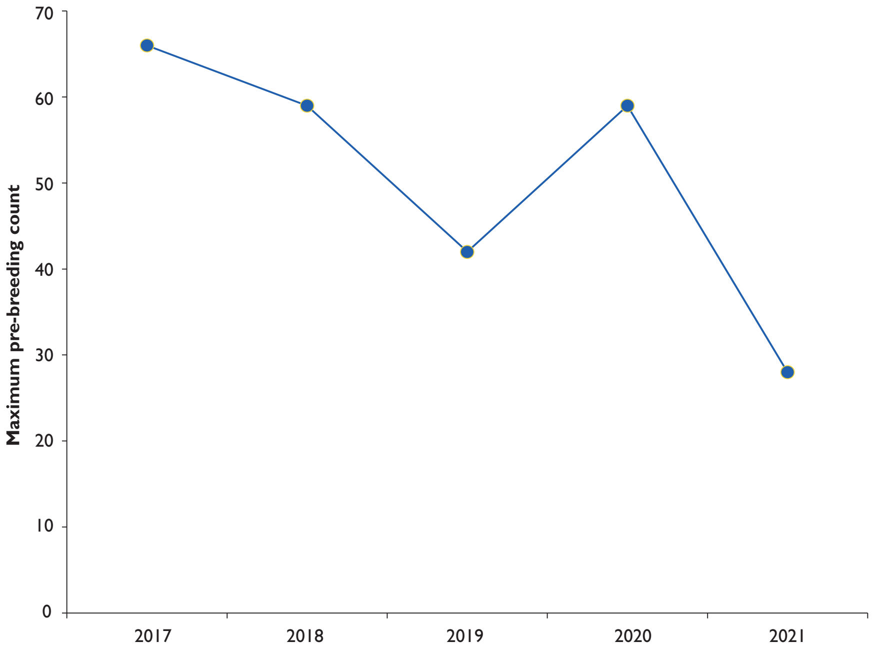



**Figure 3**

The change in the maximum number of pre-breeding lapwing seen in February and March in fields limed in 2017

outside the breeding season. For example, if soil invertebrate abundance is higher in some of the altered fields, this food resource might be exploited by birds early in the year when they first return to the farm. The maximum number of birds in February and March congregating in fields prior to resowing with the grass/clover mix was on average 85.0 (±53.9). The year after this decreased 91% on average to 7.8 (±4.8). Prior to switching to turnips, the maximum number of lapwing seen averaged 15.8 (±11.7) and after was 37.8 (±20.5), an increase of 139%. Neither change was statistically significant. Looking again at the group of fields limed in 2017 shows that here too, pre-breeding counts decreased by 58% between 2017 and 2021.

These early data show that resowing some of the fields at Auchnerran with a faster-growing ryegrass and clover mix has probably had a detrimental effect on breeding lapwing. However, it is possible that growing some turnips might be beneficial to both pre-breeding and breeding lapwing. This information from simple monitoring surveys is crucial, and we should learn from it when planning future changes at Auchnerran. It also suggests that the benefits to lapwing reported elsewhere after similar farm improvements may not be universal.

## ACKNOWLEDGEMENTS

We are extremely grateful to all those who have helped with wader monitoring at Auchnerran over the years. In particular, Beth Conway, Grace Edmundson, Alison Espie, Lauren Fisher, Ruth Highley, Kirsty Madden, Sophie McPeake, Elizabeth Ogilvie, Minna Ots, Emily Sheraton, Liv Stubbington, Katherine Thorne and Max Wright.

*Resowing some of the fields has probably had a detrimental effect on breeding lapwing. © Olivia Stubbington/GWCT*

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# Curlew nest monitoring in the New Forest

*Monitoring of curlew nests with trail cameras in 2021 revealed high levels of predation. © GWCT*

## BACKGROUND

The UK population of breeding curlew has declined by 48% since 1995 and the curlew is now regarded as England's highest conservation priority bird species. The New Forest holds one of the most important concentrations of breeding curlew in the southern lowlands, matched only by the Somerset Levels; both support 40-45 pairs. The survival of these populations is crucial to the persistence of curlew in lowland England, and should they be lost, it would cause significant range contraction to their national stronghold which is the northern uplands. Despite a relatively stable number of breeding adults, chick productivity in the New Forest has become perilously low – well below the annual 0.48-0.62 chicks per pair needed to sustain a viable population. Most existing curlew pairs breed on heathland managed by Forestry England, who support a new science-based management approach aimed at improving their productivity.

Building on previous New Forest breeding wader studies conducted by Hampshire Ornithological Society and Wild New Forest, our curlew nest monitoring in 2020 was part of a PhD project funded by the GWCT and Bournemouth University in collaboration with Forestry England, which aims to unravel the reasons for low productivity. As in previous studies, monitoring revealed very high nest losses (63% of 31 observed nests). Foxes were suspected to be a key predator although it was not possible to determine the agent of predation from field signs alone. To assist Forestry England to understand which predator species to target with appropriate lethal or non-lethal control measures, in 2021 we aimed to identify the key predators by monitoring nests with trail cameras.

We first conducted trials using artificial nests, to test different camera models and develop an effective nest-monitoring system. We settled on Browning Dark Ops cameras because of their small size; camouflaged housing; and no-glow LED lights, to minimise risk of visual detection. Other key features include a fast trigger-speed (important to record avian predation events, especially by gulls that 'swoop' to take eggs), and an internal viewfinder to facilitate speedy directional setting of the camera at the nest. Cameras were attached to metal stakes with a low visual profile and 'dressed' using local vegetation to match the surrounding habitat.

A key element of camera deployment at nests – and often overlooked in nest survival studies – is minimising deposition of foreign scent on the camera, ancillary equipment and the vegetation around the nest. This is important to reduce possible bias in nest survival outcomes, by altering behaviour of mammalian predators like

*An adult curlew incubates a nest four days after the camera was installed. © GWCT*

*Three hours later a fox arrives and takes the curlew's eggs (main picture). There was no evidence of broken eggshells around the nest the following morning. © GWCT*

foxes who have acute olfactory senses. Similarly, initial camera deployment and subsequent weekly maintenance checks were timed to minimise the risk of subsequent nest detection by diurnal avian predators, especially carrion crows.

Between April and July, we located a total of 23 fresh nest cups. Five of them were discovered empty or with predated egg remains. We set trail cameras at 18 active nests. Incubating curlews were tolerant of our nest monitoring system and typically returned to nests within 15 minutes of a camera being set or checked. Of these 18 clutches, 14 were predated (eight by foxes; three by carrion crows; one by a badger; one by cattle; one by an unknown avian predator), one was abandoned and three hatched.

We recorded regular interference with nests and incubating birds by cattle, ponies, donkeys and fallow deer, and on one occasion a single egg was destroyed by a pony. Often, entire clutches were predated early in incubation, some surviving only a day or two before they were lost. One closely monitored curlew pair made three nesting attempts, none of which was successful, which may be representative of other pairs that consistently fail to fledge chicks each year. Four eggs from three nests were infertile. The camera images are being analysed to establish how often curlews are disturbed during incubation, and how disturbance affects predation risk.

Curlew eggs were weighed and measured to predict hatch dates. Visual monitoring of the behaviour of 15 adult pairs with broods revealed rapid chick mortality, and only eight chicks from five pairs are known to have survived until fledging age (32-38 days). These chicks all fledged from three forest beats where lethal control of foxes and carrion crows occurred during the nesting period. Unfortunately, one fledged chick was killed by traffic before it left the forest.

We shall continue to monitor nests with cameras in 2022 and beyond, as it is plausible that effective control of foxes and carrion crows will result in compensatory nest predation by protected predators like badger, raven and gulls. In addition, we shall radio-tag a sample of chicks on hatch to better understand why so many fail to reach fledging age.

## KEY FINDINGS

- In 2021, we monitored 40-44 curlew breeding territories across the New Forest.
- Trail cameras deployed at 18 active nests revealed high levels of predation, especially by foxes.
- In 2021, a total of eight curlew chicks fledged, compared with only three chicks in 2020; all fledged chicks were from areas with predator management.

Elli Rivers
Mike Short

*Carrion crows were recorded eating curlew eggs on several occasions. © GWCT*

## ACKNOWLEDGEMENTS

We thank Forestry England for their support, especially Andy Page for his help finding nests and keepers Austin Weldon, Lee Knight and Maarten Ledeboer for their help in monitoring broods on their respective beats. Thanks also to Andrew Hoodless and Pete Potts for their efforts to catch and GPS-tag adult birds.

# Fisheries

Interreg
France ( Channel Manche ) England
SAMARCH
SAlmonid MAnagement Round the CHannel
European Regional Development Fund

## River Frome Atlantic salmon population

*The rotary screw trap positioned downstream of the Fluvarium in the MIllstream to sample smolts.*
*© Olly Dean/GWCT*

Despite the continued impact of the Covid pandemic, the GWCT fisheries group at East Stoke completed all planned 2021 monitoring work on the River Frome while ensuring that we kept all staff, students and volunteers safe.

Smolts: Smolt trapping commenced the last week of March and continued into May. An estimated 6,635 (95% CI ±1148) salmon smolts left the River Frome in 2021, nearly 30% down on the 10-year average (9,046, see Figure 1). This is the third lowest estimate recorded since we started quantifying emigrating smolts in 1995. During parr tagging in 2020 we encountered a low number of salmon parr particularly in the upper river where recruitment had nearly completely failed. Only 1% of the 2020 salmon PIT-tags were deployed above Lower Bockhampton (30 kilometres upstream of the tide) compared with an average of 16% in previous years. As a result, only 3% of the PIT-tagged salmon smolts detected at East Stoke in 2021 were from upstream of Lower Bockhampton, whereas the average contribution from this part of the river in previous years was 24%. Hence the low number of migrating smolts was largely down to the lack of recruitment in the upper river from the 2019 spawners.

Parr tagging: Since 2005 we have aimed to PIT-tag 10,000 salmon parr in the River Frome catchment during early autumn. To deploy this number of PIT-tags across the catchment requires a concerted effort lasting three to four weeks involving all staff, many students and other volunteers. As such, this is an annual event that staff look forward to with excitement to see if recruitment has been good, but also with slight trepidation in the knowledge of the marathon ahead. In 2021 the first day of the campaign was a baptism of fire as recruitment had been very good at the chosen site and we PIT-tagged more than 1,000 salmon. Recruitment had been good throughout

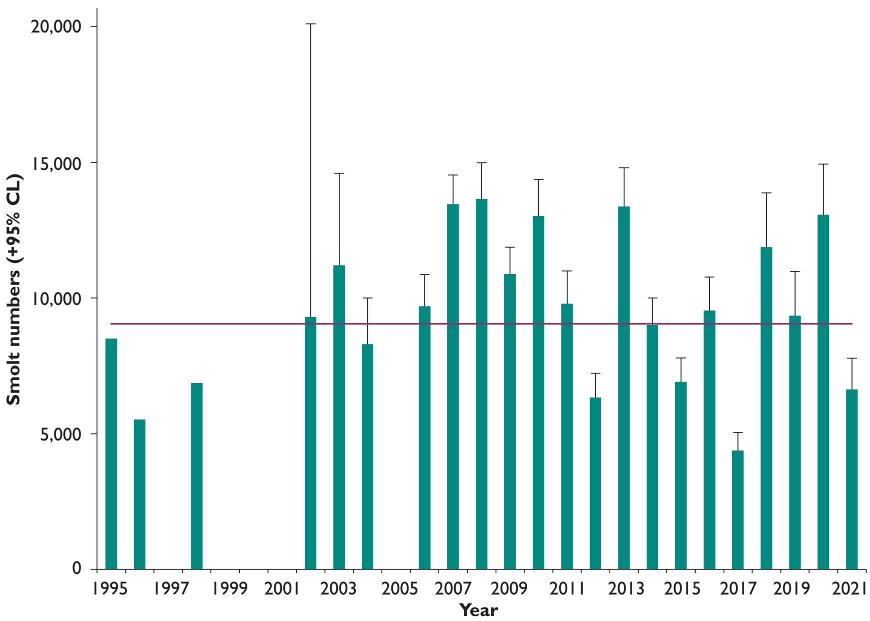
### BACKGROUND

At the Salmon & Trout Research Centre at East Stoke we carry out research on all aspects of Atlantic salmon and trout life history and have monitored the run of adult salmon on the River Frome since 1973. The installation of our first full-river-coverage PIT-tag systems in 2002 made it possible for us to study the life-history traits of salmon and trout at the level of the individual fish. The PIT-tag installation also enabled us to quantify the smolt output. The River Frome is one of only 12 index rivers around the North Atlantic reporting to the International Council for Exploration of the Sea on the marine survival of wild Atlantic salmon and the only one in the private sector.

### Figure 1

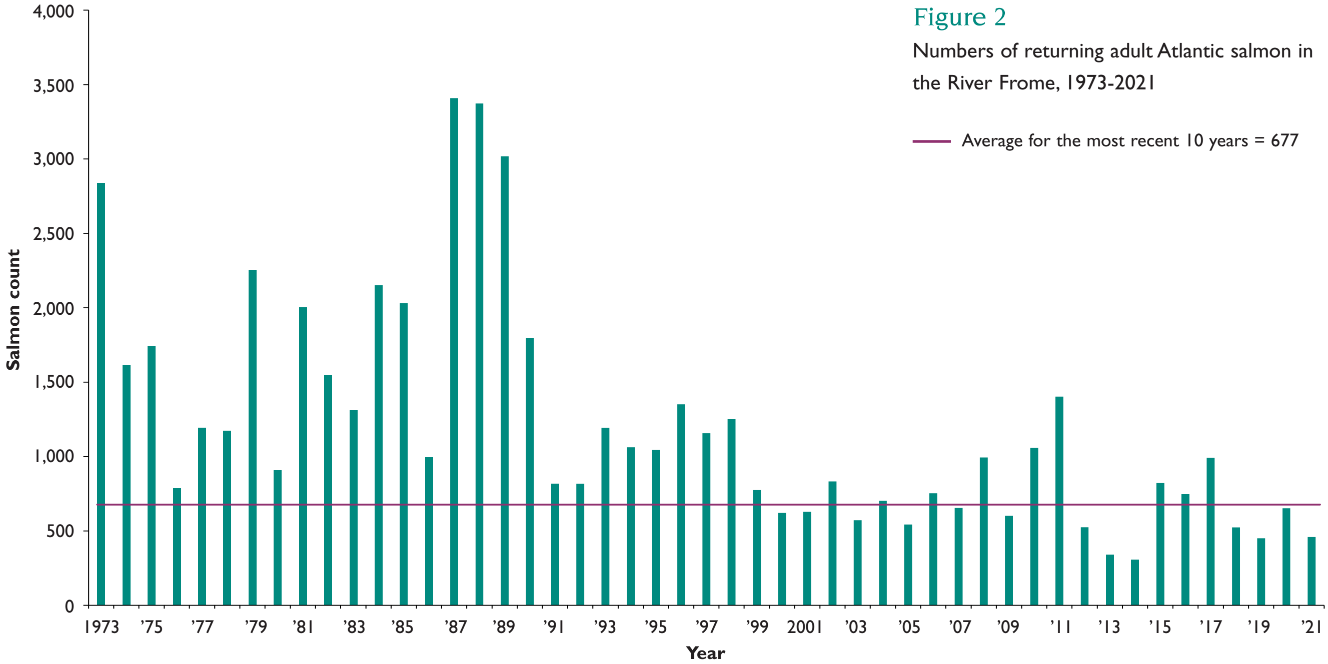
Estimated spring smolt population, (with 95% CI) 1995-2021

Average for the most recent 10 years = 9,046




### SALMONID GROWTH

River Frome salmonids grow fast and all the PIT-tagged parr are young of the year. As a result of the fast growth >97% of salmon smoltify after one year in the river, whereas trout smolts are a mixture of one and two year olds.




## Figure 2

Numbers of returning adult Atlantic salmon in the River Frome, 1973-2021

Average for the most recent 10 years = 677

most of the catchment and the river upstream of Lower Bockhampton was back on track, contributing a more 'normal' 13% of the deployed salmon PIT-tags. We were also successful in PIT-tagging our target 3,000 young-of-the-year trout, but the general feeling was that the abundance of juvenile trout was a bit below normal.

**Adults**: In 2021 the refurbishment of the resistivity counter at East Stoke continued with installation of new electronics for detecting fish movement from the electrical signal from the electrodes at the bottom of the river. The old system has served us well for more than 30 years but is proving increasingly difficult to maintain as we can no longer obtain replacement parts. The new electronics were installed in parallel to our old system, enabling us to use the data collected in 2021 to calibrate the two systems. The new system has been developed by the Environment Agency; it provides more flexibility when analysing the data and it enables us to store the electronic signal from the electrodes in perpetuity. This enables us to re-analyse the data retrospectively as we hone the settings over time.

