Review of 2014

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

www.gwct.org.uk

Game & Wildlife CONSERVATION TRUST

Make sure you never miss the latest news and events by joining the Game & Wildlife Conservation Trust

As a member of the Trust you will not only be helping to fund the scientific research, you'll be the first to hear about it

What you receive when you become a member

- ✓ Exclusive access to dozens of unique courses and events taking place throughout the year.
- ✓ The chance to visit our pioneering Allerton Project Farm at Loddington for a guided tour.
- ✓ Free copies of Gamewise, our feature-packed magazine produced three times a year.
- ✓ Your own free personal copy of our annual *Review*.
- ✓ Participation in the exclusive members' prize draw raffles.
- ✓ An invitation to the GWCT's Scottish Game Fair at Scone Palace.
- ✓ Access to our luxurious members' area at the hugely popular CLA Game Fair.
- ✓ Regular email updates containing all our latest news and research findings.
- ✓ Membership of your local county group and invitations to events in your area.
- ✓ Pleasure from the knowledge that you're helping the British countryside thrive both now and in the future.

What our members say

"Belonging to an organisation that is so dedicated to preserving the countryside makes me proud to be doing my bit. The perks that come with it are just the icing on the cake."

"My GWCT membership is worth every penny. The Trust benefit from my contribution and I get to attend some fantastic events."

Three easy ways to join today

Phone 01425 652381
Online www.gwct.org.uk/join
Post GWCT, Burgate Manor, Fordingbridge, SP6 1EF

Game & Wildlife CONSERVATION TRUST

Review of 2014

Issue 46

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

Produced by: Game & Wildlife Conservation Trust
Fordingbridge, Hampshire, SP6 1EF
Tel: 01425 652381 Fax: 01425 655848
info@gwct.org.uk

Editing: Louise Shervington & James Swyer

Design and layout: Fellows Media

Photography: Pheasant by David Mason
The Game & Wildlife Conservation Trust wishes to thank the photographers who have contributed to this publication. Their details can be obtained from Louise Shervington.

Ref: FPUBGCT-ANR0615
ISSN 1758-1613

Printed on Elemental Chlorine Free (ECF) fibre sourced from well managed forests.

GAME & WILDLIFE CONSERVATION TRUST 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.

Council

As of 1 January 2015

Patron	HRH The Duke of Edinburgh KG KT OM GBE
Chairman of the Trustees	Ian Coghill
Vice-Chairmen of the Trustees	Hugh Oliver-Bellasis FRAgS, The Hon Philip Astor
Elected Trustees	Peter Harrison, James Duckworth-Chad, Kevin Bowes, The Marquess of Downshire, Christopher Rampton, David Mayhew, The Rt Hon James Paice MP, John Shields, David Flux, Andrew Salvesen DL, The Duke of Norfolk, Dick Bronks, Richard Benyon MP, Dr. Anthony Hamilton, Sir Max Hastings FRSL FRHist.S. DL, Jonathan Wildgoose
Ex-Officio Trustees	Elly Woolston, Ian Coghill, David Mayhew, The Hon Philip Astor
Advisory Members	John Batley, Anthony Sheppard, Fürst zu Oettingen-Spielberg, Allan Edwards, Timothy Rolfe, Jeffrey Handy, Alex Hogg

President and Vice-Presidents

President	The Most Hon the Marquess of Salisbury PC DL
Vice-Presidents	Henry Hoare, Robert Clarke MA, Baron van Tuyll van Serooskerken, Sir Rudolph Agnew, John Marchington FRICS, The Lord Barnard TD, Michael Stone, Colin Stroyan, The Duke of Westminster KG CB OBE TD CD DL, David Caldow, James Bowdidge BSc ARICS, Andrew Christie-Miller DL, Charles Connell, The Earl Peel GCVO DL, Mark Hudson, Ian Haddon, Robert Miller, Richard Wills

Chairmen of GWCT County Committees in 2014

Bedfordshire	Arthur Polhill
Berkshire	no chair (Ric Kipling)
Bristol & North Somerset	Jerry Barnes
Buckinghamshire	Jennifer Thomas
Cambridgeshire	Richard Pemberton
Cheshire	Anton Aspin
Cornwall	Gary Champion
Cumbria	Gapped
Derbyshire & South Yorkshire	Jonathan Wildgoose
Devon	Roger Cross (James Griffin)
Dorset	Oliver Chamberlain (Martyn Hobrough)
Essex	John Savage
Gloucestershire	Mike Goode
Hampshire	Henry Mountain
Herefordshire	James Spreckley
Hertfordshire	Hugo Richardson
Isle of Wight	Colin Boswell
Kent	Giles Brealy
Lancashire	Nicholas Mason
Leicestershire & Rutland	Thomas Cooper
Lincolnshire	William Price
London	Gapped
Norfolk	Sophia Key
North Wales	Richard Thomas
Northamptonshire	Richard Wright
Northumberland & County Durham	William Browne-Swinburne
Nottinghamshire	Richard G Thomas
Oxfordshire	Tom Windett
Shropshire	Timothy Main
Somerset	Patrick Rose
South-east Wales	Roger Thomas
South-west Wales	Gapped
Staffordshire	Gapped
Suffolk	Philip Bodie
Surrey	Stuart Walker
Sussex	Thomas Bodley Soctt
Warwickshire & West Midlands	Jonathan Bird
Wiltshire	Ian Bowler
Worcestershire	Mark Steele (Andrew Shirley-Priest)
East Yorkshire	Stephen Dales
North Yorkshire	Toby Milbank (D'Arcy Wyvill)
West Yorkshire	Charles Hare

Scotland

Fife Region	Douglas Williams
Grampian Region	Ali Loder
Highland Region	Chris Swift
Tayside Region	George Fleming
South-east Region	Michael Dalrymple

Names in brackets were chairmen that stepped down during 2014

Contents

Setting the agenda; leading the debate

by Ian Coghill, Chairman and Teresa Dent, Chief Executive

Teresa Dent outlines the Trust's aims during our Members' Conference at the Royal Geographical Society. © Jon Farmer

'What wildlife would you like to have on your farm?' is a question we and others in the GWCT have found ourselves asking regularly in the last year or so. We have been talking to groups of farmers who are interested in developing their own landscape-scale wildlife conservation projects. Eight groups have already started, all entirely voluntarily and all working to conservation plans that they have drawn up. We have been kindly supported by Natural England in trialling this new approach; well, it could be called a new approach or it could be simply recognising some basic facts.