Our preliminary estimate of returning adult salmon for 2021 is low at 459 (see Figure 2). This is more than 20% below the 10-year average (583). The number of returning 1 sea-winter (grilse) fish was average at best, which is disappointing as these fish originated from a very large smolt run in 2020.

## KEY FINDINGS

- The estimated smolt output on the River Frome in 2021 was down nearly 30% on the 10-year average, largely owing to recruitment failure in the upper catchment from the 2019 spawning.
- The number of adult salmon returning to the River Frome was more than 20% below the 10-year average. The return of 1 sea-winter fish was particularly disappointing given the large smolt output the previous year.
- The density of parr encountered during 2021 PIT-tagging was good, indicating strong recruit-ment from the 2020 spawning.

Rasmus Lauridsen

*Releasing smolts intercepted by the rotary screw trap after taking biometrics and scanning for PIT-tags. © Olly Dean/GWCT*

# Results from the SAMARCH project so far

*As a measure to try and protect salmon and sea trout gill nets must be set at least three metres below the surface, but our research has shown that sea trout can spend up to 80% of their time swimming below three metres. © Dylan Roberts/GWCT*

Interreg France (Channel Manche) England
SAMARCH
SAlmonid MAnagement Round the CHannel
European Regional Development Fund

## BACKGROUND

The English Channel is one of the busiest parts of the ocean for shipping, commercial fishing, especially with gill nets, and marine developments. This poses several challenges for the salmon and sea trout that spawn in the 80 or so rivers in the south of England and northern France which flow directly into the Channel.

## Aims and objectives of the project

The Salmonid Management Round the Channel Project (SAMARCH) is a seven-year (2017-2023), €9m project part-funded (69%) by the EU's Interreg VA Channel Programme. This cross-border project has 10 partners, five English and five French and is led by the GWCT. The partners are a blend of research institutions, NGOs and Government organisations. SAMARCH is gathering scientific evidence to address three key areas which are preventing the effective management and conservation of salmon and sea trout:

1. By-catch of salmonids in commercial inshore fisheries. The English Channel has the most intensive commercial gill-net fishery in Europe. Each week, it is estimated that 1.4 million metres of gill-nets are set off the coast of Cornwall alone. There is a real risk that substantial numbers of salmon and sea trout are accidentally captured, damaged and killed.
2. Damage to salmonids from estuarine and inshore coastal activity and developments. The English Channel is a busy shipping channel with lots of human activities that might affect juvenile and adult salmonids. For example, dredging, flood and tidal-defence work all modify estuaries. In addition, there are plans for several tidal renewable-energy schemes.
3. Strengthening salmon stock assessment models. Working in conjunction with the network of salmon index rivers in the Channel – the Tamar and Frome in England and the Scorff, Bresle and Oir in France – the project is implementing research activities to provide new evidence to update and improve salmon stock assessment tools. These include assessing contemporary evidence on marine survival; marine growth rates over time; juvenile production; sex ratios of juveniles, grilse and multi-sea-winter adults; fecundity estimates and rod exploitation rates.

*GWCT staff working in the English Channel. © William Beaumont/GWCT*

## Progress on the three key issues

1. **By-catch of salmonids in commercial inshore fisheries**: The 10 regional Inshore Fisheries Conservation Authorities (IFCAs) are tasked with implementing bylaws to protect salmon and sea trout in England's coastal waters. These include no-fishing areas in estuaries where they will congregate and a 'headline' rule where the top of gill nets must be fished at least three metres below the surface. This assumes that salmon and sea trout swim mostly in the top three metres. Our data from tagged adult sea trout show that the headline rule is largely ineffective given that sea trout can spend up to 80% of their time swimming below three metres. We have shown by setting gill-nets in areas open to commercial gill-net fisheries that salmon and sea trout can be caught in these nets.

2. **Damage to salmonids from estuarine and inshore coastal activity and developments**: Our geolocation of adult sea trout in the English Channel has highlighted key areas for sea trout at sea. These areas are currently being overlaid with commercial fishing activities and marine developments to target stronger protection measures. Our smolt tagging work has shown that the survival rates of salmon and sea trout smolts differ during their outward migration through estuarine environments with some variation across our four study estuaries. We are working closely with our project partners the Environment Agency and Salmon & Trout Conservation Trust in England to ensure that this information is going in front of the key regulators and marine spatial planners.

3. **Strengthening salmon stock assessment models**: Data from our juvenile salmon PIT-tagging programme (see pp68-69 for more details) tells us that larger smolts are three times more likely to return from their sea journey than their smaller counterparts. We have also learnt that marine survival is low and largely independent of several environmental conditions at the time of arrival at the near-coast. We now know that smolt seaward migration is happening earlier in recent decades, such that they risk arriving at sea during unfavourable conditions.

Returning adults are getting smaller for the same sea-age. Analysis of scales from returning adults going back 30 years shows that the growth of salmon during their first summer at sea has decreased in recent decades and that this reduces the probability of returning after one year at sea. These findings have implications for population dynamics and stock assessment through reduced egg deposition in rivers.

## Going forward

Now that the data collection is almost complete, the project will focus on ensuring the project results are integrated into policy. To achieve this the project has set up a dedicated policy group, to include partners Salmon and Trout Conservation, The Environment Agency and the GWCT to draw up a best practice and new policy recommendations.

*Ludovine reading salmon scales for the analysis of their marine growth. © Dylan Roberts/GWCT*

## KEY FINDINGS

- Sea trout spend most of their time at sea below three metres particularly during the daytime.
- The size of returning salmon from the sea for the same age is now much smaller than they were 30 years ago.
- The reducing size of adult salmon after one year at sea is making them stay at sea for another year.
- Survival of salmon and sea trout smolts through Poole Harbour was low compared with other estuaries.
- Large smolts are more likely to survive to return as adults

Céline Artero
Stephen Gregory
Dylan Roberts

## ACKNOWLEDGEMENTS

We are grateful to the Environment Agency and the French Office for Biodiversity for providing funding and human resources support to recapture sea trout in England and France. We are also grateful to the EU's Interreg Channel Programme and the Missing Salmon Alliance for funding the SAMARCH project.

THE MISSING SALMON ALLIANCE

# Warm winters and cool springs

*River Frome, north stream in early spring when the salmon fry emerge from the gravel to start feeding. © GWCT*

In 2016, juvenile salmon numbers in England and Wales were among the lowest on record. It was speculated that this was caused by an unusually warm winter and wet spring. We recently published an article suggesting that winter and spring temperatures, as well as high discharge, were associated with this '2016 recruitment crash' in seven rain-fed rivers throughout Wales (see *Fisheries Review of 2019*). We observed similarly low juvenile abundance in 2016 on the River Frome, a primarily groundwater-fed chalk stream in southern England characterised by relatively benign temperature and discharge regimes. We wanted to know whether the findings from the Welsh rivers were transferable to this chalk stream.

Specifically, did temperature and discharge during spawning through to emergence influence juvenile numbers during 2015-2020? A period during which we surveyed 0+ juvenile salmon abundance at multiple sites across the catchment using depletion electric-fishing surveys in August and September (see Figure 1). We also recorded low juvenile abundance in 2020 on the River Frome, where monitoring efforts were unaffected by the Covid-19 pandemic. First, we estimated the true abundance of juveniles at each site in each year, accounting for imperfect detection of fish during surveys. To test the influence of spawning through to emergence temperature and discharge on estimated juvenile abundance, we used daily discharge data recorded at the East Stoke gauging station on the River Frome and the river lab's long-term

**Figure 1**

Sites in the River Frome catchment where abundance of juvenile salmon is surveyed

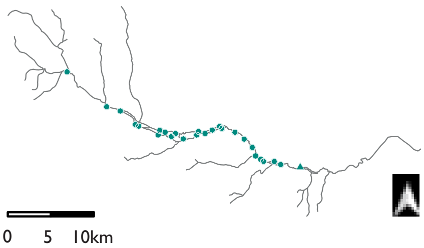
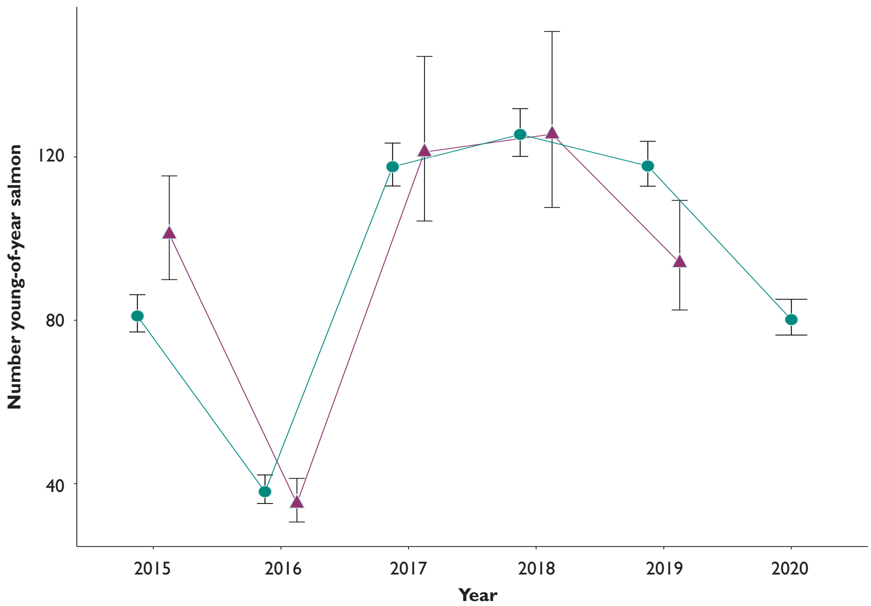


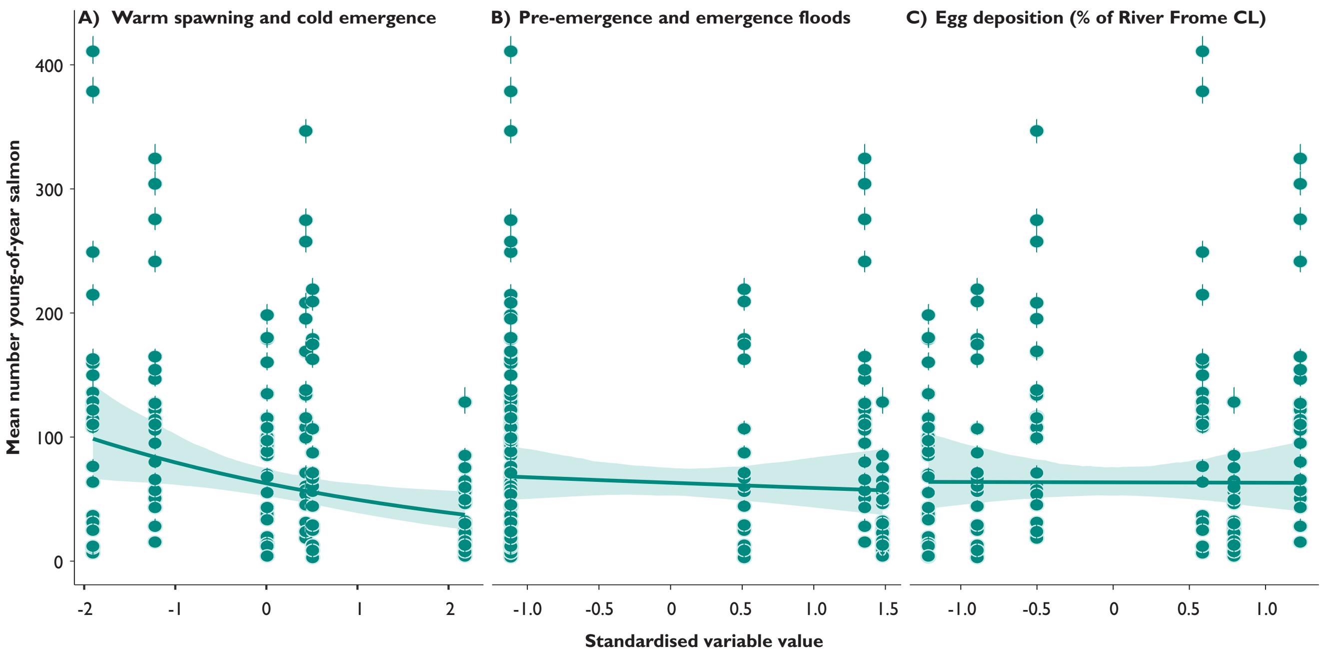

**Figure 2**

Mean site-specific juvenile salmon abundance and 95% credible intervals and mean catchment estimates of juvenile abundance and 95% confidence intervals (as smolt data are required for this estimate, data for 2020 parr could not be included)

Mean site-specific estimate

Mean catchment estimate/1,000






monitoring programme temperature data collected near the East Stoke gauging station. With these data, we calculated annual explanatory variables representing temperature during spawning and emergence, as well as the number of flood events during pre-emergence and emergence periods. To test for a relationship between estimated juvenile abundance and number of deposited eggs, we also included an explanatory variable of annual catchment-level estimates of egg deposition, calculated by the Environment Agency based on the size, sea-age and fixed sex ratios of returning adult salmon stock estimates from the GWCT resistivity fish counter and rod catch data. We then constructed a statistical model to test the influence of the fixed effects of temperature, flood events and egg deposition on the estimated juvenile abundance in each site and year, and included a site nested in year random effect to attempt to account for spatial correlation among survey sites. The abundance estimates of juvenile salmon varied annually, with the lowest number estimated in 2016. These site-specific estimates appeared to successfully capture trends in catchment-level abundance estimates obtained by mark recapture calculations (see Figure 2).

Similarly to the study of the Welsh rivers, high spawning temperatures and low emergence temperatures negatively influenced juvenile salmon abundance (see Figure 3A). Although chalk stream temperatures are relatively stable compared with rain-fed rivers, our findings suggest that changes in seasonal temperatures – even in chalk streams – have a detrimental influence on juvenile salmon recruitment. Indeed, effects of temperature are relative to local conditions and salmonid eggs are highly susceptible to increases in temperature. Relatively warm temperatures during spawning might also inhibit ovulation and affect gamete viability. Cold temperatures during emergence might reduce feeding opportunities, negatively influencing growth and survival.

Although the mean estimated effect of pre-emergence and emergence floods was negative, corresponding with findings from Wales and elsewhere in the UK, its influence on juvenile abundance in the current investigation was negligible (see Figure 3B). This suggests that flood events in the River Frome, and perhaps chalk streams generally, are less influential in salmon recruitment relative to rain-fed rivers. Chalk streams typically have a low gradient, with flood events unlikely to mobilise the redd substrate and cause egg washout or displace fry.

There was no clear and simple association between egg deposition and juvenile abundance in these data (see Figure 3C), suggesting that the temperature and flow effects were sufficient to explain the inter-annual pattern in estimated juvenile numbers for these years. As in the rain-fed rivers of Wales, temperature particularly influenced the recruitment of juvenile salmon in a groundwater-fed southern English chalk stream. These results highlight how similar freshwater conditions in contrasting river-types have potential to significantly affect juvenile salmon productivity and their subsequent population dynamics.

## Figure 3

Effects of: A) warm spawning and cold emergence, B) pre-emergence and emergence floods, and C) egg deposition on juvenile salmon abundance (after accounting for other effects). The line represents the mean effect and the green shaded area shows 95% credible intervals

## BACKGROUND

In 2016, juvenile salmon numbers in England and Wales were among the lowest on record. It was speculated that this was caused by an unusually warm winter and wet spring.

## KEY FINDINGS

- Warm winters and cold springs appear to reduce salmon recruitment in the River Frome, a groundwater-fed chalk stream.
- The effects of temperature on salmon recruitment in the River Frome were very similar to what we found in a study of rainwater-fed Welsh rivers. This highlights how similar freshwater conditions in contrasting river-types significantly affect salmon productivity.

Jessica Marsh
Rasmus Lauridsen

# Size of smolts and their survival at sea

*Juvenile body size is a key determinant of success for later life events. © Steven Gregory/GWCT*

The Atlantic salmon is a species of immense commercial, recreational and cultural importance. Native to rivers on both sides of the North Atlantic basin, this species has experienced dramatic population declines since the 1970s. The reasons are likely to be complex and due to many factors. Understanding factors affecting Atlantic salmon survival, as well as other important aspects of their life cycle like growth rates and migration phenology, is crucially important.

It has long been hypothesised that juvenile body size is an important driver of life-history events, as body size may be a proxy for overall fitness and can affect growth rates, migration timing, and survival between different life stages. The main aim of this work was to test the hypothesis that juvenile body size is a key determinant of success

## BACKGROUND

The Atlantic salmon is an anadromous fish species, meaning it spends part of its life in freshwater and part at sea. During one part of its life cycle the Atlantic salmon is known as a smolt, a key life stage during which the juvenile undergoes big physiological, morphological and behavioural changes as it leaves fresh water and enters the sea. This migration period, known colloquially as the smolt run, is often fraught with danger from novel environmental conditions and elevated predation risk. Understanding what factors affect the timing of the smolt run has important conservation implications.

*We capture the fish by electric-fishing and then PIT tag, measure and release them. © Olly Dean/GWCT*

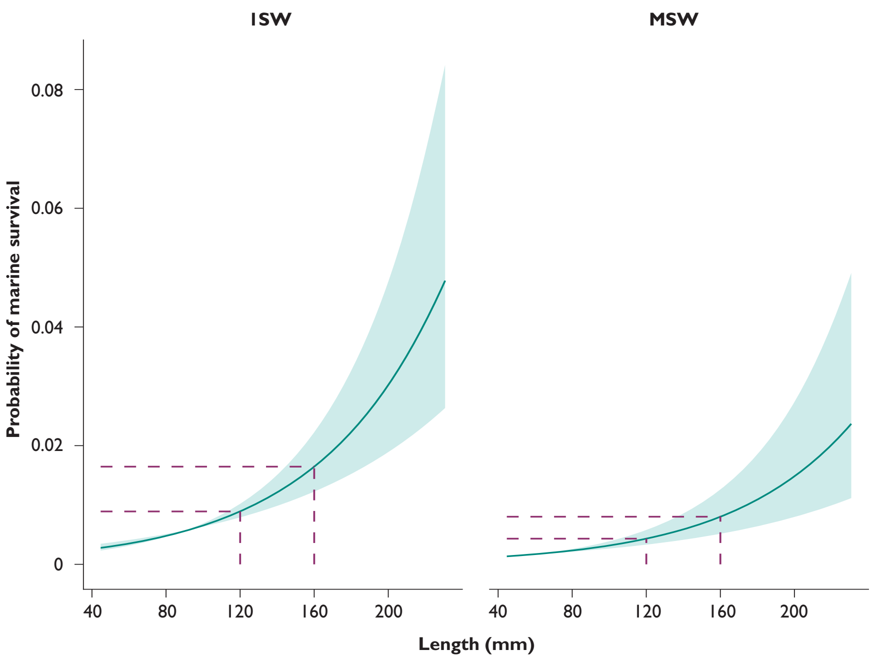



**Figure 1**

The predicted probability of survival for salmon on the River Frome after spending one year at sea (1SW) and after spending multiple years at sea (MSW) as a function of its body length as a smolt. The dashed lines show the marine return rate for a 120mm and 160mm smolt, respectively. These are two body lengths within the normal range of smolt body lengths commonly observed on the River Frome. The pale shaded area represents the 95% credible interval

for later life events using a long-term capture-mark-recapture (CMR) dataset of salmon in the River Frome, where every year since 2005 approximately 10,000 juvenile salmon (known as 'parr') have been captured throughout the river via electric-fishing. The body length of all individuals is measured, and each fish is fitted with a passive integrated transponder ('PIT') tag. Each PIT tag has a unique code that allows each individual fish to later be re-identified. In the spring, the parr metamorphose into 'smolts' and migrate downstream, where they are resampled. Approximately 1.5-6% of previously PIT-tagged individuals are trapped, measured again, and released to continue their migration. PIT-tagged individuals that successfully complete their migration and return to the river as adults (known as the 'marine return rate') can be redetected a final time by PIT-tag-reading antennae in the river.

We conducted four studies to address the main aim. Firstly, we assessed how body size and environmental variables affected overwinter growth rates. We found that small individuals grew more during the winter than expected given their initial autumn body size, and that individuals that experienced warm winters, with more variation in daily water temperatures, had the highest growth rates. Secondly, we assessed what factors affected variation in smolt migration timing. We found that relatively large smolts migrated earlier than relatively small smolts, and that while water temperature and discharge affected migration timing, the importance of these effects varied throughout the migration period. We also found that smolts were more likely to migrate in schools later in the migration period, and during the daytime instead of at night. Thirdly, we assessed factors that affected marine return rates, with an emphasis on conditions experienced by smolts during the early part of their marine migration. We found that smolt body size was the most important determinant of the probability of an individual surviving and returning as an adult, although water temperature and the presence of piscine predators may also have played a role. Finally, we combined the Frome dataset with smolt data from six other European rivers with PIT-tag programmes to assess whether smolt body size was an important determinant of marine return rates across a substantial portion of the salmon's European range. Preliminary results suggest that, as on the Frome, smolt body size was an important determinant of marine return rates across Europe, with large smolts more likely to return as adults than small smolts.

These results should be of importance for conservation efforts attempting to bolster numbers of salmon. Instead of focusing predominantly on increasing the number of juvenile salmon in the river, in the hopes of increasing the number that return to reproduce as adults, efforts should be made to ensure excellent growth conditions, as we have established that juvenile body size plays an important role in subsequent survival.

## KEY FINDINGS

- Small juvenile salmon grow more during the winter than expected given their initial size.
- Large salmon smolts migrate earlier than small salmon smolts.
- Large salmon smolts are more likely to survive their marine migration and return to the Frome as adults than small ones.

Olivia Simmons

## ACKNOWLEDGEMENTS

We would like to thank John Davy-Bowker for access to the River Lab long-term monitoring project temperature data. This study is part of the SAMARCH project, and the studentship was part-funded by Bournemouth University.

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European Regional Development Fund


# Do winter game crops help breeding songbirds?

*Hedges up to several hundred metres from game crop blocks contain more breeding birds.*

## BACKGROUND

In spring and summer 2021, the lowland gamebird research group undertook a project in the Exmoor region of Devon, looking at the effect of winter game crop plots with feeding on breeding songbirds in the subsequent spring.

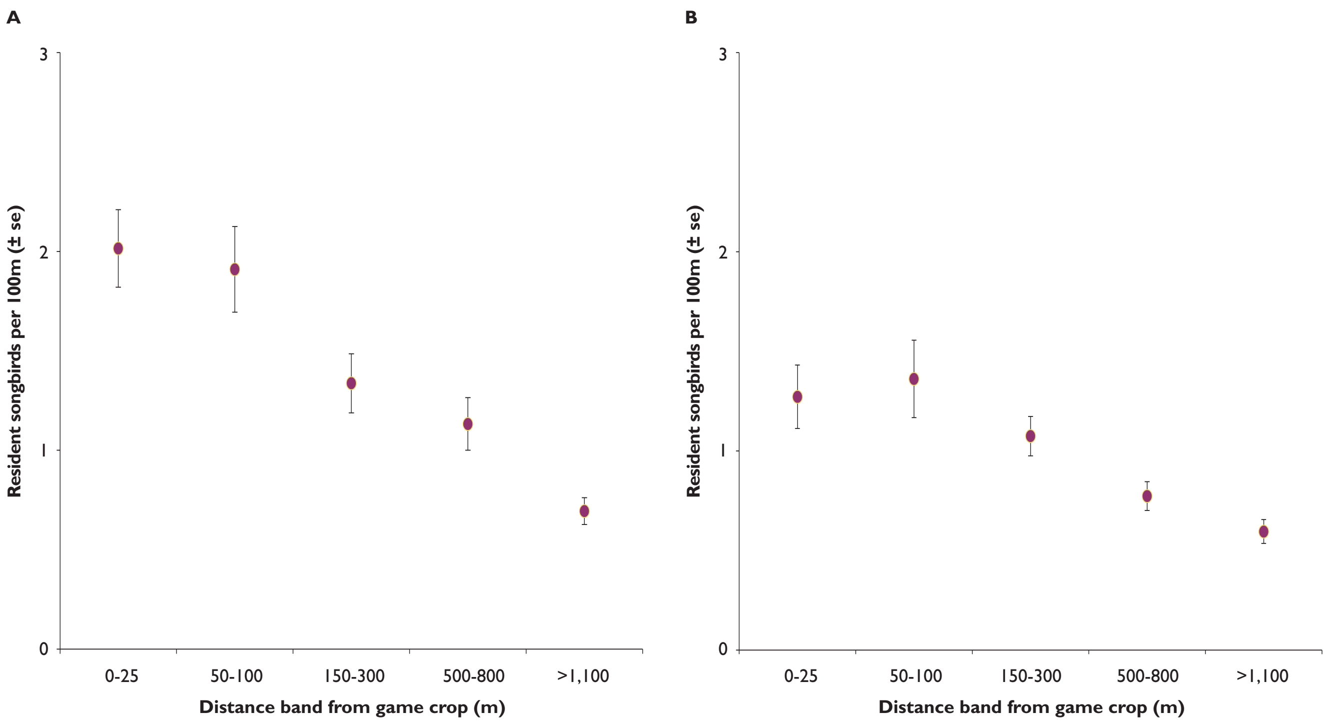
Game crop plots can be a valuable habitat and food source for a wide variety of farmland and woodland-edge birds throughout the winter, when food can be scarce elsewhere in the modern farmed landscape, especially predominantly grassland ones like on our Exmoor study area.

We looked at whether the beneficial effect in winter continued to help songbirds breeding in nearby hedgerows in the spring, even after many of the game crops themselves were no longer present (some game crops are annual, and hence ploughed in early spring, while others are perennial and left in place). Is it the case that holding birds in the landscape in winter means they stay to initiate territories in early spring and go on to breed? The study followed some work undertaken in the region in spring 2017 in which hedgerows within 200 metres (m) or so of game crops on game estates contained more breeding birds than hedgerows on an area without a game interest in the same region (see *Review of 2017*).

In 2021, we wanted to find out more about the effect of distance from game crops on breeding songbird numbers and to properly randomise the selection of hedgerows to ensure that the study was suitable for publishing in a scientific journal. To do this, across an area of 6,000 hectares, we identified hedgerows along 80 directionally random survey lines (transects) extending out from where game-crop plots had been sited the previous winter. Along these, the nearest hedgerows to the line were identified in different distance bands from the plots (0-25m, 50-100m, 150-300m,

### Figure 1

Mean number of resident songbirds per 100m of hedgerow in relation to distance of the hedgerow section from a game crop. (A) Early spring (April to mid-May), (B) late spring (mid-May to June)



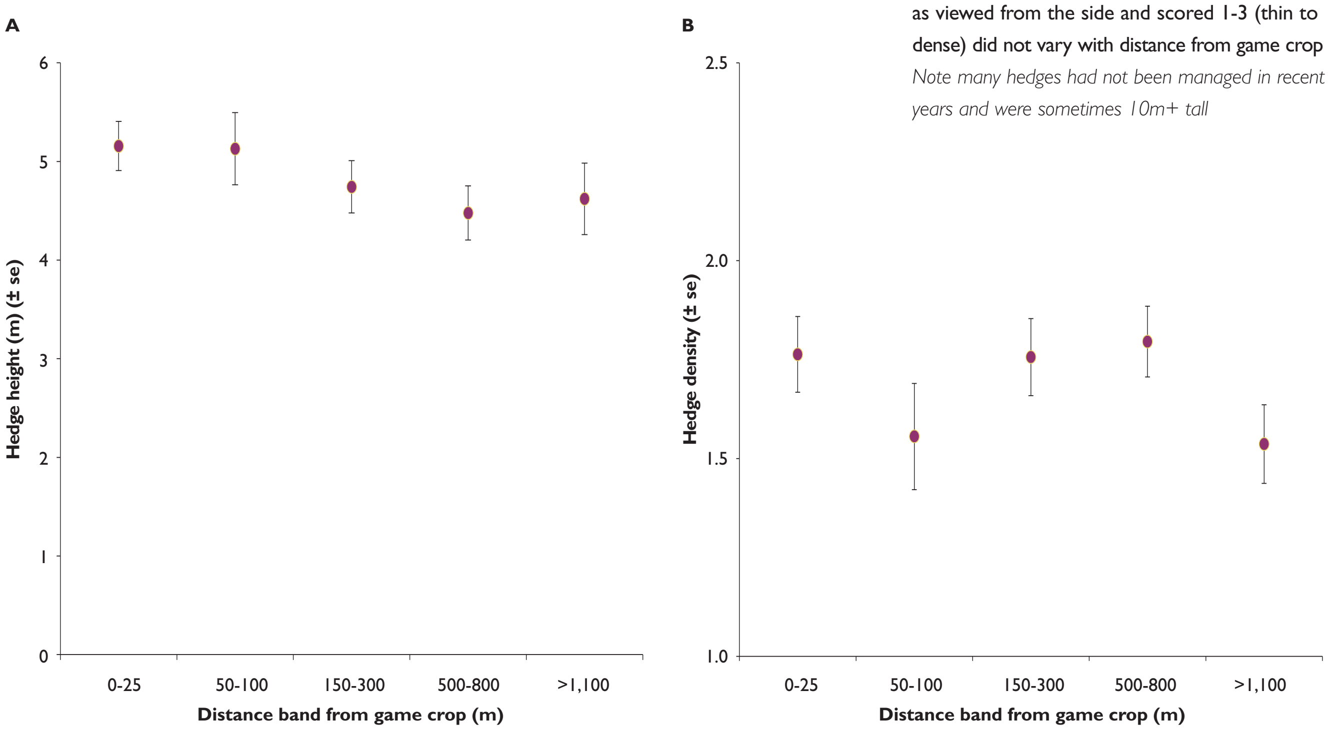



**Figure 2**

Mean hedge height (A) and hedge density (B) as viewed from the side and scored 1-3 (thin to dense) did not vary with distance from game crop

*Note many hedges had not been managed in recent years and were sometimes 10m+ tall*

500-800m and more than 1,100m). Game plots that had been in use the previous winter, and also some game-plot sites that were not being used because of Covid-19 restrictions in the 2020/2021 season were used. There was a wide variety of game crop types encountered; the dominant ones were maize, kale, cereal-based crops, canary grass and root crops. Hedges were between 200m and one kilometre (km) long and surveyed in early spring (April to mid-May) and again in late spring (mid-May to late June). All encounters with songbirds using the hedgerow were recorded. Hedgerow height, width and a density score were estimated.

At the height of the breeding season in April/May, there were twice as many breeding resident songbirds in hedgerows within 150m of an active game crop plot, as in those more than 500m away (see Figure 1). Hedgerows up to 300m away from the game crops still contained more birds. In the late May/June survey, the relative difference remained the same although bird numbers were around 30% lower than in April/May. The characteristics of the hedgerows were roughly the same regardless of their distance to the game plots (see Figure 2), so our results were not an artifact of hedgerow quality. The pattern was not seen in transects around game crop plots that had not been used the previous winter. Migrant birds were not common but did not show the trends found for resident species either. These secondary results further suggest it is the presence of these game crops for shooting that benefits wild birds breeding in nearby hedgerows.

The landscape in which this study was conducted is predominantly one of livestock farming, with improved pasture, leys and woodland (much of which is used and retained for game management), there is also a little arable and the game crop plots. Areas like this can be poor for farmland birds in general, with limited resources. This means that the number of species and individuals we saw in this study was not especially high.

While the results demonstrate an extended benefit of game management to breeding birds, they also have wider implications. It has been suggested by many observers that using seed-bearing crops (ie. game crops) to supplement winter food availability, could be used within environmental schemes to benefit birds in grassland farmland and other landscape types. The results of this study provide confirmation and some guidance on how far apart plots might be located in a landscape to see an overall improvement in breeding bird numbers.

## KEY FINDINGS

- We know game crops on farmland attract songbirds in winter.
- This study looked at whether breeding songbirds were more common in hedges near to game crops in a grassland landscape.
- Otherwise similar hedges near to game crops (<150m away) contained up to twice as many resident songbirds than hedges further away (>500m) throughout spring.

Rufus Sage
Sam McCready
Maureen Woodburn

## ACKNOWLEDGEMENTS

This study was funded by the Greater Exmoor Shoot Association.


# Wader tracking at GWSDF Auchnerran

*Waders breeding at the same site, do not winter in the same locations. © Marlies Nicolai/GWCT*

## BACKGROUND

Waders nesting on grassland are declining across Europe owing to land-use change over the last 50 years and higher predation rates of nests and chicks are now limiting population recovery where efforts have been made to improve habitat. We have conducted studies of wader breeding success and through projects like LIFE Waders for Real we have demonstrated the measures that need to be implemented to increase breeding numbers of lapwing and redshank. GPS tracking of individual birds enables us to obtain detailed insights into habitat use and even to estimate timing of nest and brood loss, which can help with refining habitat recommendations. However, a better understanding of patterns of winter dispersal and factors operating outside the breeding season is also desirable.


## ACKNOWLEDGEMENTS

We are grateful to Elizabeth Ogilvie and Max Wright for monitoring waders and downloading lapwing data in 2020, and to Pete Potts and Lizzie Grayshon for advice and assistance. We would like to thank everyone who has donated to our wader tracking appeal.