First, that it is their farm, that they like wildlife and, that being so, of course they want more. Second, that working with neighbours expands the area over which they have influence, and allows them to join up habitat and find ways to expand their local population of butterflies, birds and pollinating insects. And that farmers prefer to come up with their own plans, and then seek help and advice to achieve them; it's the way they operate with every other aspect of their business. The UK is incredibly fortunate to have the wonderful wildlife charities that we have – we must be the envy of the world in that respect – but with so many people and projects saving wildlife, it can begin to feel to a farmer that this is someone else's job, not his. Not true, of course. 70% of our countryside is managed by farmers and other land managers, our wildlife reserves (wonderful places though they are) collectively fit within the M25, our National Parks and areas designated for nature are largely formed of privately owned land, and as Alastair Leake, who runs GWCT's own demonstration farm, said a year or two ago: 'every day I make four, five or six small decisions that affect the balance between food production and nature conservation'. It is those collective tiny brush strokes that create a masterpiece. In modern parlance it is called mindfulness. None of this replaces the need for agri-environment schemes; it is not the Exchequer's dream. Even the most mindful farmer is going to need compensation to take land out of production, but having done that mindfulness can transform whether that land makes a real difference for wildlife or not.

Landscape-scale conservation was strongly called for by Professor Sir John Lawton in his report in 2010. Defra and Natural England have picked up on that and on the success of the farmer-led Nature Improvement Area on the Marlborough Downs, and have introduced a landscape-scale collaborative element into the new Countryside Stewardship middle tier schemes, which will be open to applications in summer 2015.

All of these conservation groups have been borne out of the GWCT's Partridge Count Scheme, which in turn grew out of the GWCT being a membership organisation. It is just another example of how the support of our members and our relationship with

them is vital to the success of our work. Membership numbers increased to 20,580 in 2014 and we would like to welcome all those for whom this is their first Annual Review. This publication is the main way we communicate our scientific work to our members. For our wider communications, like everyone nowadays we rely more and more on social media alongside more traditional press and media.

A total of 11,507 people now receive the weekly GWCT email news updates. Staff posted a total of 423 website blog posts, allowing more people to follow the progress of our work as it evolves. Perhaps more importantly, social media also provides an instant way for members and supporters to contribute to the ongoing development of GWCT communication and wider policy work. So, for example, when Natural England began its consultation on the Open General Licence, members and supporters were able to help directly with the development of the GWCT response. As always, the expertise, energy and enthusiasm of our staff is our biggest asset, and the leadership and direction provided without reward by our committed trustees is hugely valued.

… and thank you to our generous supporters

Thank you to our fundraisers and supporters across the country. Fundraising is the lifeblood of every charity and we are incredibly grateful to every member, supporter and donor who has responded in 2014. Your generosity is wonderful and to you we extend our warmest thanks.

It is the long-standing support of passionate and dedicated individuals that makes much of our fundraising activity possible. Ten years ago, our North Yorkshire Committee started up again under the aegis of Nick Downshire, Nick Barnard and Nigel Graham with a strong supporting cast. Ten years on, the ever-expanding committee, with the two Nicks and Nigel in support, returned £74,000 to HQ, a cracking effort. Indeed the full sum from all Yorkshire was a few hundred short of £100,000 – bravo to all involved.

There were 35 shoot walks around the country, 50-100 attending each one, and we are hugely grateful to all the owners for permitting their land to be walked and talked over at length by Mike Swan. It is a fascinating way for those who don't shoot to hear how game management can benefit the bees, the birds and the butterflies.

Henry Pelham was presented with a picture by Ashley Boon by Ian Bowler, chairman of our Wiltshire branch, in gratitude for letting us use Thruxton go-karting free for 10 years in succession, thereby giving the Trust in the region of £70,000. We're very grateful to Henry and will be holding the event again this year.

Visits to the Allerton Project in Leicestershire are popular with our committees, particularly in May or June; last year we took parties totalling 150, including a valiant group of farmers from South Wales who enjoyed it greatly despite a 10-hour round trip. That's the key, of course: having a lot of fun raising this money which makes our research possible.

Ian Coghill debating at the CLA Game Fair.
© Jon Farmer

Claudia Beamish, Shadow Minister for Environment, Climate Change and Land Reform (second from the right), visiting Langholm Moor.
© Adam Smith/GWCT

Policy review 2014

by Adam Smith, Director Scotland, and Alastair Leake, Director of Policy

Engaging with policymakers in Scotland

Exactly how 'bonnie' Scotland's countryside and wildlife would appear in the future was rather absent as part of the Scottish independence referendum debate in 2014. Conservation was not a topic during this most dominant of policy issues, but the debate of course impacted on conservation policy. The most unfortunate effect was the stifling of political decision-making, just one example of which was the delay over clarifying the status of illegally released beavers in Scotland. The debate did draw out that there are different policy issues across the UK regions. Wildlife crime, carbon storage, productive farming through CAP reform, and forestry through woodland expansion were the main topics in play in Scottish conservation policy. Top this heady mix with the social justice issues explicit and implicit in land reform and community engagement agendas and one might think it was a challenging year.

We are engaged with policymakers on most of these issues; we sit on 27 (not counting all subgroups) public sector committees in Scotland alone. We submitted consultation responses on a variety of topics throughout the year, including the proposed extension of powers to the SSPCA and the SNH draft Peatland Plan for Scotland. We highlighted alternative approaches to conservation, challenging proposed strategies that left little room for nature and promoting the need to actively manage the countryside. We made it clear that there are approaches that can deliver practical and effective conservation alongside more peat, more barley and more conifers.

We had a strong positive input into how the greening of farming and agri-environment schemes will be delivered through the Scottish Rural Development Programme. Using our farmer focus groups, we gave Scottish Government confidence in the applicability and acceptability of a number of conservation measures. Our input ensures that game crops can be planted on fallow land to enhance it and that a full suite of options proven and used by game conservationists were included in agri-environment.

Independently of England, we are delighted that predator control remains an option. The impacts of predators that cannot be legally controlled occupied policy interest through the issue of wildlife crime. Our focus is describing the challenge and testing solutions as we have been doing through the Langholm Moor Demonstration Project, which completed its seven-year review (**www.gwct.org.uk/langholm**). But elsewhere the reality was that the focus was unremittingly on legal remedies such as Vicarious Liability, restrictions to the General Licences and catching criminals – not about understanding and reducing the need for conflict.

Joint Hen Harrier Recovery Plan

There were signs of a subtly different debate in the English uplands. After being developed by a group of bodies including GWCT for three years the existence of the Joint Hen Harrier Recovery Plan became public knowledge. Though not yet adopted as public policy, our public relations helped the media, police and many others understand the concepts behind it (**www.gwct.org.uk/grouseguide**). Such forward thinking approaches are vital if we are to retain the best of what game conservation offers our country's upland areas. We summarised this view in a document prepared for the party conference season in October and through our joint position statement with Scottish Natural Heritage on the management of mountain hares in Scotland.

Informing environmental policies

However, if the uplands and north lacked a certain sunlit quality, the English lowlands were positively glowing. Following a visit to our Allerton Project by the then Secretary of State for the Environment, the Rt Hon Owen Patterson, we were invited to brief Defra officials about the effect of predation on biodiversity. We have presented the key results of our work on Salisbury Plain, Allerton, Royston, Otterburn and the Avon Valley and look forward to further discussions as to how our findings might be integrated into environmental policies. This should be helped by our recently awarded membership of the Natural England Terrestrial Biodiversity Group.

Terrestrial biodiversity, water quality, soil protection and climate change mitigation are all now objectives to be supported under the Common Agricultural Policy (CAP). The EU Commission's proposals for reform of the CAP included measures to introduce higher environmental standards attached to the payments made to farmers. Whilst politically it is attractive to be able to tell EU citizens that subsidy payments have such conditions attached to them, it's important that these measures do not undermine agricultural productivity and really deliver benefits to the environment.

As in Scotland, we have been much involved in the discussions surrounding the development of the three-crop rule (the requirement for farmers to grow at least three crop types in any one year), permanent pasture land and the options available for the 5% of land which is managed for "ecological benefit", and whilst imperfections exist, we have made good progress with most aspects. Particularly pleasing is the inclusion of legumes and cover crops as options deemed to be "ecological", but in contrast the three-crop rule is very likely to fail to achieve any benefits.

If the three-crop rule is unlikely to achieve its objectives, it means that our work to develop the new Countryside Stewardship Scheme becomes more critical. With less funding available, it is important that we get the most out of each agreement. We know that where farmers get good advice when putting together their applications, these applications tend to be better. We continue to press for advice to be included in the new scheme.

Wildlife Licences

We assembled a robust response to the proposed changes to the Wildlife Licences laws put forward by Natural England. Having drafted an initial response, we put this out to our members for their comments. This proved to be a valuable exercise, as many responded with their own experiences of dealing with licensing, and we were able to weave these into our response. Hard evidence and first-hand experience provide us with powerful evidence when dealing with people trying to interpret laws from their offices.

We faced a similar situation when Sir John Randall moved to bring a bill before the House of Commons to establish a closed season for brown hares. Whilst on the face of it this appears laudable, the existing law, which limits the sale of hares during the breeding season, offers the population a high level of protection. If you remove the ability of a farmer to cull individual hares grazing off precision-drilled vegetable or sugar beet crops then there is a real danger that they will legally cull the population down hard during the open season to lessen the likelihood of a conflict later. We were able to show Sir John our extensive work on hares, particularly showing how predation can be the major impact on the population. Not only did Sir John withdraw his bill, but he came and spoke at our Members' Conference emphasising the importance of good science in informing good decisions.

The GWCT Beaver Tea held at the Scottish Game Fair provided the ideal forum to discuss Scotland's beaver population.

Our Making the most of Moorland report informed politicians about the issues facing the uplands as we approach the general election.

© Laurie Campbell

Hen harriers and red grouse conflict – an historical perspective

Teresa Dent, Chief Executive, and Adam Smith, Director Scotland

The GWCT has been working on solving the conflict between raptor conservation and grouse moor management for thirty years. Our first meeting with the then Minister for Agriculture, Fisheries and Food, John Selwyn Gummer, was in about 1984. He was keen to find a solution, but said that he would need evidence of impact before management or policy decisions could be made.

The result was the Joint Raptor Study (JRS), which was hosted mainly by Langholm Moor in Dumfriesshire from 1992 to 1996. The results were conclusive: harrier numbers went from 2 to 20 nesting pairs; the rise was rapid and exacerbated by the harrier's semi-colonial and philopatric nesting behaviour, grouse numbers crashed and driven shooting was rendered unviable. Subsequently, gamekeepers were withdrawn, ending habitat and predator management. Within a few years hen harrier numbers fell back and wader numbers plummeted. Sheep grazing income became more important but led to heather habitat shrinking by 25% under grazing pressure. The local economy and the capital value of the moor both suffered. The JRS confirmed that harriers can benefit from grouse moor management in terms of habitat, food supply and protection from predators, but it left gamekeepers convinced that large numbers of hen harriers on grouse moors were to be avoided.

Initially the study suffered from differing interpretations, but in 2004 the GWCT and RSPB jointly published a review of what the study meant, and this made a critical contribution to progress. The GWCT was convinced that the goal should be to move the concerned gamekeeper and moor owner audiences, and English Nature as the statutory body involved, to consider management solutions, namely diversionary feeding and some sort of harrier quota scheme.

The review gave Natural England (NE) and Scottish Natural Heritage (SNH) an agreed interpretation of the evidence. Both agencies saw that a management solution could lead to crime prevention, thus improving harrier conservation; but each agency adopted a different approach to move forward.

NE started a stakeholder consultation process. This concluded that non-lethal direct management of some harrier broods was part of the way forward. It could reduce predation pressure on grouse and increase the confidence of moor owners that they could manage the risk of allowing harriers to settle and breed. Despite this positive conflict resolution process, backed by research, a complete stakeholder consensus could not be reached.

Defra's response to this stalemate was to set up a sub-group of the Upland Stakeholder Forum, which in less than two years came up with the Joint Hen Harrier Recovery Plan. This includes crime prevention, increased monitoring of harrier

movements, diversionary feeding, and consideration of reintroducing harriers across suitable habitat in England. It also includes a trial of the temporary movement of hen harrier young to aviaries (called 'brood management').

The Plan has not been implemented as some bodies maintain that forty pairs of harriers must be breeding before the brood management trial is allowed to start. This betrays a misunderstanding of a key aspect of the problem – overcoming the harriers' semi-colonial nesting behaviour, which could result in the forty hen harriers nesting on a very few moors. Such a repeat of the JRS is exactly what we are trying to avoid.

At the time of writing, it seems unlikely that Defra will launch the Joint Recovery Plan in time for a brood management scheme to be trialled in spring 2015. While disappointing for harrier and grouse conservation, we have still made enormous progress. Moor owners and gamekeepers are signed up to the Recovery Plan; it could produce more hen harriers, alongside the continuation of driven grouse shooting, which will underpin the management that provides the harriers with the habitat they need. If Defra is happy to push the button, we are good to go.

In the meantime, Scottish Natural Heritage resolved to go back to Langholm Moor to try to demonstrate a solution to the conflict in practice. The resulting Langholm Moor Demonstration Project (LMDP) was launched in autumn 2007, with gamekeeping restarting in spring 2008, and diversionary feeding of all harrier nests. Again it was a partnership project with Buccleuch Estates, Scottish Natural Heritage and the GWCT, joined by the RSPB and Natural England. Those involved with the project would be the first to admit that it has taught them a great deal about the reality of both grouse moor management and raptor/red grouse conflict. The LMDP reported its interim results in December 2014 set against six criteria for success. Three criteria have been achieved: heather habitat is improved, harrier numbers have met the SPA target, and 'outreach' has been good with a constant stream of visitors from conservation, grouse shooting and political circles. Indeed, Langholm Moor is supporting a whole suite of raptors: it has buzzards, goshawks, peregrines, merlins, ravens and short-eared owls. A fourth criterion is that other moorland birds should increase: that is a partial success, with black grouse increasing but the wading bird response being less clear.