Breeding waders are disappearing from the British landscape and numbers of curlew, oystercatcher and lapwing have all declined in recent decades, including across lowland Scotland. Using small GPS tags, we have started to track these species to better understand their use of different habitats during the breeding season, particularly during chick-rearing. These tags also allow us to track their movements away from breeding sites, because currently we have a very poor understanding of where waders breeding in Scotland winter and the pressures they might face outside the breeding season. During 2018-2021, we fitted GPS tags to 13 lapwings, four curlews and four oystercatchers on the Game & Wildlife Scottish Demonstration Farm at Auchnerran, Deeside. The smallest of the tags, fitted to lapwings, record two locations a day and require downloading of data to a base station within about 300 metres (m) of the tag or recapture of the bird for direct download from the tag. The larger tags fitted to curlews and oystercatchers transmit data via the GSM mobile network and solar charging enables a position fix once an hour. Locations are accurate to 5-15m.

What soon became apparent from our tracking is that waders breeding at the same site do not winter in the same locations. Individuals of all three species, even when tracked in the same year, have left Auchnerran after breeding and arrived back in spring at different times. The oystercatchers were most consistent in their post-breeding departure times, leaving Auchnerran between 1 and 18 July. One flew to the Firth of Forth, two to Morecambe Bay and one to northern France. The curlews departed between 3 July and 3 August, one wintering near Fraserburgh, one in Northern Ireland and two in Ireland.

Our expectation from previous ring recoveries and resightings of lapwings colour-ringed as chicks was that the tagged lapwings would most likely winter in Ireland or southern England. We recovered data for nine tagged lapwings which showed that birds wintered 110-654km from Auchnerran, one in Scotland, three in Northern Ireland and eight in Ireland (see Table 1). The lapwings exhibited greater variation in

*Most lapwings left in August. © Merlin Becker/GWCT*

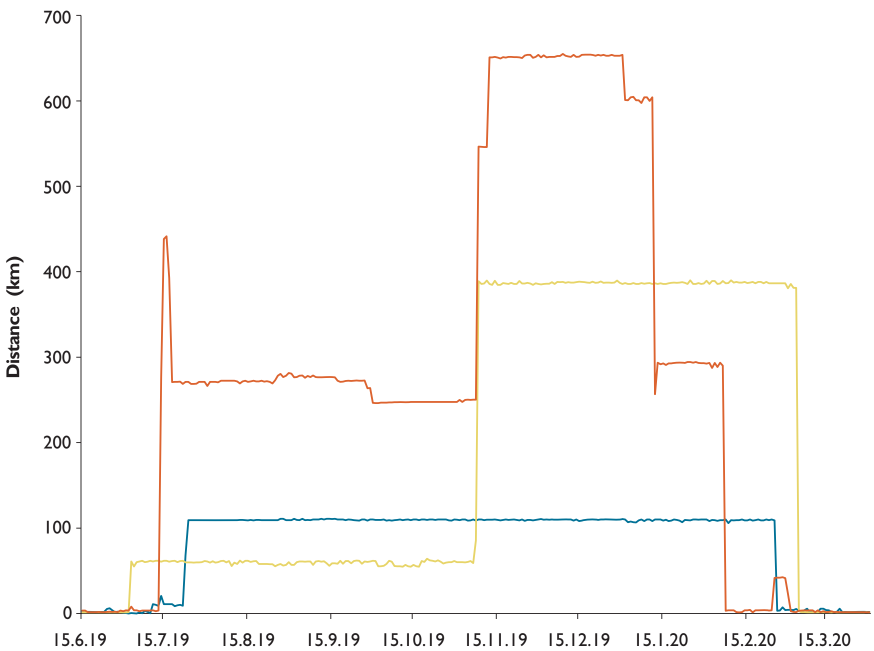
TABLE 1

**Movement dates, wintering locations and wintering site distances from GWSDF Auchnerran of nine lapwings tracked from spring 2019 to spring 2020**

| First depart GWSDF | Arrive main wintering site | Depart main wintering site | Arrive GWSDF | Winter location | Winter site distance (km) |
|---|---|---|---|---|---|
| 29 June | 6 November | 24 February | 17 March | Wicklow, Ireland | 490 |
| 2 July | 8 November | 4 March | 5 March | Newry, Northern Ireland | 385 |
| 10 July | 23 July | 25 February | 26 February | Dornoch, Scotland | 110 |
| 10 July | 19 October | 23 February | 14 March | Tuam, Ireland | 543 |
| 13 July | 12 November | 11 January | 7 February | Kilrush, Ireland | 654 |
| 21 July | 20 October | 1 March | 2 March | Athlone, Ireland | 517 |
| 28 July | 15 November | 14 February | 2 March | Enniscrone, Ireland | 313 |
| 16 October | 18 October | 3 March | 4 March | Strathfoyle, Northern Ireland | 350 |
| 19 October | 18 November | 23 January | 7 February | Portrush, Northern Ireland | 318 |

post-breeding departure date and pre-breeding return date than the oystercatchers or curlews. Most of the lapwings left Auchnerran in July, typically moving 15-60km presumably to moulting sites, with three returning for 29-78 days, before heading off to their main wintering sites or staging sites. Two birds, however, remained at Auchnerran throughout the summer until departing in mid-October (see Table 1). Flights between sites were made at night and while three individuals flew direct to one main wintering site, six stopped at staging sites for two to 128 days (see Figure 1). We found similar variation between birds in spring, with a difference of almost six weeks (7 February-17 March) in return date to Auchnerran between the first and last bird. Five birds stopped at intermediate sites on their return journeys for 10-26 days.

Our tracking data indicate that curlews and oystercatchers remain faithful to the same wintering sites each year, but we need further data to establish whether the same is true for lapwings. The fact that waders from one breeding site move to widespread wintering sites suggests that dispersal of young birds in their first autumn is innate and exploratory, with the location of the eventual wintering site likely dependent on temperature and prevailing wind direction and strength. From a conservation perspective, the broad dispersal means that the loss or degradation of an important wintering site is unlikely to have a large impact on one breeding site, but likely to affect individuals belonging to several breeding populations.




## KEY FINDINGS

- Individual lapwings, curlews and oystercatchers breeding at the same location mostly exploited unique wintering locations.
- Eight of a sample of nine tracked lapwings (89%) wintered in Ireland or Northern Ireland. Arrival dates at Auchnerran in spring varied by up to six weeks.
- Three lapwings made direct flights to their wintering sites, with the others using intermediate stopover sites for two to 128 days in autumn. In spring, five lapwings used stopover sites on their return journeys for 10-26 days.

Andrew Hoodless
Marlies Nicolai
Dave Parish
Ryan Burrell

**Figure 1**

Timing and distances moved from GWSDF Auchnerran by three tracked lapwings during June 2019 to March 2020


### ACKNOWLEDGEMENTS

We thank Hampshire Ornithological Society for the grant to purchase the tags in 2021 and for its continued support. Clive Bealey for project development and planning, along with conducting many breeding redshank surveys. We also thank all the farmers, landowners and keepers for their continued support, particularly Rupert Brewer and Martin Button, who dedicate a huge amount of time to wader conservation, and Paul Coombes, whose detailed site knowledge helps hugely with identifying territories in the spring.


# Understanding the Avon Valley redshank recovery

*Adult redshank colour ringed in 2021. © Lizzie Grayshon/GWCT*

### BACKGROUND

The Avon Valley provides a stronghold for breeding redshank in Hampshire. Redshank are an amber-listed species in the UK because they have declined by 42% over the last 25 years and a priority species for Countryside Stewardship targeting in the Avon Valley. Throughout the LIFE Waders for Real project, we monitored the number of breeding redshank and documented an increase from 19 pairs in 2015 to 35 in 2019. This increase was likely brought about by habitat improvements, predator exclusion and predator management linked to the project.

The Lower Avon Valley Farmer Cluster was established in January 2020. The group comprises of 14 official farmers, but the interest in the group goes much wider than this and includes many landowners and keepers, covering 6,851 hectares (ha), with the Avon Valley at the centre the group spans over Hampshire, Dorset and Wiltshire.

In 2021 we conducted a pilot study to assess the feasibility of catching adult redshank and fitting GPS-tags and colour rings to explore:

- Territory size and movements during breeding.
- Fine-scale habitat use by breeding adults and broods.
- Outcomes of breeding success.
- Site fidelity among individuals.

This research will feed into direct conservation measures across the water meadows in the Avon Valley. Information will be able to be provided to the newly-formed Farmer Cluster and encourage more joined-up conservation across sites and the region.

The Avon Valley is a linear water meadow system where little is known about territory size and movement of redshank, or its between- and within-year site fidelity. There is evidence that territorial birds travel large distances from nests to feeding locations, often crossing and possibly sharing other pairs' territories. A better understanding of redshank movements is required to properly understand the habitat

**Figure 1**

**GPS locations of a breeding male/female redshank registered at 60-minute intervals and tracks between points 14/05/2021-31/05/2021**

*© Google Earth Pro 7.3.4.8248. (2021). Avon, 50.801492°, -1.802638°. (Online). Accessed: 01/04/2022*

requirements and breeding success of Avon Valley birds to further conservation efforts as well as improve the reliability of survey methods for this species in similar landscapes.

Before conducting a large-scale-tracking study, we assessed feasibility using a small-scale pilot. In 2021, we trialled GPS-UHF tags on redshank to determine the most appropriate capture methods, identify any potential impacts of the tag, and ensure that sufficient data could be acquired to provide a viable study. The tags were lightweight (3.2g), highly accurate (1-10 metres (m)) GPS devices that stored locations. These locations were then downloaded remotely using a base-station that uses a UHF signal transmitted over distances of up to 500m.

Breeding wader surveys began in late March 2021, with a total of 27 redshank pairs observed across the four main sites in the Avon Valley. Nests were found and egg measurements taken to calculate a predicted hatch date, then adults were caught as close to the hatching date as possible. The cold, dry conditions in early spring meant that grass growth was unusually slow, and redshank nests were more exposed than in previous years.

A heart-shaped walk-in trap was placed over five nests, resulting in four successful captures of the incubating adult. We equipped all four with GPS-UHF tags weighing 3.2g (2.4% of body weight). After release, we watched tagged individuals from a distance for up to 30 minutes, to record any immediate negative effects of the tag. Birds demonstrated normal behaviour and quickly adapted to the tag. All tagged redshank returned to the nest and continued incubation, and all individuals were resighted with chicks within a week after tagging, with at least three successfully fledging broods. We collected a large amount of positional data from each bird that will provide a considerable amount of novel information on redshank behaviour during nesting and brood-rearing periods (see Figure 1).

This pilot study successfully validated the method of capture and we plan to repeat the work in 2022 with a slightly larger sample size and fine-scale vegetation monitoring alongside tracking data. We shall use the data to investigate territory size, movements during breeding, and fine-scale habitat use by breeding adults and broods.

We thus expect GPS tracking to be a useful tool to demonstrate the value of habitat improvements made by local landowners, and encourage further work and management for this priority species.

### Colour ringing

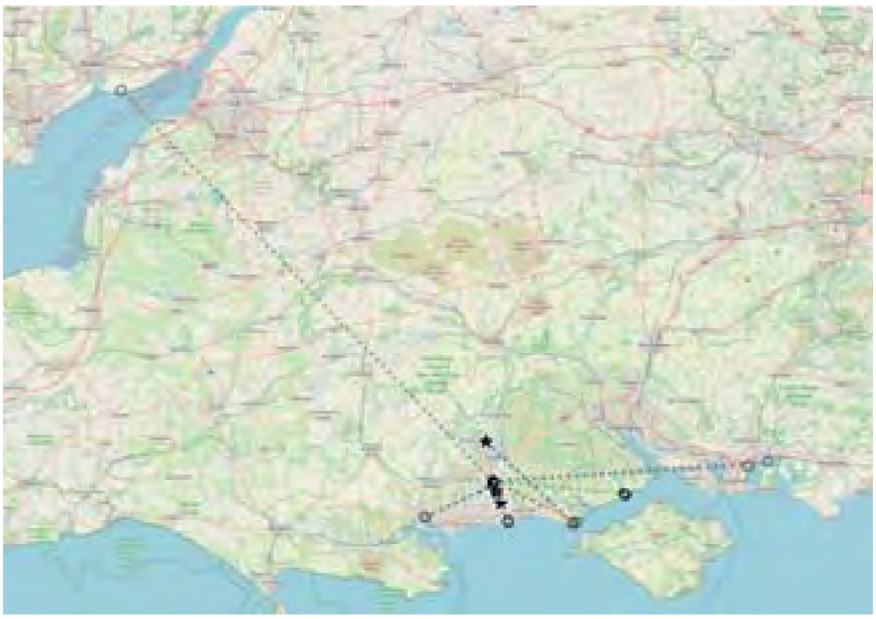
During the spring, eight redshank chicks were colour ringed, along with the four captured adults. All of these colour-ringed individuals have been resighted since ringing, nine of them outside the Avon Valley. Most sightings have been at various wetland reserves along the Hampshire coast, including Stanpit Marsh, North Solent NNR, and Langstone and Keyhaven; one bird was even spotted at Gwent Levels Wetland Reserve in Newport, Wales (see Figure 2).

*Redshank nest found in April 2021 – note the short vegetation and exposed eggs. © GWCT*

## KEY FINDINGS

- Redshank pairs in the Avon Valley increased from 19 in 2015 to 35 in 2019, likely brought about by habitat improvements, predator exclusion and predator management.
- We use a combination of colour ringing and GPS tracking to better understand their movements and habitat requirements within and outside the breeding season.
- Four adult redshank were successfully caught and fitted with lightweight (3.2g), highly accurate (1-10m) GPS devices over the chick rearing period.
- We shall use the data to investigate territory size, movements during breeding, and fine-scale habitat use by breeding adults and broods.

Lizzie Grayshon
Andrew Hoodless



*© Google Earth Pro 7.3.4.8248. (2021). Avon, 50.801492°, -1.802638°. (Online). Accessed: 01/04/2022*

### Figure 2

Redshank ringing locations (ringing period 29/04/2021-23/06/2021) and resightings (colour ring sightings 27/05/2021-9/02/2022). Coloured lines show movement of different individuals

★ Ringing location

○ Resighting location

# Research projects

by the Game & Wildlife Conservation Trust in 2021

## PARTRIDGE AND BIOMETRICS RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Partridge Count Scheme (see p16)* | *Nationwide monitoring of grey and red-legged partridge abundance and breeding success* | *Neville Kingdon, Nicholas Aebischer, Julie Ewald, Rachel Cook, George Scarisbrick, Josh Deakin, Christopher Owen* | *Core funds, GCUSA* | *1933- ongoing* |
| *National Gamebag Census (see p26)* | *Monitoring game and predator numbers with annual bag records* | *Nicholas Aebischer, Corinne Duggins, Cameron Hubbard, Rachel Cook, George Scarisbrick, Bradley Blyther, Josh Deakin, Christopher Owen* | *Core funds* | *1961- ongoing* |
| *Sussex study* | *Long-term monitoring of partridges, weeds, invertebrates, pesticides and land use on the South Downs in Sussex* | *Julie Ewald, Nicholas Aebischer, Steve Moreby, Cameron Hubbard* | *Core funds, Ernest Kleinwort Charitable Trust* | *1968- ongoing* |
| *Wildlife monitoring at Rotherfield Park* | *Monitoring of land use, game and songbirds for the Rotherfield Demonstration Project* | *Francis Buner, Julie Ewald, Ellie Raynor Amelia Corvin-Czarnodolski* | *Core funds, Interreg (EU North Sea Region)* | *2010-2023* |
| *Grey partridge management* | *Researching and demonstrating grey partridge management at Whitburgh Farms* | *Dave Parish, Hugo Straker, Adam Smith, Fiona Torrance, Tamara Spivey, Elizabeth Fitzpatrick, Holly Owen, Tanith Jones* | *Whitburgh Farms, Core funds* | *2011-2021* |
| *Cluster Farm mapping* | *Generating cluster-scale landscape maps for use by the Advisory Service and the Farm Clusters* | *Julie Ewald, Neville Kingdon, Cameron Hubbard, Rachel Cook, George Scarisbrick, Josh Deakin, Christopher Owen* | *Core funds* | *2014- ongoing* |
| *Developing novel game crops* | *Developing perennial game cover mixes* | *Dave Parish, Fiona Torrance, Hugo Straker, Tamara Spivey, Elizabeth Fitzpatrick, Holly Owen, Tanith Jones* | *Balgonie Estates Ltd, Core funds, Kingdom Farming, Kings Crops Scottish Agronomy* | *2014-2022* |
| *Grey partridge recovery (see p18)* | *Monitoring grey partridge recovery at Balgonie Estate and impacts on associated wildlife* | *Dave Parish, Hugo Straker, Fiona Torrance, Tamara Spivey, Elizabeth Fitzpatrick Holly Owen, Tanith Jones* | *Balgonie Estates Ltd, Core funds, Kingdom Farming, Kings Crops Scottish Agronomy* | *2014-2022* |
| *PARTRIDGE (see p22)* | *Co-ordinated demonstration of management for partridge recovery and biodiversity in the UK, the Netherlands, Belgium, Germany and Denmark* | *Francis Buner, Fiona Torrance, Julie Ewald, Dave Parish, Paul Stephens, Ben Stephens, Corinne Duggins, Ellie Raynor, Tamara Spivey, Elizabeth Fitzpatrick, Amelia Corvin-Czarnodolski, Holly Owen, Tanith Jones, Cameron Hubbard, John Szczur, Chris Stoate, Roger Draycott, Francesca Pella, Nicholas Aebischer* | *Interreg (EU North Sea Region) Core funds* | *2016-2023* |
| *Recovery of grey partridge populations in Scotland* | *Encouraging grey partridge management and monitoring across Scotland* | *Dave Parish, Fiona Torrance* | *Core funds* | *2017- ongoing* |
| *Lowland Gamebird Impact Study* | *Compare land holdings with released gamebird shooting to geographically matched land holdings without such management* | *Neville Kingdon, Cameron Hubbard, Julie Ewald, Nicholas Aebischer, Rachel Cook, George Scarisbrick, Josh Deakin, Christopher Owen* | *The Wates Family Charities* | *2019-2024* |