The fifth criterion – a bag of a thousand brace of driven grouse shot in one year – has not been achieved. Red grouse numbers increased initially but recently this response has slowed and no shooting has taken place. The biggest factor limiting grouse recovery is now predation and the evidence shows that despite the success of diversionary feeding at low harrier numbers 78% of grouse found dead have been killed by raptors. Field signs on dead grouse can tell us that, though not which raptors killed them. Population modelling suggests that the targets for sustainable shoot economics cannot be met without some sort of adaptive management being put in place to improve grouse numbers. So the last criterion – a balance between raptor interests and driven grouse shooting – is still to be reached.

The challenge for all of us now is to find solutions and consider adaptive management options for the future. Reconciling raptor conservation with economically viable driven grouse shooting that maintains investment in our moorlands remains the common objective. That is the agreed end; now we have to agree means. If the GWCT were to offer a silent prayer, it would be to ask all of those involved to focus on the ends and be pragmatic about the means.

The Joint Hen Harrier Recovery Plan includes crime prevention, increased monitoring of harrier movements, diversionary feeding and consideration of reintroducing harriers across suitable habitat in England. © Laurie Campbell

Explaining the results of our applied science to practitioners. © Roger Draycott/GWCT

Shaping the future of conservation

by Roger Draycott,
Head of Advisory Services

The Advisory team plays an important role in disseminating our applied practical research to the managers of the countryside. We also strive to inform and educate the next generation of land managers through our tertiary education and training programmes.

The ways we engage with people working in the countryside are diverse – it can take the form of formal one-to-one visits to advise on specific game and wildlife issues on a farm or estate. Or, it could be on shoot walks where GWCT members and non-members are able to spend an enjoyable couple of hours on a summer's evening learning about the latest GWCT research within the context of a real farm shoot. In 2014, advisors were able to help communicate the work of the GWCT at around 100 events throughout Britain on broad-ranging subjects including woodcock migration patterns, best-practice predation control techniques, sustainable management of released pheasants, grouse diseases, encouraging farmland pollinators, CAP reform, grey partridge conservation and the GWCT shoot biodiversity assessment service. These events give farmers, gamekeepers and other practitioners the specialist advice and confidence required to make the right decisions every day.

The GWCT has always sought to undertake relevant and practical research of real value to our members. A great example of this is our work on quantifying the impacts of pheasant releasing on wildlife and habitats. This research led to our guidelines on sustainable pheasant releasing. These guidelines help ensure that the environmental impacts of releasing pheasants and the management associated with it will have an overall net positive effect on the woodlands and surrounding habitats. Some conservationists are sceptical of the environmental credentials of large-scale pheasant releases. Our research provides the science base for our Shoot Biodiversity Assessment service, which helps provide an informed opinion and practical advice for pheasant shoots. In 2014 we undertook Shoot Biodiversity Assessments on 20 pheasant shoots and we worked with Marks & Spencer and its suppliers to help develop its Code of Practice for game production.

Understanding the impact of predation on game and wildlife and developing efficient and humane methods of predation control are areas where the GWCT has a vast amount of experience and expertise. The Advisory Service plays an important role in promoting and demonstrating these control techniques to game interests and the wider land management sector. In 2014 we were delighted to welcome Austin Weldon to the Advisory team. Austin had worked previously for the Trust in both the pheasant and

predation control research teams. He has a wealth of knowledge in these areas and will be a great asset to the Trust.

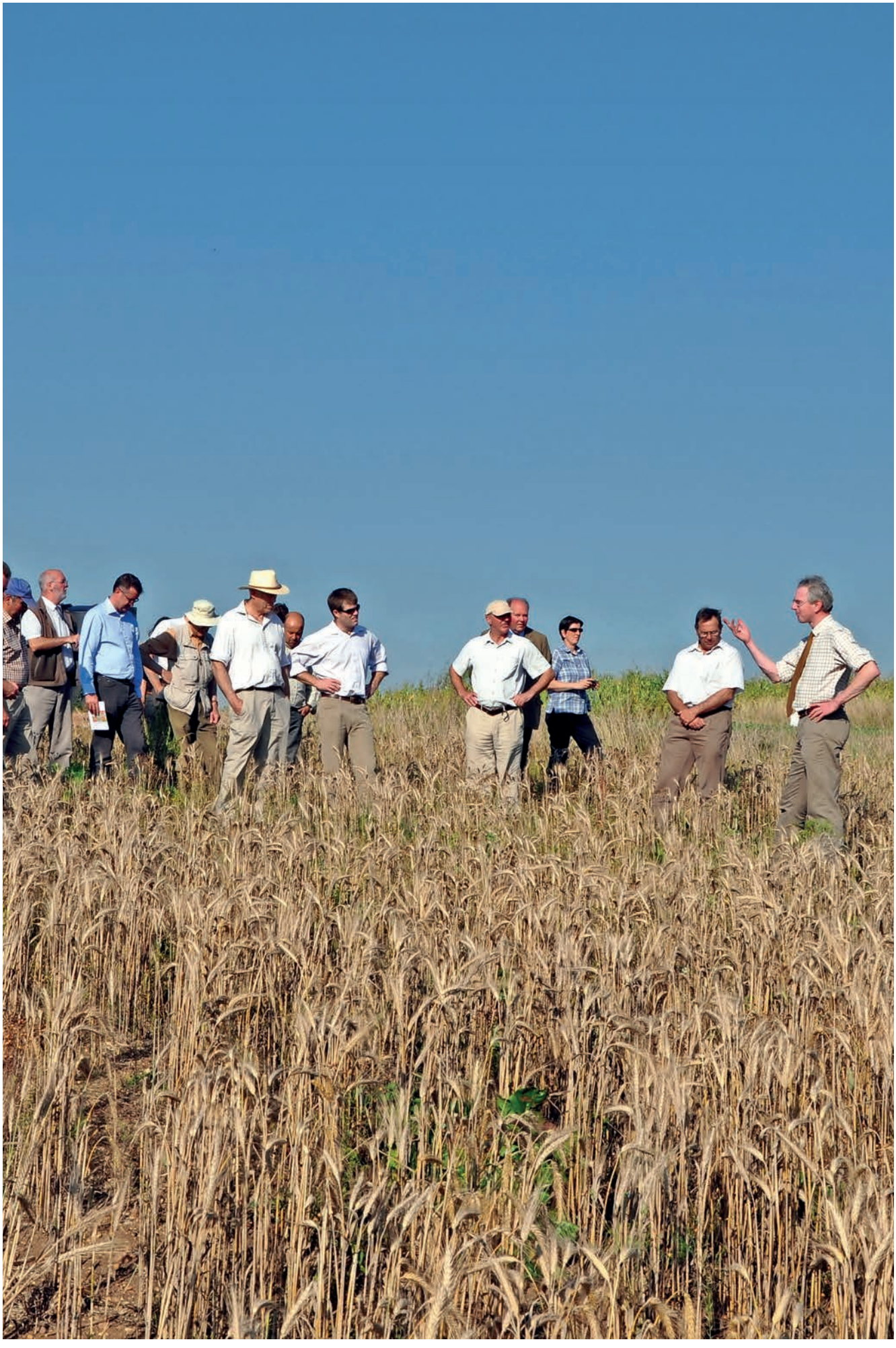
Over the last 18 months, there has been much debate about CAP greening and the development of the new Countryside Stewardship Scheme. The GWCT was involved in these discussions at policy level but also by ensuring that practitioners were up to speed with changes and by providing advice on how the changes can be managed in ways to provide maximum benefit for game and wildlife. One of the best conduits for this advice is through our national network of grey partridge conservation groups. These fora enable us to engage with conservation-minded farmers to help them provide the best possible habitat and management for grey partridges and other farmland birds. We have 12 of these groups across England and Scotland, and they are a fantastic demonstration of how farmer-led conservation can lead to wildlife recovery on the ground. We are always encouraging more farms to get involved with the Partridge Count Scheme (see page 26 for further details).