## UPLANDS RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Grouse count scheme (see p30)* | *Annual grouse and parasitic worm counts in relation to moorland management indices and biodiversity* | *David Baines, Philip Warren, Kathy Fletcher, Sonja Ludwig* | *Core funds, Gunnerside Estate* | *1980- ongoing* |
| *Black grouse monitoring* | *Annual lek counts and brood counts* | *Philip Warren, David Baines, Kathy Fletcher* | *Core funds, Natural England* | *1989- ongoing* |
| *Capercaillie brood surveys* | *Surveys of capercaillie and their broods in Scottish forests* | *Kathy Fletcher, David Baines, Phil Warren* | *Cairngorms National Park Authority, Seafield Estates* | *1991- ongoing* |
| *Heather burning on peatland* | *Vegetation and hydrological responses to burning on peatland* | *Sian Whitehead, Madeleine Benton* | *Core funds* | *2018-2027* |
| *Repeat moorland bird surveys* | *Repeat of bird and vegetation surveys conducted on circa 90 UK moors 2007-2012* | *David Baines, Philip Warren, Madeleine Benton, Kathy Fletcher* | *Core funds* | *2019-2021* |
| *Development of Black Grouse Study Groups in Scotland* | *Co-ordinating volunteer inputs into annual lek monitoring across several regions of Scotland* | *Philip Warren, Kathy Fletcher* | *Heritage Lottery Fund* | *2019-2021* |
| *Development of long-term heather burning experiments on blanket peat (see p38)* | *Are burning and cutting useful management tools for blanket bog restoration? Does the structure and composition of pre-burn vegetation influence post-burn vegetation recovery?* | *Sian Whitehead, Madeleine Benton, Liam Thompson* | *Core funds* | *2019-2028* |
| *Rush management for breeding waders* | *Experimental rush cutting to improve habitat for breeding lapwing* | *David Baines, Madeleine Benton, Sian Whitehead* | *Philip Wayre Uplands Trust* | *2020-2021* |
| *How many curlew breed in Upper Teesdale?* | *Habitat based randomized survey of breeding curlew to provide a population estimate* | *David Baines, Phil Warren, Madeleine Benton* | *Cotherstone & Raby Estates* | *2020-2022* |
| *Black grouse and human disturbance* | *Winter surveys and lek counts in relation to public access restrictions imposed following CROW Act 2005* | *Philip Warren, Madeleine Benton* | *Natural England* | *2020-2022* |
| *Recovery of heather post-beetle outbreak (see p36)* | *Experimental cutting and burning to aid heather recovery after heather beetle attacks* | *Sian Whitehead* | *Gunnerside Estate* | *2021* |
| *Cranefly monitoring* | *Pilot study to test methods of quantifying cranefly emergence periods on peatland habitats* | *David Baines* | *Core funds* | *2021* |
| *Meadow pipits* | *Standardized permanent transects to consider annual variations in pipit abundance and defining optimal diurnal survey periods* | *David Baines, Liam Thompson* | *Core funds* | *2021* |

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|---|---|---|---|---|
| *Mountain hares* | *Does culling hares reduce sheep tick parasitization of grouse chicks sufficient to effect chick survival?* | *Sonja Ludwg, Kathy Fletcher, David Baines* | *Core Funds (Scotland)* | *2020-2021* |
| *Merlin (Magic) Recovery Project (see p34)* | *Testing proposed hypotheses of merlin decline on grouse moors in northern England* | *David Baines, Philip Warren, Georgia Isted* | *Defra Green Recovery Challenge Fund through HLF* | *2021-23* |

## FARMLAND RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Chick-food and farming systems (see p40)* | *A comparison of grey partridge chick-food in conventional and organically farmed crops and habitats* | *John Holland, Steve Moreby, Niamh McHugh, Ellie Ness, Inca Johnson, Ben Prego Ruby Woollard, Seshi Humphrey-Ackumey* | *Private funds* | *2015- ongoing* |
| *Long-term monitoring* | *Monitoring of wildlife on BASF demonstration farms* | *John Holland, Lucy Capstick,Holly Turner, Jayna Connelly, Ben Prego, Inca Johnson, Ruby Woollard, Seshi Humphrey-Ackumey* | *BASF* | *2017- ongoing* |
| *Chick-food invertebrate levels (see p40)* | *Chick-food invertebrate levels in crops and non-crop habitats on three estates* | *John Holland, Steve Moreby, Holly Turner, Inca Johnson, Ben Prego, Ruby Woollard, Seshi Humphrey-Ackumey* | *Private funds, The Millichope Foundation* | *2017- ongoing* |
| *Farmland bumblebee project* | *Assessment of bumblebee nest densities across SW England* | *John Holland* | *Private funds* | *2017- ongoing* |
| *Acoustic detectors for monitoring woodcock* | *Evaluation of acoustic detectors for monitoring woodcock* | *Niamh McHugh, Chris Heward, Andrew Hoodless* | *Core funds* | *2018- ongoing* |
| *BEESPOKE* | *Increasing the area of pollinator habitat and pollination* | *John Holland, Niamh McHugh, Jade Hemsley, Jayna Connelly, Ellie Jackson-Smith, Lucy Capstick* | *EU Interreg North Sea Region* | *2019-2023* |
| *Bat monitoring in Devon* | *Identification of bat species on a Devon demonstration farm* | *Niamh McHugh, Jodie Case, Holly Turner* | *Private funds* | *2020-2021* |
| *The Owl Box Initiative (see p46)* | *Barn Owl conservation, research and engagement project* | *Niamh McHugh, Chris Heward, Jodie Case, Ellie Ness* | *Green Recovery Challenge Fund* | *2020-2022* |
| *FRAMEwork (see p44)* | *Evaluation and development of Farmer Cluster approach across Europe* | *John Holland, Niamh McHugh, Ellie Ness, Inca Johnson, Ben Prego* | *EU Horizon 2020* | *2020-2025* |
| *Farmland birds and farming systems* | *Comparison of farmland bird abundance relative to conventional and organically farmed crops and agri-environment habitats* | *Niamh McHugh, Ellie Ness* | *Private funds* | *2020- ongoing* |
| *H3 Healthy soils, healthy food, healthy people* | *Ecological evaluation of Regenerative Agriculture* | *Niamh McHugh, John Holland, Lucy Capstick, Ellie Ness, Ruby Woollard, Seshi Humphrey-Ackumey* | *UKRI (Subcontract) Cambridge University* | *2021-2025* |
| *PhD: Solitary bees* | *Seed mixes for solitary bees* | *Rachel Nichols. Supervisors: John Holland, Prof Dave Goulson (University of Sussex)* | *NERC/GWCT* | *2018- ongoing* |
| *PhD: Biodiversity footprint of foods* | *Creating an index of crop-farming traits to assess the biodiversity footprint of foods* | *Helen Waters. Supervisors: John Holland, Alfred Gathorne-Hardy (University of Edinburgh), Barbara Smith (Coventry University)* | *NERC/GWCT* | *2019- ongoing* |

## ALLERTON PROJECT RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Monitoring wildlife at Loddington (see p48)* | *Annual monitoring of game species, songbirds, invertebrates, plants and habitat* | *Chris Stoate, John Szczur, Alastair Leake, Steve Moreby, John Holland* | *Allerton Project funds* | *1992- ongoing* |
| *Effect of game management at Loddington* | *Effect of ceasing predator control and winter feeding on nesting success and breeding numbers of songbirds* | *Chris Stoate, Alastair Leake, John Szczur* | *Allerton Project funds* | *2001- ongoing* |
| *Water Friendly Farming* | *A landscape-scale experiment testing integration of resource protection and flood risk management with farming in the upper Welland* | *Chris Stoate, John Szczur, Jeremy Biggs, Penny Williams, (Freshwater Habitats Trust), Professor Colin Brown (University of York)* | *EA, Regional Flood and Coastal Committee* | *2011-2027* |
| *School farm catchment* | *Practical demonstration of ecosystem services* | *Chris Stoate, John Szczur* | *Allerton Project, EA, Anglian Water, Agrii* | *2012- ongoing* |
| *Soil monitoring* | *Survey of soil biological, physical and chemical properties* | *Chris Stoate, Jenny Bussell, Alastair Leake, Phil Jarvis, Gemma Fox* | *Allerton Project* | *2014- ongoing* |
| *SoilCare (see p54)* | *Soil management to meet economic and environmental objectives across Europe* | *Chris Stoate, Jenny Bussell, Gemma Fox John Szczur* | *EU H2020* | *2016-2021* |
| *Soil Biology and Soil Health (see p56)* | *The role of soil biology in crop production systems* | *Chris Stoate, Jenny Bussell, Gemma Fox* | *AHDB* | *2016-2021* |
| *Conservation Agriculture* | *Economic and environmental impacts of three contrasting crop production approaches* | *Alastair Leake, Phil Jarvis, Joe Stanley, Chris Stoate, Jenny Bussell, Gemma Fox, John Sczur, Oliver Carrick* | *Syngenta* | *2017-2022* |
| *RePhoKUs* | *Understanding food system phosphorus balance at a range of scales* | *Chris Stoate, Paul Withers and partners* | *Research Councils* | *2018-2021* |
| *Agroforestry* | *Optimising tree densities to meet multiple objectives in grazed pasture* | *Chris Stoate, Jenny Bussell, Gemma Fox, Alastair Leake, John Szczur* | *Woodland Trust* | *2018- ongoing* |
| *SARIC* | *Restoring soil quality through the re-integration of leys and sheep into arable rotations* | *Alastair Leake, Oliver Carrick, Phil Jarvis plus multiple external stakeholders* | *BBSRC & UKRI* | *2018-2022* |

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|---|---|---|---|---|
| *Farming with Nature* | *Promoting sustainable farming practice & IPM* | *Saya Harvey, Jemma Clifford, Joe Stanley* | *Marks & Spencer* | *2019- ongoing* |
| *Tree leaves as ruminant fodder* | *Assessing the nutritional value of tree leaves for ruminants* | *Chris Stoate, Jenny Bussell, Gemma Fox, Nigel Kendall (Nottingham University)* | *Woodland Trust* | *2019-2022* |
| *Compaction and infiltration* | *Exploring the relationship between soil compaction and infiltration in the Eye Brook catchment* | *Chris Stoate, Gemma Fox, Jenny Bussell* | *EA* | *2020-2021* |
| *Monitoring soil health under potato production* | *Comparing soil biological activity and organic matter under different treatments* | *Jenny Bussell, Gemma Fox, Alastair Leake* | *McCains/McDonalds* | *2021-2022* |
| *Hedgerow Carbon Code* | *Creating a matrix for hedge carbon management & associated carbon credit trades* | *Alastair Leake* | *Defra/Natural England* | *2021-2022* |
| *AgriCapture* $CO_2$ | *Promoting regenerative agricultural practice & use of farm carbon credits across Europe* | *Alastair Leake, Joe Stanley, Jemma Clifford* | *EU Horizon 2020* | *2021-2024* |
| *PhD: Mapping ecosystem services* | *Mapping ecosystem services across the Welland river basin* | *Max Rayner. Supervisors: Chris Stoate, Dr Heiko Balzter (Leicester University)* | *NERC* | *2017-2021* |

## AUCHNERRAN PROJECT RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Core biodiversity monitoring (see p58)* | *Monitoring of key groups to assess impacts of farming changes* | *Dave Parish, Marlies Nicolai, Sophie McPeake, Olivia Stubbington, Gemma Morgan, Amy Cooke* | *Core funds* | *2015- ongoing* |
| *Rabbit population monitoring* | *Assessing rabbit numbers in relation to control methods and impacts on other species* | *Dave Parish, Marlies Nicolai, Sophie McPeake, Olivia Stubbington Gemma Morgan, Amy Cooke* | *Core funds* | *2016- ongoing* |
| *GWSDF Cromar Farmer Cluster* | *Developing the Cromar Farmer Cluster* | *Dave Parish, Marlies Nicolai, Ross MacLeod* | *Core funds, Working for Waders* | *2016- ongoing* |
| *Liming experiment* | *Split-field experiment investigating impacts of liming on invertebrates, including mud snails* | *Dave Parish, Marlies Nicolai, Elizabeth Ogilvie, Max Wright* | *James Hutton Institute, Core funds* | *2016-2021* |
| *Wader population monitoring (see p62)* | *Surveying of wader numbers, distribution and productivity at multiple sites, GPS tagging curlew, oystercatcher and lapwing at Auchnerran* | *Dave Parish, Marlies Nicolai, Andrew Hoodless, Elizabeth Ogilvie, Max Wright* | *Core funds, Working for Waders, Perdix Wildlife Supplies* | *2017- ongoing* |
| *Mud snail and liver fluke interactions* | *Investigating the importance of intermediate/alternative fluke hosts and land-use* | *Dave Parish, Marlies Nicolai* | *Core funds, Moredun Research Institute* | *2017- ongoing* |
| *Assessing carbon and natural capital audits* | *Assessing the applicability of audit protocols* | *Dave Parish, Marlies Nicolai, Ross MacLeod, Sophie McPeake, Olivia Stubbington* | *Core funds* | *2021-2023* |
| *The impact of egg predators on waders* | *Quantifying the impact of different predators of wader eggs on overall wader productivity* | *Dave Parish, Marlies Nicolai, Sophie McPeake, Olivia Stubbington, Gemma Morgan, Amy Cooke* | *Core funds, Working for Waders, Perdix Wildlife Supplies* | *2021-2024* |
| *Distribution of hill-grazing sheep* | *Investigating the implications of sheep distribution on the hill for habitat and tick management* | *Dave Parish, Marlies Nicolai* | *Core funds* | *2021-2023* |

## PREDATION RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Grey squirrel trapping strategy* | *Scientific write-up of optimal trapping strategy for grey squirrel control* | *Jonathan Reynolds, Mike Short* | *Core funds* | *2013-2021* |
| *Foxes in the Avon Valley* | *Analysis of GPS tracking data and DNA evidence to determine resident density, activity patterns and habitat use of foxes in the Avon Valley, in the context of declining wading bird populations* | *Mike Short, Tom Porteus, Jonathan Reynolds* | *Core funds* | *2015- ongoing* |
| *Use of tunnels by small mustelids in a river meadow habitat* | *Revision of scientific write-up following peer review* | *Jonathan Reynolds, Mike Short, Tom Porteus* | *Core funds* | *2015-2021* |
| *Diet of foxes in the Avon Valley and New Forest* | *Analysis of stomach and faecal analysis to determine main dietary components supporting foxes in areas where wading birds breed* | *Mike Short, Jodie Case Elli Rivers, Nathan Williams* | *Core funds* | *2021- ongoing* |
| *Wader nest monitoring in the New Forest (see p66)* | *Use of trail cameras to monitor nesting success of curlew and lapwing breeding in the New Forest* | *Mike Short, Elli Rivers (Bournemouth University PhD student)* | *Core funds* | *2021- ongoing* |
| *PhD: Why are there so many foxes?* | *How the large-scale spatial population dynamics of the red fox, may determine the local fate of wading birds breeding in the Avon Valley and New Forest* | *Nathan Williams Supervisors: Mike Short, Tom Porteus, Andy Hoodless, Emilie Hardouin, Demetra Andreou, Richard Stillman* | *Core funds, private funds* | *2021- ongoing* |

## FISHERIES RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| *Fisheries research* | *Develop wild trout fishery management methods including completion of write-up/reports of all historic fishery activity* | *Dylan Roberts* | *Core funds* | *1997- ongoing* |
| *Salmonid life-history strategies in freshwater (see p68)* | *Understanding the population declines in salmon and sea trout* | *Rasmus Lauridsen, Dylan Roberts, William Beaumont, Luke Scott, Stephen Gregory* | *EA, Cefas, The Missing Salmon Alliance* | *2009- ongoing* |
| *Grayling ecology* | *Long-term study of the ecology of River Wylye grayling* | *Stephen Gregory, Luke Scott, Jessica Marsh* | *NRW, Core funds, Grayling Research Trust, Piscatorial Society* | *2009- ongoing* |