One of the great successes of 2014 was our work with farmers through our 'Farmer Clusters' project. This initiative aims to get farmers working together at the landscape level to bring about wildlife recovery. We have now helped farmers set up eight of these clusters across England. The GWCT's approach of working alongside farmers at a "bottom-up" level, discovering what their needs, problems and views were and then discussing how these issues might be solved, has proved highly effective. Farmers in the past had usually been approached with a rather top-down "ask", stating what they should be doing, and they told us that they found this "bottom-up" approach refreshing and much more helpful in creating change. This new approach to farmland conservation has been welcomed by Natural England and will be an integral component of the new Countryside Stewardship Scheme. The GWCT aims to continue to provide a leading role in this initiative by helping to facilitate more farmer clusters across the country.

As a charitable organisation, education is one of our key objects. However, with limited resources, we direct the majority of our educational activities where we believe it will have the most impact – which is the tertiary sector. In 2014 we lectured at over 30 universities and colleges. We undertake lectures each year to students on many of the postgraduate courses in wildlife management and environmental conservation. The young people on these courses will be some of the next generation of conservation officers and policy makers.

We need people like this to have a good understanding of wildlife management so that, in time, we get good policy. Vocational training at many of the countryside colleges is also vital, so we can engage with the next generation of gamekeepers, farmers and land agents, who will be responsible for looking after hundreds of thousands of acres of rural Britain in the future and can make their own contribution to game and wildlife conservation.

Austin Weldon discussing the importance of humane and efficient predation control. © Roger Draycott/GWCT



Science with boots on – the value of GWCT demonstration farms

by Nick Sotherton, Director of Research

Members of the Trust and followers of our work will be aware of the tremendous success we have wrung from our Allerton Project demonstration farm at Loddington, which recently celebrated its 21st birthday. But why does the Trust, a research and education charity, staffed primarily by scientists and spending most of its income on research, feel the need to manage land, grow crops and raise livestock?

In research terms, our hallmark studies are very "applied"; by that we mean research is undertaken to solve a particular issue (for example why grey partridges are in decline) rather than research that adds to our knowledge of grey partridges. Our research leads to measurable outputs (more partridges) and to do that, it has also to be practical, workable and cost-effective. We always like to ground-truth our research on commercially managed land, away from the experimental trial plot, to make sure our ideals are effective on working farms. GWCT scientists come in boots, waterproofs and 4WDs, not white lab coats. But working on other people's farms has its limitations.

We are always humbled by the invitations to "come and work on my farm". We have an embarrassing array of invitations that are overwhelmingly supportive and generous. And we always feel that we disappoint because my honest response to such offers is "thank you, but we need funding for our scientists to do the work more than we need places to work".

Also, on other people's land, we tend not to test ideas that may seem extreme or radical. If they fail and we cause crop losses, then we have to rely on the altruistic goodwill of our hosts, or have deep pockets ourselves. With our own farm or land under our management, we can push the boundaries and can put in place the total game/wildlife management package together in one place at the same time. Our first demonstration of the grey partridge management prescription, involving the three key elements of providing nesting habitat and brood cover; winter feed; and seasonal, selective, legal predator control took place on the chalk soils near Royston. Starting with a spring pair density of less than three pairs per km^2, we got to over 18 pairs in five years. On adjacent, less intensively managed land, there was only a slight increase. Many other estates have followed this model and the success in Sussex is reported on pages 32 to 35.

As well as grounding our science, demonstration farms have an important role to play in helping us achieve our policy objectives: getting the science in front of policy makers, their advisors, and key players in the media.

As soon as the Allerton Project was reversing declines in farmland birds, wild gamebirds and brown hares, we organised a Ministerial visit. This was at the time that the latest round of CAP reform was making it necessary to devise the agri-environment measures and formulate what in England became ELS and HLS. That afternoon, in 2002, we showed Sir Don Curry around the Allerton Project and he saw what a 'broad and shallow' environment scheme could look like.

The production of terse dry science in the peer-reviewed journals is a vital part of our work but this is not what works best to convince policy makers – show them round a commercial, working farm with abundant wildlife and our message is successfully delivered.

The final success of our demonstration farms has been in delivering our educational remit. With our new visitor centre, we now show round Loddington over 3,000 visitors a year as well as the small groups of key movers and shakers. The majority of our guests are farmers and they, like everyone, find the written science indigestible, but show them round a farm, with our keeper and farm manager available to take questions, and the message gets delivered. I defy any visitor to Loddington not to be able to take on one message, one they take back to the home farm to instigate. The place buzzes with innovation.

The Trust and its predecessors have been involved in demonstration farms since the basic grey partridge work on West Park, Damerham, close to Fordingbridge in the 1950s through to our latest demonstration of grey partridge restoration and game management at Rotherfield Park near Alton in Hampshire. Here, starting with an extinct population, our release of grey partridges has been a success and the population is restored. We aim to hold many events at Rotherfield Park in the future, courtesy of Sir James Scott and his family – do please come along.

GWCT Research – Looking to the past, planning for the future

Radiotracking red grouse. © GWCT

by Nick Sotherton Director of Research

The research done by the GWCT is not unique but it is special nonetheless. Research work comes in many guises from the very pure, blue-sky inventive type that identifies new particles at a subatomic level to the very applied type of research that tells us why grey partridges are in decline, and most importantly, how to turn decline into increase. The GWCT's research is mostly of the applied kind, the kind that solves problems, but we have also been known to reveal some of the fundamental aspects of the biology of the species we study. For example, we wrote the identification keys that allow scientists to distinguish between the species of sawfly larvae that grey partridge chicks eat.

Other practical, research-based solutions to problems faced by wildlife that have come out of the GWCT stable have included mink rafts, insect-rich conservation headlands, medicated grit, beetle banks and Larsen traps (invented by the Danes but developed in the UK by our Predation Control Studies research team). And, watch this space, there is much more to come! But despite this success, getting the work funded, particularly by the public sector, has been and remains a struggle.

Government-funded research by the Research Councils has tended to concentrate on funding the more pure research that establishes fundamental facts. Our problem-solving approach, to apply our research to solve difficult issues, rarely finds favour. Today, things might be changing as the need to have research produce tangible benefits begins to swing our way. Public-funded research now has to have 'impact'. We can but hope.

Traditionally, some government thinking regarded applied research as "something the market would pay for". Previous administrations closed many government-funded research institutes in the belief that the market would fund such research. It didn't and we saw institutes carrying out applied research, such as the Weed Research Organisation, Long Ashton Research Station and the Institute for Terrestrial Ecology Research Stations (now Centres of Ecology and Hydrology), close. Research cuts are not new but they do question the kind of research work government can support from the public purse, the kind conducted by the GWCT.

Research takes time and things can change in timespans measured in generations. In the early 1970s, when we first suspected that herbicides in cereal crops were not only killing weeds as intended but also removing the host plants of the insects eaten by young grey partridge chicks, Dr Dick Potts, my eminent predecessor, stood up at an international pesticide conference in front of thousands of delegates to tell them this. He hypothesised that the indirect effect of pesticides was the cause of the grey partridge decline and he barely escaped the room in one piece. In 2000, 40 years later, the host organisation of that conference gave Dick's successor their research medal for the Trust's work identifying the problems caused by pesticides and coming up with mitigation measures to lessen these impacts. Things

GWCT Mink Raft (pictured bottom right). In the early 1980s, when American mink had escaped from fur farms and successfully spread across nearly all of the country, there was much debate about the likely impact. Mink are an occasional menace in pheasant release pens, but their impact on other wildlife species – notably water voles – has caused great concern. The GWCT Mink Raft was conceived in 2001 and first tested in 2002. The raft encourages mink to leave evidence of their presence in the form of footprints on the raft, establishing the best place to set a trap. This means you are only trapping where you have evidence of mink. The raft can change from monitoring mode to trapping mode and mink are usually trapped within the week. Through a series of practical trials, we established that one raft per kilometre of river gives you multiple opportunities to detect each mink and that a single raft left for two weeks within the range of a mink has a 50% chance of detecting that mink. In a series of studies up to 2010, we demonstrated how it was possible to eliminate mink and reintroduce water voles on a 421km^2 catchment of the river Monnow on the Welsh Borders.

Conservation Headlands (pictured bottom left). In the 1980s, we ran a series of trials asking farmers to reduce the sprays along the six-metre crop margin (the headland) of some of their cereal crops.

The results were astonishing: annual arable wild flowers that had been lost for a generation reappeared, insect abundance increased and consequently partridge chick survival rates increased, sometimes to levels last seen in pre-war days.

Conservation headlands encourage the growth of a number of broad-leaved weed species and the abundance of insects which live on them, providing a vital source of food for gamebird chicks and other birds including linnet, bullfinch and corn bunting.

In addition, the weeds and their seeds provide food for small mammals and the flowers are important nectar sources for butterflies.

Conservation headlands also act as a refuge for rare and declining plants, once common members of the arable flora, and for many species of beneficial insects.

Beetle Banks

Developed by the Trust in the 1980s, beetle banks are grassy ridges which run across the middle of large arable fields and can provide shelter for a wealth of predatory insects and spiders which, in turn, naturally reduce pest numbers. Easy to establish and positioned to not disrupt normal farm management, they act as refuges where predators can overwinter and from where they can spread across the adjacent crops in spring. The numbers of insects and spiders which inhabit such ridges can even exceed those in traditional/existing field boundaries. Beetle banks also provide habitat for ground-nesting birds and small mammals, such as corn bunting and skylark.

do change, science can prevail, but it does take time. Our work in the 1980s was based on our continuous annual monitoring of insects and weeds in Sussex cereal fields for over 15 years.

Today, that farmland database is in its 45th consecutive year and is giving us insights into climate change and the impacts of neonicotinoid insecticides. Its strengths are in its long-term nature and the consistent way in which the information is gathered. Who in the public sector can afford to mount and fund such continuous monitoring? The trend towards publicly funded research in three-year work packages continues, so who will fund the Sussex Study or the Grey Partridge or Red Grouse Count Schemes of the future? Accurately knowing what is going on (or going wrong) has to be the starting point before attempting to put it right.

Private sector funding, through a membership organisation like the GWCT and with a hard-working funding team, is a precarious business but it is the support of our members, sponsors, funders and readers of this Review that makes it happen and provides us with the resource to do what we do.

Conservation headlands can house vital food for game and farmland birds; Francis Buner handling a grey partridge; Dick Potts collecting insect samples in Sussex; Setting a mink raft.
© GWCT

Pheasant chick perching and survival

Giving pheasant chicks early access to perches improves their tendency to roost off the ground when they go to wood. © GWCT

BACKGROUND

Up to 25% of released pheasants die of natural causes within the first year of release. The highest cause of mortality is predation, particularly by foxes. For pheasants, a common anti-predation behaviour is roosting at night. However, birds upon release often exhibit poor roosting behaviour. This is probably a function of the barren environment that the pheasants experience prior to release, which does not allow the appropriate behavioural and physiological developments to be made that are required to cope in the wild. We want to provide a system that would allow such developments associated with roosting to better enable the bird to avoid predators after release.

A common anti-predation behaviour for ground-dwelling birds is the use of roosts off the ground at night. Poor roosting behaviour is suggested to be one of the reasons why hand-reared pheasants suffer from high predation immediately after release. At around three weeks old, in the wild a mother pheasant will use contact calls to encourage her chicks to follow her to roost off the ground, initially utilising small and low perches. Pheasant chicks bred for shooting are usually artificially reared in a motherless and unstimulated system of heated huts and outdoor pens before releasing into the wild. Mark Whiteside, a PhD student at the Centre for Research in Animal Behaviour at the University of Exeter, investigated whether the provision of perches during the early development of pheasant chicks affected their behaviour and physiology. This study continues our research looking at ways of improving the quality of released pheasants, to enable them to survive and thrive following release, and if unshot, to contribute to a breeding population the following spring. Some early results are presented below.