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|---|---|---|---|---|
| Headwaters and salmonids | Contribution of headwaters to migratory salmonid populations and the impacts of extreme events | Rasmus Lauridsen, William Beaumont, Luke Scott, Dylan Roberts, Stephen Gregory, Will Beaumont, Bill Riley | Cefas/Defra, The Missing Salmon Alliance | 2015- ongoing |
| Salmon and trout smolt tracking | Movements and survival of salmon and sea trout smolts through four estuaries in the English Channel as part of the SAMARCH project | Céline Artero, Rasmus Lauridsen, William Beaumont, Luke Scott, Dylan Roberts, Stephen Gregory, Elodie Reveillac (Agrocampus Ouest), Will Beaumont | EU Interreg The Missing Salmon Alliance | 2017-2023 |
| Sea trout kelt tracking | Movements and survival of sea trout kelts at sea from three rivers in the English Channel as part of the SAMARCH project | Céline Artero, Rasmus Lauridsen, William Beaumont, Luke Scott, Dylan Roberts, Elodie Reveillac, Will Beaumont | EU Interreg The Missing Salmon Alliance | 2017-2023 |
| Genetic tools for trout management | Creation of a genetic database for trout in the Channel rivers (ca. 100 rivers) and a tool for identifying areas at sea important for sea trout | Jamie Stevens, Andy King (Exeter University), Sophie Launey (INRA), Dylan Roberts, Rasmus Lauridsen | EU Interreg The Missing Salmon Alliance | 2017-2023 |
| New salmon stock assessment tools (see p70) | Providing new information for stock assessment models and new stock assessment tools in England and France as part of the SAMARCH project | Stephen Gregory, Marie Nevoux (INRA), Etienne Rivot (Agrocampus Ouest), Rasmus Lauridsen, William Beaumont, Luke Scott, Dylan Roberts, Will Beaumont | EU Interreg The Missing Salmon Alliance | 2017-2023 |
| New policies for salmon and sea trout in coastal and transitional waters | Developing new policies for the better management of salmon and sea trout in coastal and transitional waters based on the outputs of SAMARCH | Dylan Roberts, Will Beaumont, Lawrence Talks and Simon Toms (EA), Laurent Beaulaton (Association of French Biodiversity), Gaelle Germis (Bretagne Grands Migrateurs), Paul Knight, Lauren Mattingley (S&TC, UK), Jerremy Corr (Normandie Grands Migrateurs) | EU Interreg The Missing Salmon Alliance | 2017-2023 |
| Pink salmon | Use new eDNA methods to determine distribution of non-native pink salmon in the UK and to use stable isotopes to study the ecosystem effect of pink salmon where present | Rasmus Lauridsen, Gordon Copp (Cefas), Iwan Jones (QMUL) , Phil Davidson (Cefas), Michał Skóra, Hui Wei | Cefas, The Missing Salmon Alliance | 2019-2022 |
| PhD: Effects of smolt-characteristics on their migration and survival (see p74) | Quantify the effects of smolt characteristics, among other factors, on their migration and marine survival in the Frome and elsewhere | Olivia Simmons. Supervisors: Robert Britton & Phillipa Gillingham (Bournemouth University) Stephen Gregory | EU Interreg, Bournemouth University | 2018-2021 |
| PhD: Trout metal tolerance | Disentangling the three main factors affecting trout ability to tolerate metals: evolution, local adaption and pollution | Daniel Osmond. Supervisors: Rasmus Lauridsen, Jamie Stephens (Exeter University), Mike Bruford (Cardiff University), Bruce Stockley (WRT) | GW4 FRESH CDT, Core funds | 2019-2023 |

## LOWLAND GAME RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| Lowland gamebird population studies | The effect of different releasing and wild game management strategies on winter survival and breeding | Roger Draycott, Maureen Woodburn, Rufus Sage | Core funds | 1996- ongoing |
| Consequences of releasing | Understanding the wider ecological consequences of releasing for shooting | Rufus Sage, Maureen Woodburn, Jenny Coomes | Core funds, BASC | 2019-2022 |
| Game crops and breeding birds in the Exmoor region (see p76) | The effect of gamecrops planted on grassland farmland on hedgerow breeding birds | Rufus Sage, Maureen Woodburn, Sam McCready | Greater Exmoor Shoot Association | 2021-2022 |
| Releasing gamebirds and foxes | Does releasing increase fox density and does fox control reduce it? | Rufus Sage, Maureen Woodburn, Jenny Coomes, Joseph Werling, Mike Short, Jodie Case | BASC | 2021-2023 |
| Release gamebird dispersal | Documenting movement and dispersal of released gamebirds | Rufus Sage, Maureen Woodburn, Jenny Coomes, Joseph Werling | BASC | 2021-2023 |

## WETLAND RESEARCH IN 2021

| Project title | Description | Staff | Funding source | Date |
|---|---|---|---|---|
| Woodcock monitoring | Examination of annual variation in breeding woodcock abundance | Chris Heward, Andrew Hoodless, collaboration with BTO | Shooting Times Woodcock Club | 2003- ongoing |
| Woodcock survival and site fidelity | Intensive ringing and recapture of woodcock at three winter sites | Andrew Hoodless, Chris Heward, collaboration with the Woodcock Network | Core funds | 2012- ongoing |
| Woodcock migration and breeding site habitat use | Use of GPS tags to understand autumn migration and breeding site habitat use | Andrew Hoodless, Chris Heward, collaboration with ONCFS | Shooting Times Woodcock Club, private donors, Woodcock Appeal | 2017-2022 |
| Habitat use by breeding woodcock | Use of GPS tags to examine fine-scale habitat use by breeding woodcock and the value of habitat management | Chris Heward, Andrew Hoodless | Private donors, Core funds | 2018-2021 |
| Lapwing on the South Downs | Monitoring of lapwing breeding success on the South Downs | Lizzie Grayshon, Andrew Hoodless, collaboration with RSPB and South Downs National Park | Core funds | 2018-2022 |
| Use of Special Protection Area habitats by waders | GPS tracking of oystercatchers and curlews on the Exe Estuary | Ryan Burrell, Andrew Hoodless, collaboration with NE and University of Exeter | NE | 2018-2022 |
| Use of Southampton Water by waders, ducks and geese | Winter GPS tracking of curlew, oystercatcher, wigeon, teal, brent goose to examine use of shore and field habitats | Lizzie Grayshon, Ryan Burrell, Chris Heward, collaboration with Farlington Ringing Group and ABPmer | Associated British Ports | 2019-2021 |
| Winter movements of lapwings (see p78) | Comparison of lapwings breeding in Scotland and southern England using GPS tracking | Andrew Hoodless, Dave Parish, Marlies Nicolai, Lizzie Grayshon, Ryan Burrell | EU LIFE, Associated British Ports, Core funds | 2019-2023 |
| Breeding redshank in the Avon Valley (see p80) | Examining habitat use and breeding success of redshank in the Avon Valley using GPS tracking and colour-ringing | Lizzie Grayshon, Clive Bealey | Hampshire Ornithological Society | 2021-2023 |
| Avon Valley Farmer Cluster | Farmer-led habitat restoration and wader recovery in the Avon Valley | Lizzie Grayshon | NE Facilitation Fund, Core funds | 2020-2022 |

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|---|---|---|---|---|
| *PhD: Woodcock in Ireland* | *Breeding woodcock distribution and habitat relationships. Effect of shooting on winter woodcock behaviour and mortality rate* | *James O'Neill. Supervisors: Andrew Hoodless, Prof John Quinn (UCC)* | *Irish Research Council, NARGC, NPWS, Core funds* | *2019-2022* |
| *PhD: Role of camouflage in the survival and conservation of ground-nesting birds* | *Influence of nest and chick crypsis on lapwing breeding success and possible modifications to field and sward management* | *George Hancock. Supervisors: Andrew Hoodless, Dr Jolyon Troscianto, Dr Martin Stevens (University of Exeter), Dr Innes Cuthill (University of Bristol)* | *NERC* | *2019-2022* |
| *PhD: Landscapes for curlews* | *Monitoring breeding success and use of GPS tracking to determine foraging areas of adult curlews and brood ranges* | *Elli Rivers. Supervisors: Andrew Hoodless, Prof Richard Stillman, Dr Kathy Hodder (Bournemouth University), Andy Page (FC)* | *Hampshire Ornithological Society, Forestry England, private donors* | *2020-2022* |
| *PhD: Lapwings and avian predators* | *Quantifying lapwing chick survival in arable habitats and the effects of disturbance by corvids and raptors* | *Ryan Burrell. Supervisors: Andrew Hoodless, Prof Richard Stillman, Dr Kathy Hodder (Bournemouth University)* | *Core funds* | *2020-2022* |

*Key to abbreviations: AHDB = Agriculture and Horticulture Development Board; BEESPOKE = Benefiting Ecosystems through Evaluation of food Supplies for Pollination to Open up Knowledge for End users; BTO = British Trust for Ornithology; CEFAS = Centre for Environment, Fisheries & Aquaculture Science; Defra = Department for Environment, Food and Rural Affairs; EA = Environment Agency; EU = European Union; FC = Forestry Commission; FRAMEwork = Farmer clusters for Realising Agrobiodiversity Management across Ecosystems; GCUSA = Game Conservancy USA; GWSDF = Game & Wildlife Scottish Demonstration Farm; H2020 = Horizon 20:20; HLF = Heritage Lottery Fund; INRA = Institut National de la Recherche Agronomique; Interreg = European Regional Development Board; LIFE = L'Instrument Financier pour l'Environnement; NARGC = National Association of Regional Game Councils; NE = Natural England; NERC = Natural Environment Research Council; NRW = Natural Resources Wales; ONCFS = Office National de la Chasse et de la Faune Sauvage; PARTRIDGE = Protecting the Area's Resources Through Researched Innovative Demonstration of Good Examples; QMUL = Queen Mary University of London; RePhoKUs = Role of Phosphorus in the Resilience and Sustainability of the UK Food System; RSPB = Royal Society for the Protection of Birds; SAMARCH = SAlmonid MAnagement Round the CHannel; SNH = Scottish Natural Heritage; S&TC, UK = Salmon & Trout Conservation UK; UCC = University College Cork; UKRI = UK Research Innovations; WRT = Westcountry Rivers Trust.*

# Scientific publications

by staff of the Game & Wildlife Conservation Trust in 2021



**Aebischer, NJ & Burrell, RA** (2021) Grey Partridge *Perdix perdix*, Galliformes, Phasianidae. In: Powolny, T. (ed.) *Conservation and Management of Huntable Bird Species in Europe:* 37-49. OMPO, Paris, France.

Awan, MN, Saqib, Z, **Buner, FD**, Lee, DC & Pervez, A (2021) Using ensemble modelling to predict breeding habitat of the red-listed Western Tragopan *(Tragopan melanocephalus)* in the Western Himalayas of Pakistan. *Global Ecology and Conservation,* 31(e01864): 1-13.

**Bussell, J, Crotty, F & Stoate, C** (2021) Comparison of compaction alleviation methods on soil health and greenhouse gas emissions. *Land,* 10: 1397.

**Hall, A, Sage, RB** & Madden, JR (2021) The effects of released pheasants on invertebrate populations in and around woodland release sites. *Ecology and Evolution,* 11: 13559-13569.

**Hemsley, JA & Holland, JM** (2021) Does the non-native Harlequin ladybird disrupt the feeding behaviour of the native two-spot ladybird? *Bulletin of Entomological Research*, 111(6): 741-745.

**Holland, JM McHugh, NM** & Salinari, F **(2021)** Field specific monitoring of yellow dwarf disease aphid vectors and factors influencing their immigration. *Pest Management Science*, 77: 4100-4108.

**Hoodless, AN & Sage, RB (2021)** Climate and management effects on tick-game animal dynamics. In: *Climate, Ticks and Disease*, 18: 132-138. CABI Publishing, Boston, USA.

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*GWCT staff in bold.*

# Financial report
for 2021

**The summary report and financial statement for the year ended 31 December 2021, set out below and on pages 90 to 91, consist of information extracted from the full statutory Trustees' report and consolidated accounts of the Game & Wildlife Conservation Trust and its wholly-owned subsidiaries Game & Wildlife Conservation Trading Limited, Game & Wildlife Scottish Demonstration Farm and GWCT Events Limited. They do not comprise the full statutory Trustees' report and accounts, which were approved by the Trustees on 26 April 2022 and which may be obtained from the Trust's Headquarters. The auditors have issued unqualified reports on the full annual accounts and on the consistency of the Trustees' report with those accounts, and their report on the full accounts contained no statement under sections 498(2) or 498(3) of the Companies Act 2006.**

### KEY POINTS

- Income was £9.34 million, compared with £7.73 million in 2020.
- Expenditure on charitable activities was £5.49 million (an increase of 7.0%).
- There was a surplus of £694,000 on unrestricted funds.
- The Trust's net assets were £11.5 million at the end of the year.

The Covid-19 pandemic continued to affect the Trust although it was able to carry out more of its usual fundraising activities and to conduct a near-normal research programme, albeit with appropriate adaptions to meet Covid-19 guidelines. With the continuing generosity of the Trust's supporters and the receipt of some extremely welcome legacies, we have been able to build our reserves to the revised target level which we established.

The Trustees reviewed the Trust's reserves policy in the light of the pandemic and determined that the target should be increased to between £2 million and £2.5 million, to reflect the uncertainties which it created. Although the effects of Covid are continuing to ease, the UK and the world economy remain under strain and we feel that the revised level remains appropriate. Having established this new level the Trustees continue to be satisfied that the Trust's financial position is sound.

### Plans for future periods

1. To establish and build significant public support for a more positive approach to conservation.
2. To tackle research knowledge and evidence gaps in released gamebird dispersal, the quantification of the 'environmental offer' of game management for wild and released game, and the recovery of salmonid species.
3. To persuade game managers to practise GWCT's Sustainable Game Management Principles, embed the ethos of net biodiversity gain into their game management, quantify their gains and accredit it through GWCT Shoot Biodiversity Assessments.
4. To secure policy change such that the role of predation control in species recovery is embedded in the Environment Land Management Scheme (ELMS) and equivalent Agri-environment Schemes (AES) in Wales; that there are practical, workable licences for the control of protected predators to enhance nature conservation; that post-Brexit Agri-Environment Schemes are fit for purpose and informed by GWCT's researched options; that environmental principles are pragmatically implemented into future policy and that game management remains economically and culturally active enough to continue to make a net contribution to biodiversity gain.
5. To be a leader in the demonstration and uptake of greener farming.
6. Support our staff through our first People Strategy/People Plan and creating a flexible team of scientists delivering accessible high-quality science.
7. To maintain the GWCT's financial viability by increasing the number of membership subscriptions, reviewing and increasing our cash reserves and raising funds from a committed, engaged group of members, supporters, and donors.

Sir Jim Paice
Chairman of the Trustees

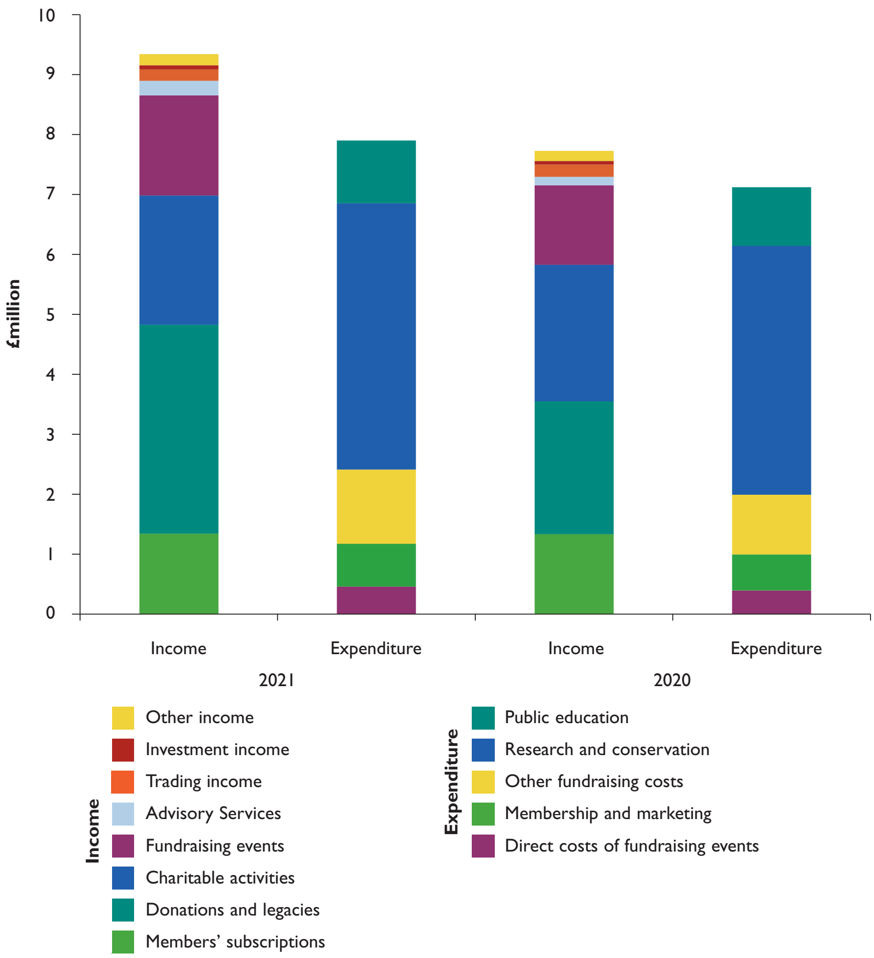


Figure 1

Total incoming and outgoing resources in 2021 (and 2020) showing the relative income and costs for different activities

# Independent auditors' statement

## to the Trustees and Members of the Game & Wildlife Conservation Trust (limited by guarantee)

We have examined the summary financial statement for the year ended 31 December 2021 which is set out on pages 90 and 91.