Nine hundred one-day-old pheasants, hatched in May 2013, were marked with wing tags and randomly allocated to one of two treatments differing only in the provision of perches: (1) with perches; (2) without perches. Chicks were housed in groups of 30 in a heated house (130 x 130 cm) for the first two weeks. For the next five weeks they also had access to an open grass run (130 x 680 cm), half with perches and half without. Following these two treatments the birds were mixed and placed into one of two release pens. The work was undertaken at the Middleton Estate in Hampshire.

For the first six weeks after release, Mark monitored the birds by sitting in the release pen at night using night-vision equipment to record the number of birds roosting, identifying them and the perching treatment they came from by their wingtags. In the first two weeks after release, around 70% of the birds roosting had been reared with access to perches (see Figure 1). Six weeks later the effect of the treatment had disappeared and birds roosted equally regardless of rearing condition. The first couple of months post-release are critical for the survival of the birds, with sometimes 25% or more being predated during this time, so any advantage to birds in early use of perches will likely improve their survival during this period. Using perches for roosting is not simply a matter of experience; birds also need the physiological mechanisms to 1) fly to a higher and safer perch, and 2) have the balance skills to roost overnight on sometimes small branches in windy conditions. Birds reared with early access to perches were heavier and had thicker tarsal bones on the day of release. Before release, such pheasants would fly up to perches, then perform balancing behaviour such as wing-flapping and leg muscle contraction; these promote muscle development, bone mineralisation and bone strengthening. All these are physiological characteristics to aid prolonged roosting on high

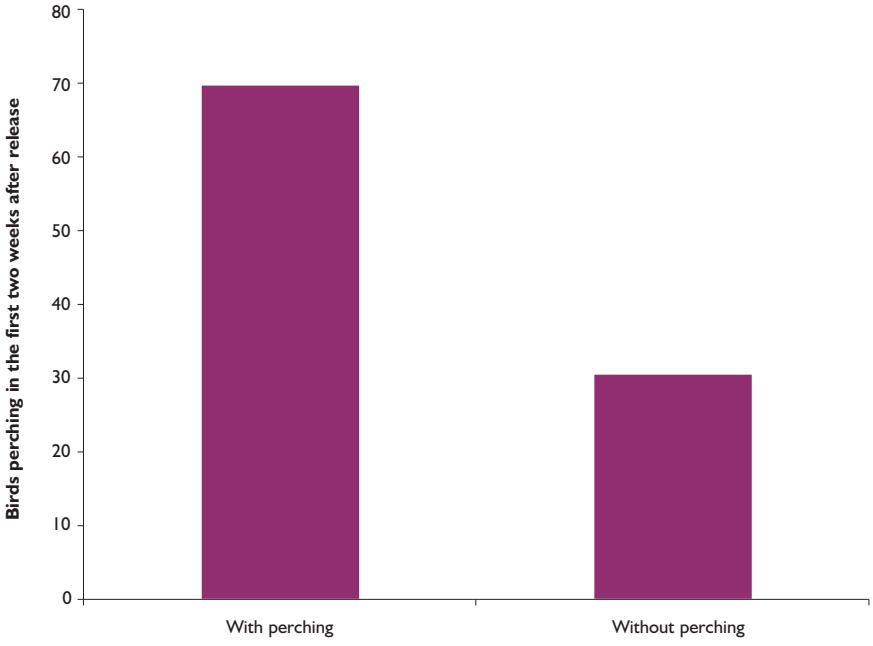


Figure 1

The percentage of pheasants that perched in the first two weeks after release.

branches. This had survival implications after release because birds reared without access to perches had higher rates of mortality due to natural causes than ones reared with access to perches.

This work suggests that adding perches to a chick-rearing system will not only increase the readiness of birds to perch upon release, but also give them the physical attributes to fly to high branches and have the muscles to hold on to the branch for a prolonged period of time (see Figure 1). Developing an adaptive roosting behaviour will greatly reduce the risk of fox predation at night, resulting in a greater proportion of released birds surviving beyond the first two months after release.

© GWCT

KEY FINDINGS

- This PhD study, in association with Exeter University, looked at how the survival of released pheasants could be improved by small changes to the management of their early rearing environment.
- Giving chicks early access to perches improved their propensity to roost off the ground when gone to wood and their tendency to perch for extended periods of time. These features may help explain their improved survival over birds reared conventionally.

Mark Whiteside
Rufus Sage
Joah Madden

ACKNOWLEDGEMENTS

This work is jointly funded by numerous contributions to the GWCT, both directly and via the Middleton Estate Shooting Syndicate. University of Exeter supported 50% of costs. Middleton Estate has also provided accommodation, a rearing field and access to the shoot areas for study.

Factors influencing gapeworm at release sites

Release pen and bluebells. © Owen Gethings

BACKGROUND

Gapeworm is very common amongst released pheasant populations. It can kill birds directly and it may make birds more vulnerable to predation. Despite this, little work has been done. Understanding basic epidemiology of infections at release sites may allow game managers to avoid or reduce its prevalence and effects.

Gapeworm (*Syngamus trachea*) is a common parasitic nematode that causes a disease called syngamiasis in poultry and gamebirds. In the 1930s and 40s, Dr Phyllis Clapham (one of the first scientists working for a predecessor of the GWCT) documented the life cycle of this parasitic nematode in pheasants for the first time, from egg to infective larval development, through to the ingestion by birds and how the worm causes disease. Since her work, little research has been done on gapeworm, yet many game managers are aware of its prevalence at release sites and the damage it can cause. Despite its widespread presence in the countryside, its epidemiology and relationship with temperature and humidity has not been properly documented, although many keepers know that infections increase in mild wet weather.

In 2014, Owen Gethings undertook the first year of his GWCT/Harper Adams University PhD looking at gapeworm infections in released pheasants. The aim is to show how pheasant pens, feed sites and pheasant releases can be managed to minimise gapeworm infections. Here we present the first-year findings on disease dynamics in the field. Owen worked at 12 release pens on two pheasant release sites in central southern England. He collected 15 soil samples at random from each pen in spring 2014 to determine overwinter egg survival. He then undertook weekly sampling of larvae on ground vegetation from 1 April to 31 August from one pen at each site. He also collected data on pen age and size, stocking density, soil moisture content, air temperature, relative humidity and rainfall. Gapeworm eggs and larvae are microscopic so they were separated from soil and faecal samples by first sieving then using centrifuge or sedimentation techniques before counts were made under the microscope.

Abundance of viable eggs differed significantly between pens at each site. Considering variables individually, stocking density (mean = 1500 ± 300; ranging from 800 to 2000 birds/hectare) explained 47% of the between-pen variation in egg abundance, pen age explained 38% and soil moisture (mean = 39.2 ± 4.77; ranging from 32.1 to 47.3%) explained 66% (see Figure 1). In combination, soil moisture and stocking density provided the best balance between number of variables and the amount of variation explained (85%). Abundance of questing larvae in the vegetation samples during the spring and summer was significantly correlated with relative humidity and temperature at both sites, reaching a peak around August. Three-quarters of crows and magpies caught in Larsen traps in early spring at one site where trapping took place had gapeworm infections.