### Opinion

In our opinion the summary financial statement is consistent with the full annual financial statements of the Game & Wildlife Conservation Trust for the year ended 31 December 2021 and complies with the applicable requirements of Section 427 of the Companies Act 2006 and the regulations made thereunder.

### Respective responsibilities of Trustees and Auditors

The Trustees are responsible for preparing the summarised Financial Report in accordance with applicable United Kingdom law. Our responsibility is to report to you our opinion of the consistency of the summary financial statement with the full annual financial statements and the Trustees' Report, and its compliance with the relevant requirements of section 427 of the Companies Act 2006 and the regulations made thereunder.

We also read the other information contained in the summarised Financial Report and consider the implications for our report if we become aware of any apparent misstatement or inconsistencies with the summary financial statement. The other information comprises only the Review of Financial Performance.

FLETCHER & PARTNERS
Chartered Accountants and Statutory Auditors
Salisbury, 29 April 2022

Consolidated

# Statement of financial activities

| | General Fund £ | Designated Funds £ | Restricted Funds £ | Endowed Funds £ | **Total 2021 £** | Total 2020 £ |
|---|---|---|---|---|---|---|
| **INCOME AND ENDOWMENTS FROM:** | | | | | | |
| Donations and legacies | | | | | | |
| Members' subscriptions | 1,339,656 | - | - | - | **1,339,656** | 1,332,661 |
| Donations and legacies | 1,680,513 | - | 1,809,262 | - | **3,489,775** | 2,218,055 |
| | 3,020,169 | - | 1,809,262 | - | **4,829,431** | 3,550,716 |
| Charitable activities | - | - | 2,152,610 | - | **2,152,613** | 2,277,295 |
| *Other trading activities* | | | | | | |
| Fundraising events | 1,671,508 | - | - | - | **1,671,508** | 1,324,000 |
| Advisory Service | 244,700 | - | - | - | **244,700** | 145,628 |
| Trading income | 190,223 | - | - | - | **190,223** | 200,239 |
| Investment income | 11,791 | - | 55,823 | - | **67,614** | 62,108 |
| Other | 111,323 | - | 77,419 | - | **188,742** | 168,657 |
| **TOTAL** | 5,249,714 | - | 4,095,114 | - | **9,344,828** | 7,728,643 |
| **EXPENDITURE ON:** | | | | | | |
| *Raising funds* | | | | | | |
| Direct costs of fundraising events | 456,677 | - | - | - | **456,677** | 391,559 |
| Membership and marketing | 714,326 | - | - | - | **714,326** | 604,671 |
| Other fundraising costs | 1,233,349 | - | | 8,740 | **1,242,089** | 995,157 |
| | 2,404,352 | - | | 8,740 | **2,413,092** | 1,991,387 |
| *Charitable activities* | | | | | | |
| Research and conservation | | | | | | |
| Lowlands | 800,710 | - | 1,087,615 | - | **1,888,325** | 1,565,311 |
| Uplands | 121,819 | - | 378,565 | - | **500,384** | 647,590 |
| Demonstration | 222,761 | - | 1,169,984 | 4,150 | **1,396,895** | 1,339,131 |
| Fisheries | 210,580 | - | 442,950 | - | **653,530** | 599,272 |
| | 1,355,870 | - | 3,079,114 | 4,150 | **4,439,134** | 4,151,304 |
| Public education | 795,408 | - | 254,582 | - | **1,049,990** | 981,073 |
| | 2,151,278 | - | 3,333,696 | 4,150 | **5,489,124** | 5,132,377 |
| **TOTAL** | 4,555,630 | - | 3,333,696 | 12,890 | **7,902,216** | 7,123,764 |
| Income/(expenditure) before investment gains | 694,084 | - | 761,418 | (12,890) | **1,442,612** | 604,879 |
| Net gains/(losses) on investments: | | | | | | |
| Realised | 39,847 | - | | 65,616 | **105,463** | (70,340) |
| Unrealised | 164,206 | - | | 180,730 | **344,936** | 226,221 |
| **NET INCOME/(EXPENDITURE)** | 898,137 | - | 761,418 | 233,456 | **1,893,011** | 760,760 |
| **Transfers between funds** | (204,564) | - | 204,564 | - | **-** | - |
| **NET MOVEMENT IN FUNDS** | 693,573 | - | 965,982 | 233,456 | **1,893,011** | 760,760 |
| **RECONCILIATION OF FUNDS** | | | | | | |
| Total funds brought forward | 3,500,613 | - | 1,183,090 | 4,882,356 | **9,566,059** | 8,805,299 |
| **TOTAL FUNDS CARRIED FORWARD** | £4,194,186 | - | £2,149,072 | £5,115,812 | **£11,459,070** | £9,566,059 |

Consolidated

# Balance sheet

as at 31 December 2021

| | 2021 | | 2020 | |
|---|---|---|---|---|
| | £ | £ | £ | £ |
| FIXED ASSETS | | | | |
| Tangible assets | | 3,622,618 | | 3,615,810 |
| Investments | | 5,427,761 | | 3,078,851 |
| | | 9,050,379 | | 6,694,661 |
| CURRENT ASSETS | | | | |
| Stock | 426,954 | | 376,596 | |
| Debtors | 1,684,020 | | 1,337,808 | |
| Cash at bank and in hand | 1,659,815 | | 2,748,753 | |
| | 3,770,789 | | 4,463,157 | |
| CREDITORS: | | | | |
| Amounts falling due within one year | 1,044,661 | | 1,023,967 | |
| NET CURRENT ASSETS | | 2,726,128 | | 3,439,190 |
| TOTAL ASSETS LESS CURRENT LIABILITIES | | 11,776,507 | | 10,133,851 |
| CREDITORS: | | | | |
| Amounts falling due after more than one year | | 317,437 | | 567,792 |
| **NET ASSETS** | | £11,459,070 | | £9,566,059 |
| *Representing:* | | | | |
| CAPITAL FUNDS | | | | |
| Endowment funds | | 5,115,812 | | 4,882,356 |
| INCOME FUNDS | | | | |
| Restricted funds | | 2,149,072 | | 1,183,090 |
| Unrestricted funds: | | | | |
| Designated funds | - | | 8,045 | |
| Revaluation reserve | 327,222 | | 218,647 | |
| General fund | 3,832,585 | | 3,241,602 | |
| Non-charitable trading fund | 34,379 | | 32,319 | |
| | | 4,194,186 | | 3,500,613 |
| **TOTAL FUNDS** | | £11,459,070 | | £9,566,059 |

Approved by the Trustees on 26 April 2022 and signed on their behalf

J PAICE
*Chairman of the Trustees*

# Staff of the Game & Wildlife Conservation Trust in 2021

| | |
|---|---|
| CHIEF EXECUTIVE | Teresa Dent BSc, FRAgS, CBE |
| Personal Assistant | Laura Gell |
| Business Assistant | Liz Scott *(from June)* |
| Chief Finance Officer | Nick Sheeran BSc, ACMA, CGMA |
| Accountant | Leigh Goodger |
| Finance Senior | Hilary Clewer BA |
| Finance Assistant | Lindsey Chappé De Leonval |
| Accounts Assistant | *Wendy Ranger (June-July); Alan Gray (from October)* |
| Head of Administration & Personnel | Alastair King Chartered MCIPD, MAHRM |
| HR Administrator | Thomas Davis *(from November)* |
| Head Groundsman (p/t) | Craig Morris *(until June)* |
| Headquarters Site Maintenance | Steve Fish |
| Site Maintenance | Kevin Hill *(from September)* |
| Cleaner | Theresa Fish |
| Head of Information Technology | James Long BSc |
| IT Assistant | Dean Jervis HNC, BA |

| | |
|---|---|
| DIRECTOR OF RESEARCH | Andrew Hoodless BSc, PhD |
| Personal Assistant (p/t) | Lynn Field |
| Public Sector Fundraiser | Paul Stephens BApp.Sc |
| Public Sector Fundraiser Administrator | Ben Stephens MAAT |
| Head of Fisheries | Dylan Roberts BSc |
| Head of Fisheries – Research | Rasmus Lauridsen BSc, MSc, PhD |
| Senior Fisheries Scientist (p/t) | William Beaumont MIFM |
| Fisheries Scientist | Stephen Gregory BSc, MPhil, PhD *(until September)* |
| Fisheries Ecologist | Luke Scott |
| Project Scientist | Céline Artero BSc, MSc, PhD |
| Fisheries Project Officer | Will Beaumont BSc |
| Research Assistant | Thomas Lecointre |
| Wylye Grayling Project | Jessica Marsh BSc, MSc, PhD *(until June)* |
| Fisheries Communications Officer | Sarah Bayley-Slater *(from October)* |
| PhD Student *(University of Southampton)* - beavers and salmonids | Robert Needham BSc |
| PhD Student *(Queen Mary University of London)* - low flows on salmonids and river ecosystems | Jessica Picken BSc, MSc |
| PhD Student *(Bournemouth University)* - smolt migration and survival | Olivia Simmons BSc, MSc |
| PhD Student *(University of Exeter)* - adaption of trout to metal polluted rivers | Daniel Osmond BSc, MSc |
| Head of Lowland Gamebird Research | Rufus Sage BSc, MSc, PhD |
| Ecologist - Pheasants, Wildlife | Maureen Woodburn BSc, MSc, PhD |
| Ecologist - Gamebirds, Wildlife | Jenny Coomes BSc, MSc, PhD *(from August)* |
| Placement Student *(University of Leeds)* | Samuel McCready *(until August)* |
| Placement Student *(University of Sheffield)* | Joseph Werling *(from September)* |
| Head of Wetland Research | Andrew Hoodless BSc, PhD |
| Ecologist | Lizzie Grayshon BSc |
| Postdoctoral Scientist | Chris Heward BSc, PhD |
| Research Assistant | Jodie Case BSc *(until February)* |
| PhD student *(University College Cork)* - woodcock | James O'Neill BSc |
| PhD student *(University of Exeter)* - lapwing nest crypsis | George Hancock BSc, MSc |
| PhD student *(Bournemouth University)* - curlew | Elli Rivers BSc, MSc |
| PhD student *(Bournemouth University)* - lapwings and avian predators | Ryan Burrell BSc |
| Placement Student *(University of Exeter)* | Daisy Gillman *(until August)* |
| Placement Student *(University of Sheffield)* | Molly Brown *(from October)* |
| Head of Predation Control Studies | Jonathan Reynolds BSc, PhD *(until March)* |
| Senior Field Ecologist | Mike Short HND |
| Head of Farmland Ecology | Prof. John Holland BSc, MSc, PhD |
| Senior Entomologist | Steve Moreby BSc, MPhil |
| Senior Scientist | Niamh McHugh BSc, MSc, PhD |
| Postdoctoral Scientist | Lucy Capstick BSc, PhD |
| Research Assistant | Jodie Case BSc *(from February)* |
| Research Assistant | Holly Turner BSc, MSc *(from February)* |
| Research Assistant | Eleanor Ness BScs |
| PhD Student *(University of Sussex)* - solitary bees | Rachel Nichols BSc, MSc |
| PhD Student *(University of Edinburgh)* - biodiversity footprint of foods | Helen Waters BSc |
| Undergraduate student *(University of Southampton)* - woodcock vocals | Thomas Bristow BSc *(until September)* |
| Undergraduate student *(Swansea University)* - tree sparrow | Lucy Robertson BSc *(until September)* |
| Placement Student *(Plymouth University)* | Inca Johnson *(until August)* |
| Placement Student *(Durham University)* | Benjamin Prego *(until August)* |
| Placement Student *(Sheffield University)* | Ruby Woolard *(from September)* |
| Placement Student *(University of Sussex)* | Seshi Humphrey-Ackumey *(from September)* |
| Director of Upland Research | David Baines BSc, PhD |
| Office Manager, Uplands | Sarah Grondowski *(until August)* |
| Senior Scientist - Scottish Upland Research | Sonja Ludwig MSc, PhD *(until July)* |
| Senior Research Assistant - Scottish Upland Research | Kathy Fletcher BSc, MSc, PhD |
| Research Assistant | Michael Richardson BSc *(until February)* |
| Senior Scientist | Phil Warren BSc, PhD |
| Placement Student *(University of Leeds)* | Alexander Donovan *(until July)* |
| Research Assistant | Madeleine Benton BSc *(until June)* |
| Research Assistant | Georgia Isted *(from September)* |
| Placement Student *(Harper Adams University)* | Lucy Marsden *(from August)* |
| Senior Scientist | Sian Whitehead BSc, DPhil |
| Research Assistant | Liam Thompson *(from October)* |
| Placement Student *(University of York)* | Kimberley Holmes *(until July)* |
| Placement Student *(University of Reading)* | Bethany Tilley *(from August)* |
| Team Support Officer | Leah Cloonan *(from October)* |
| Head of Scottish Lowland Research | David Parish BSc, PhD |
| Research Assistant - GWSDF Auchnerran | Marlies Nicolai BSc |
| Research Assistant - Scottish Grey Partridge Recovery Project | Fiona Torrance BSc |
| MSc Student *(University of Stirling)* - farmland biodiversity | Ayse Terzioglu BSc |
| MSc Student *(University of Plymouth)* - invertebrate-rich habitats | Rory Quin BSc |
| Placement Student *(Queens University Belfast)* | Sophie McPeake *(until July)* |
| Placement Student *(Reading University)* | Tamara Spivey *(until August)* |
| Placement Student *(Plymouth University)* | Olivia Stubbington *(until July)* |

| | |
|---|---|
| Placement Student *(Leeds University)* | Elizabeth Fitzpatrick *(until August)* |
| Placement Student *(University of Bangor)* | Tanith Jones *(from September)* |
| Placement Student *(University of Exeter)* | Holly Owen *(from September)* |
| Placement Student *(Harper Adams University)* | Amy Cooke *(from September)* |
| Placement Student *(Reading University)* | Gemma Morgan *(from October)* |
| Placement Student *(University of Plymouth)* | *Jude Dinham-Price (September-November)* |

| DIRECTOR OF ADVISORY & EDUCATION | Roger Draycott HND, MSc, PhD[2] |
|---|---|
| Co-ordinator Advisory Services (p/t) | Lizzie Herring |
| Biodiversity Advisor – Farmland Ecology | Jessica Brooks BSc, MSc, ACIEEM |
| Trainee Advisor | Amber Lole BSc, MSc |
| Head of Education & regional advisor | Mike Swan BSc, PhD |
| Regional Advisor | Alex Keeble BSc *(from March)* |
| Game Manager (p/t) – Allerton Project | Matthew Coupe |
| Biodiversity Advisor – northern England (p/t) | Jennie Stafford BSc |
| Farmland Biodiversity Advisor | Megan Lock BSc, MCIEEM *(from June)* |

| DIRECTOR OF POLICY, PARLIAMENTARY AFFAIRS & THE ALLERTON PROJECT | Alastair Leake BSc, MBPR (Agric), PhD, FRAgS, FIAgrM, CEnv |
|---|---|
| Secretary (p/t) | Sarah Large |
| Policy Officer (England) (p/t) | Henrietta Appleton BA, MSc |
| Head of Research for the Allerton Project | Prof. Chris Stoate BA, PhD |
| Ecologist | John Szczur BSc |
| Soil Scientist (p/t) | Jennifer Bussell BSc, PhD |
| Research Assistant (p/t) | Gemma Fox |
| Welland Project Officer | Chris French |
| Welland Community Engagement Officer | Perry Burns *(until August);* Susan Perry *(from September)* |
| PhD student *(Leicester University)* - ecosystem services mapping | Max Rayner BSc |
| Head of Farming, Training & Partnerships | Philip Jarvis MSc *(until July);* Joe Stanley *(from June)* |
| Assistant Farm Manager | Oliver Carrick BSc |
| Farm Assistant | Michael Berg |

| DEPUTY DIRECTOR OF RESEARCH | Nicholas Aebischer Lic ès Sc Math, PhD, DSc |
|---|---|
| Librarian, National Gamebag Census Co-ordinator & Head of CRM | Corinne Duggins Lic ès Lettres |
| Senior Conservation Scientist & Head of PARTRIDGE | Francis Buner Dipl Biol, PhD |
| PARTRIDGE placement student *(Manchester Metropolitan University)* | Ellie Raynor *(until August)* |
| PARTRIDGE placement Student *(University of Leicester)* | Amelia Corvin-Czarnodolski *(from September)* |
| Head of Geographical Information Systems | Julie Ewald BS, MS, PhD |
| Partridge Count Scheme Co-ordinator | Neville Kingdon BSc |
| Biometrics/GIS Assistant | Cameron Hubbard BSc, MSc |
| Placement Student shared with Wetland *(Bangor University)* | George Scarisbrick *(until August)* |
| Placement Student shared with Wetland *(Bangor University)* | Rachel Cook *(until August)* |
| Computer Science Placement Student *(Aberystwyth University)* | Bradley Blyther *(from September)* |
| Placement Student *(University of Leicester)* | Amelia Corvin-Czarnodolski *(from September)* |
| Placement Student shared with Wetland *(University of Reading)* | Joshua Deakins *(from September)* |
| Placement Student shared with Wetland *(University of West of England)* | Kit Owen *(September-November)* |

| DIRECTOR OF FUNDRAISING | Jeremy Payne MA, MCIOF |
|---|---|
| Prospect Researcher | Tara Ghai |
| Events and Engagement Manager London | Vanessa Steel |
| Northern Regional Fundraiser (p/t) | Sophie Dingwall |
| Southern Regional Fundraiser | Max Kendry |
| Eastern Regional Fundraiser (p/t) | Lizzie Herring |
| Regional Organiser (p/t) | Gay Wilmot-Smith BSc |
| Regional Organiser (p/t) | Charlotte Meeson BSc |
| Regional Organiser (p/t) | David Thurgood |
| Regional Organiser (p/t) | Pippa Hackett |
| Regional Organiser (p/t) | Fleur Fillingham |
| Administration Assistant | Daniel O'Mahony |

| DIRECTOR OF COMMUNICATIONS, MARKETING & MEMBERSHIP | Andrew Gilruth BSc |
|---|---|
| Team Assistant | Helen Smith *(until July)*; Vivienne Tomlin *(from October)* |
| Membership & Shop Manager | Beverley Mansbridge |
| Membership Administrator | Heather Acors |
| Shop & Database Administrator | Emily Norris *(until July)*; Helen Pape *(from October);* Angela Alexander *(from December)* |
| Press & Publications Manager | James Swyer |
| Publications Officer (p/t) | Louise Shervington |
| Communications Officer | Katherine Williams |
| Graphic Designer | Chloe Stevens |
| Online Marketing Manager | Rob Beeson |
| Website Editor | Oliver Dean |
| Online Marketing Officer | Danny Sheppard |
| National Recruitment Manager | Les Fisher *(until April)* |
| Writer & Research Scientist (p/t) | Jen Brewin BSc, MSc, PhD |
| Science Writer | Emily Horrocks *(until April);* Amber Hopgood *(from July)* |
| Specialist Writer | Joe Dimbleby |

| DIRECTOR SCOTLAND | Bruce Russell BSc, MBE, DL *(until March)*, David Noble *(March-June)*, Rory Kennedy *(from June)* |
|---|---|
| Scottish HQ Administrator (p/t) | Irene Johnston BA *(until December)*; Beth Davies *(from December)* |
| Director of Policy (Scotland) (p/t) | Adam Smith BSc, MSc, DPhil *(until July)* |
| Head of Policy (Scotland) | Ross Macleod MA, MBA |
| Regional Organiser | Rory Donaldson |
| Senior Scottish Advisor & Scottish Game Fair Chairman | Hugo Straker NDA[1] |
| Advisor Scotland | Nick Hesford |
| Shepherd Manager GWSDF Auchnerran | Allan Wright |

| DIRECTOR WALES | Sue Evans |
|---|---|
| Curlew Country | Amanda Perkins |
| Advisor | Matthew Goodall BSc, MSc |
| Projects Officer | Lee Oliver |
| Communications & engagement officer | Emma Mellen BA, PgCert *(from April)* |
| Members' Liaison Officer | Wyn Rowlands *(September-December)* |

[1] *Hugo Straker is also Regional Advisor for Scotland and Ireland;* [2] *Roger Draycott is also Regional Advisor for eastern and northern England.*

# External committees with GWCT representation

*Sphagnum palustre*. © Sian Whitehead/GWCT

| | | |
|---|---|---|
| 1. | Advanced NFP OpenEngage User Group Executive | James Long |
| 2. | Agriculture and Rural Development Stakeholder Group | Ross Macleod |
| 3. | Aim to Sustain group (Wales) | Sue Evans |
| 4. | Animal Network Welfare Wales Group | Matt Goodall |
| 5. | Arun to Adur Farmer Cluster Steering Group | Julie Ewald |
| 6. | BASC Gamekeeping and Gameshooting | Mike Swan |
| 7. | BBC Rural Affairs Committee | Mike Short |
| 8. | BBC Scottish Rural and Agricultural Advisory Committee | Bruce Russell/ Rory Kennedy |
| 9. | BBSRC Agriculture and Food Security Strategy Advisory Panel | Phil Jarvis |
| 10. | Birds of Conservation Concern Steering Group | Nicholas Aebischer |
| 11. | British Ecological Society Scottish Policy Group | Adam Smith |
| 12. | British Game Alliance Advisory Group | Roger Draycott |
| 13. | Camlad Valley Project | Matt Goodall |
| 14. | Capercaillie Science Advisory Group | David Baines |
| 15. | CFE National Co-ordination group | Jess Brooks |
| 16. | CIC Head of Small Game Specialist Group | Francis Buner |
| 17. | CNPA Cairngorm Upland Advisory Group | Adam Smith |
| 18. | CNPA Nature Index Group | Ross Macleod |
| 19. | Code of Good Shooting Practice | Mike Swan |
| 20. | Cold Weather Wildfowling Suspensions | Mike Swan/Adam Smith/Matt Goodall |
| 21. | Cornish Red Squirrel Project | Nick Sotherton |
| 22. | Cors Caron Project | Matt Goodall |
| 23. | Curlew Recovery Partnership (England) Steering Group | Andrew Hoodless/ Teresa Dent |
| 24. | Gylfinir Cymru | Amanda Perkins/Sian Whitehead/Matt Goodall |
| 25. | Cynnal Coetir Sustainable Management Scheme Elwy Project | Lee Oliver/ Sue Evans |
| 26. | Deer Management Qualifications | Alex Keeble |
| 27. | Defra AIHTS Technical Working Group | Jonathan Reynolds |
| 28. | Defra Hen Harrier Action Plan Group | Adam Smith |
| 29. | Defra Upland Stakeholder Forum and Upland Management sub-group | Adam Smith/Teresa Dent/ Sian Whitehead |
| 30. | Dorset Beaver Trial | Dylan Roberts |
| 31. | EA Salmon Technical Group | Stephen Gregory |
| 32. | Echoes Project Advisory Board | Matt Goodall |
| 33. | Ecosystems and Land Use Stakeholder Engagement Group (Scotland) | Ross Macleod |
| 34. | Environmental Farmers Group | Teresa Dent |
| 35. | Environmental Land Management Stakeholder Group | Alastair Leake |
| 36. | European Sustainable Use Group | Nicholas Aebischer/ Julie Ewald (Chair) |
| 37. | Executive Board of Agricology | Alastair Leake |
| 38. | Farmer Cluster Steering Committees | Jess Brooks/Roger Draycott |
| 39. | Fellow of the National Centre for Statistical Ecology | Nicholas Aebischer |
| 40. | Fish Welfare Group | Dylan Roberts |
| 41. | Freshwater Fisheries Defra Meetings | Rasmus Lauridsen |
| 42. | Frome, Piddle & West Dorset Fisheries Association | Rasmus Lauridsen |
| 43. | FWAG (Administration) Ltd | Alastair Leake |
| 44. | Gamekeepers Welfare Trust | Mike Swan |
| 45. | Gelli Aur Slurry Project Steering Group | Sue Evans |
| 46. | Glamorgan Rivers Trust | Dylan Roberts |
| 47. | Greenhouse Gas Recovery Biochar Demonstrator Expert Advisory Group | Chris Stoate |
| 48. | Hampshire Avon Catchment Partnership | Andrew Hoodless |
| 49. | Hampshire Ornithological Society, Scientific Committee | Ryan Burrell |
| 50. | Honorary Scientific Advisory Panel of the Atlantic Salmon Trust | Rasmus Lauridsen |
| 51. | ICES Trout Working Group | Rasmus Lauridsen |
| 52. | ICES Working Group on North Atlantic Salmon | Stephen Gregory |
| 53. | International Association of Falconry Biodiversity Working Group | Julie Ewald/ Francis Buner |
| 54. | International Organisation for Biological and Integrated Control - WPRS Council | John Holland |
| 55. | International Wader Study Group, scientific panel | Ryan Burrell |
| 56. | Interreg PARTRIDGE Steering Group | Roger Draycott |
| 57. | IUCN Species Survival Commission Galliformes Specialist Group | Francis Buner/ Nicholas Aebischer |

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| 58. | IUCN Species Survival Commission Grouse Specialist Group | David Baines |
| 59. | IUCN Species Survival Commission Re-introduction Specialist Group | Francis Buner |
| 60. | IUCN Species Survival Commission Woodcock & Snipe Specialist Group | Andrew Hoodless/ Chris Heward |
| 61. | IUCN Sustainable Use and Livelihoods Specialist Group (SULI) | Nicholas Aebischer/ Julie Ewald |
| 62. | LEAF Policy and Communications Advisory Committee | Alastair Leake |
| 63. | Mammal Expert Group of the England Biodiversity Strategy | Jonathan Reynolds |
| 64. | Missing Salmon Alliance Steering Group | Teresa Dent/ Dylan Roberts |
| 65. | Missing Salmon Alliance Technical Group | Rasmus Lauridsen/ Dylan Roberts |
| 66. | Moorland Management Best Practice Steering Group | Adam Smith/ Ross Macleod |
| 67. | Mountain Hare Monitoring Group | Ross Macleod |
| 68. | National Trust for Scotland, Natural Heritage Advisory Group | Adam Smith |
| 69. | Natural England Hen Harrier Brood Management Project Board and Scientific Advisory Group | Adam Smith |
| 70. | Natural Resources Wales Fish Eating Birds Review Group | Dylan Roberts |
| 71. | Natural Resources Wales Fisheries Forum | Dylan Roberts |
| 72. | Natural Resources Wales Wild Bird Review - Stakeholder Meeting - Land Management and Shooting Sector Group | Matt Goodall/Sue Evans |
| 73. | NatureScot - Natural Capital External Advisory Group | Ross Macleod |
| 74. | New Forest Consultative Panel (Chair) | Andrew Gilruth |
| 75. | NFU East Midlands Combinable Crops Board | Phil Jarvis |
| 76. | NFU National Crops Board | Phil Jarvis |
| 77. | NFU National Environment Forum | Phil Jarvis |
| 78. | NGO Committee | Mike Swan |
| 79. | Northern Uplands Local Nature Partnership | Sian Whitehead |
| 80. | Oriental Bird Club Conservation manager for Pakistan and Northern India | Francis Buner |
| 81. | Perthshire Black Grouse Group | Kathy Fletcher |
| 82. | Pesticides Forum Indicators Group of the Chemicals Regulation Directorate | Julie Ewald |
| 83. | PHCI Fisheries Sub group | Stephen Gregory/ Dylan Roberts |
| 84. | Poole Harbour Agriculture Sub Group | Dylan Roberts |
| 85. | Poole Harbour Catchment Initiative | Stephen Gregory/ Will Beaumont |
| 86. | Purdey Awards | Mike Swan |
| 87. | RASE Awards Panel | Alastair Leake |
| 88. | Resilient Dairy Landscapes Stakeholder Advisory Group | Alastair Leake |
| 89. | River Deveron Fisheries Science | Dylan Roberts |
| 90. | River Otter Beaver Trial | Dylan Roberts/Mike Swan |
| 91. | Rural Environment & Land Management Group (Advisors) | Adam Smith/RossMacleod/ Bruce Russell/Rory Kennedy |
| 92. | Rutland Agricultural Society | Alastair Leake |
| 93. | Scotland's Moorland Forum and sub-groups | Adam Smith/Ross Macleod/Nick Hesford |
| 94. | Scottish Black Grouse BAP Group | Phil Warren/David Baines |
| 95. | Scottish Capercaillie Group | David Baines/Kathy Fletcher |
| 96. | Scottish Farmed Environment Forum | Ross Macleod |
| 97. | Scottish Government Technical Assessment Group (Snares and traps) | Hugo Straker |
| 98. | Scottish Land & Estates Moorland Working Group | Adam Smith |
| 99. | Scottish Moorland Groups | Adam Smith/Hugo Straker/Nick Hesford |
| 100. | Scottish Muirburn Code Review Group | Nick Hesford |
| 101. | Scottish PAW Executive, Raptor and Science sub-groups | Adam Smith |
| 102. | SGR Monitoring Group | Alastair Leake |
| 103. | Shoot Liaison Committee Wales | Matt Goodall/Sue Evans |
| 104. | SNH National Species Reintroduction Forum | Adam Smith |
| 105. | SNH South of Scotland Golden Eagle Reintroduction Project Scientific Steering Group | Adam Smith |
| 106. | South Coast White-tailed Eagle Reintroduction project steering group | Mike Short |
| 107. | South Downs Farmland Bird Initiative | Julie Ewald |
| 108. | South East England Pine Marten Working Group | Mike Short |
| 109. | Southern Curlew Forum | Andrew Hoodless/ Amanda Perkins |
| 110. | Sparsholt College Industry Liaison Group – Land & Wildlife | Mike Short |
| 111. | Species Survival Commission Galliformes Specialist Group | Francis Buner |
| 112. | Speyside Black Grouse Study Group | Kathy Fletcher |
| 113. | The Bracken Control Group | Alastair Leake |
| 114. | The CAAV Agriculture and Environment Group | Alastair Leake |
| 115. | The Curlew Country Board | Amanda Perkins/Sue Evans |
| 116. | UK & Ireland Curlew Action Group | Sian Whitehead |
| 117. | UK Avian Population Estimates Panel (JNCC-led) | Nicholas Aebischer |
| 118. | UK Upland Shoot Liaison Committee | Adam Smith |
| 119. | Uplands Management Group | Sian Whitehead |
| 120. | Voluntary Initiative National Steering Group | Alastair Leake |
| 121. | Voluntary Initiative Water sub-Group | Chris Stoate |
| 122. | Welland Resource Protection Group (Chair) | Chris Stoate |
| 123. | Welland Valley Partnership | Chris Stoate |
| 124. | Welsh Government Fox Snaring Advisory Group | Matt Goodall |
| 125. | Welsh Government Land use Stakeholder Group | Sue Evans |
| 126. | Wild Purbeck Group | Dylan Roberts |
| 127. | Wildlife Estates England Scientific Committee | Andrew Hoodless |
| 128. | Wildlife Estates England Steering Group | Roger Draycott |
| 129. | Wildlife Estates, European Scientific Committee | Alastair Leake |
| 130. | Wildlife Estates Scotland Board & Sub Groups | Adam Smith/Ross Macleod |
| 131. | Working for Waders | Adam Smith/Ross Macleod |
| 132. | World Pheasant Association Scientific Advisory Committee | David Baines |

*Key to abbreviations: AIHTS = Agreement on International Humane Trapping Standards; BAP = Biodiversity Action Plan; BASC = British Association for Shooting and Conservation; BBSRC = Biotechnology and Biological Sciences Research Council; CAAV = Central Association of Agricultural Valuers; CFE = Campaign for the Farmed Environment; CIC = International Council for Game and Wildlife Conservation; CNPA = Cairngorms National Park Authority; EA = Environment Agency; FWAG = Farming & Wildlife Advisory Groups; ICES = International Council for the Exploration of the Sea; IOBC-WPRS = International Organisation for Biological and Integrated Control of Noxious Animals and Plants-West Palearctic Regional Section; IUCN = International Union for Conservation of Nature, JNCC = Joint Nature Conservation Committee; LEAF = Linking Environment And Farming; NE = Natural England; NFU =National Farmers' Union; NGO = National Gamekeepers' Organisation; NIA = National Improvement Area; PAW = Partnership for Action Against Wildlife Crime; RASE = Royal Agricultural Society of England; SGR = Second Generation Rodenticide; SNH = Scottish Natural Heritage.*

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