These first-year results already provide us with new insights. Although eggs are susceptible to desiccation through drying, if the soil remains reasonably moist during the spring and early summer they are able to persist in release pens between years. This means that while dosing birds at release clears them of existing infections, these birds

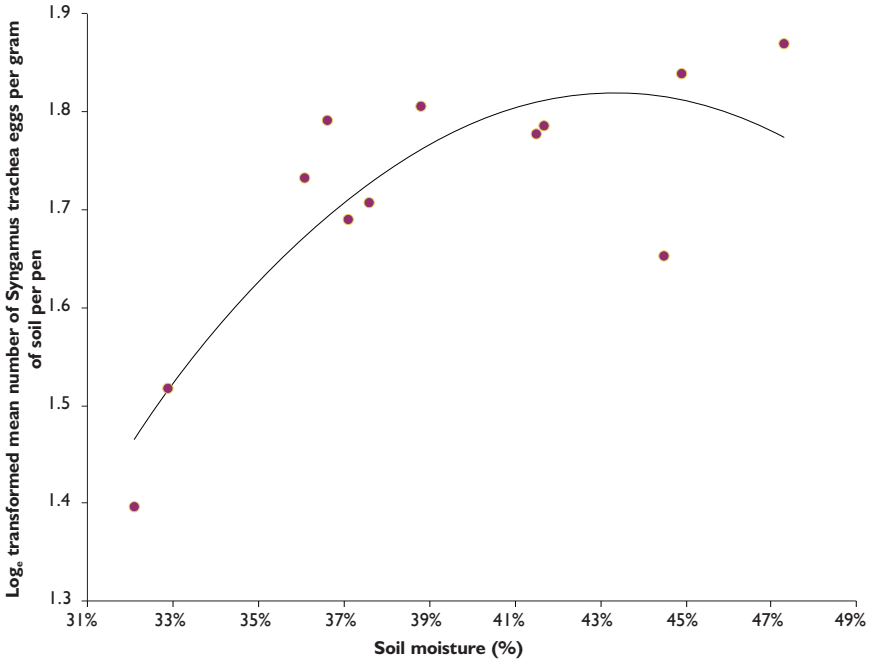


Figure 2
The number of infective gapeworm eggs in the soil increases with soil moisture.

can be immediately re-infected. Birds pick up eggs by pecking on the ground, but in the spring and early summer the ingestion of infective larvae on grass and other vegetation is probably the primary route of infection for breeding birds.

Over the next two years, Owen hopes to find out more about the parasite's life cycle in pheasants and other animals including crows and magpies. From Phyllis Clapham's work we know that many invertebrate species can contain infective larvae, so we want to know whether this possible route of transmission is also important in infecting pheasants. We also want to find out more about the spatial distribution of infections on sites and how this might vary over time within and between years.

KEY FINDINGS

- Our new PhD study on gapeworm in pheasants is the first substantial work on this topic for many decades
- The abundance and survival of gapeworm eggs in the soil year round depends on pheasant stocking densities and soil moisture.
- Infective larvae questing on vegetation is probably a key transmission route in the spring and summer.
- This is the first year of a three-year study and we expect to discover more about variations of infection levels across space and time.

Rufus Sage
Owen Gethings
Simon Leather

Gapeworm egg. © Owen Gethings

ACKNOWLEDGEMENTS

This PhD is funded by the BBSRC.

Reversing the decline of waders in the Avon Valley

Increasing breeding success so that more chicks fledge is essential. © Andrew Hoodless/GWCT

BACKGROUND

Waders breeding on farmland are in trouble throughout Europe owing to agricultural intensification over the last 60 years. More recently, increased predation has become an issue alongside habitat loss and degradation.

Agri-environment schemes have yet to reverse the declines of birds like the lapwing, redshank and snipe. We have initiated a landscape-scale project in the Avon Valley, which picks up on the aims of the Lawton (2010) report (bigger, better, more joined-up), to increase wader numbers. 38 farmers are involved and we are working over a total area of c.1700 ha.

We have been monitoring numbers of breeding waders in the Avon Valley between Salisbury and Christchurch periodically since 1990 and have assessed lapwing breeding success in each of the last eight years. We estimate that between 1990 and 2010 lapwing numbers declined from 208 to 71 pairs, redshank from 117 to 22 pairs and snipe from 29 displaying males in 1990 to none in 2010, although a single male has been recorded since. Numbers of young fledged by lapwings in recent years have typically been at about half the level required to maintain a stable population and our evidence suggests that this is mainly owing to high rates of nest predation (see *Review of 2013*, pp.24-25).

In 2013 we contacted all the farmers in the valley and held a meeting to discuss the perceived issues responsible for the wader declines and obstacles to achieving higher lapwing breeding success. It was agreed that to halt the decline of lapwing and redshank we urgently needed to intervene to improve breeding success, which in the longer term should lead to increases in breeding density. Thus was born a farmer-led initiative to demonstrate what could be achieved through collaboration, and we started applying for funding to support additional work on the ground.

Considerable financial investment through agri-environment schemes has been made in the Avon Valley, primarily to benefit the breeding waders, over the last 20 years. However, this has involved solely habitat creation and management, and in places the work has been dispersed and at a small scale. Our intention is to create 'hotspots' of increased breeding success in the landscape by addressing management of habitat and predation across groups of fields. In April 2014, we heard that we had been successful with an EU LIFE+ funding bid for a four-year project, commencing in July 2014, to pursue this approach and monitor the outcome. Partnership working is essential and, as well as the farmers, we are working closely with the Hampshire & Isle of Wight Wildlife Trust, Natural England and the Environment Agency. We will also trial, adapt and implement a new approach called *Planning for Real* to deliver engaged, owned and lasting delivery of conservation actions.

Example of a lapwing nest predated by a corvid or gull. Clutch survival in recent years has been low.
© Andrew Hoodless/GWCT

We plan to work on four 'hotspots' of about 100-150 ha each, where we aim to increase lapwing and redshank productivity and numbers, with a view to boosting numbers of both species in the valley as a whole by at least 50%. Achieving this will require habitat works additional to those already implemented under Higher Level Stewardship (HLS) schemes on our trial sites, to extend the areas of habitat suitable for nesting and to ensure that there are in-field features which remain optimal for broods into summer. Detailed plans are being drawn up for each site, but all include some tree felling, pollarding, scrub clearance, rush management, ditch clearance, and ditch and scrape creation. The LIFE+ funding will enable us to monitor the effects of restoration for waders on other typical floodplain species, particularly the flora, invertebrates and wintering wildfowl.

Fundamental to the success of the project will be devising effective and practical methods of reducing predation of wader eggs and chicks in this wet meadow landscape. Our monitoring of lapwing breeding success in recent years indicates that nest survival has only been about 32 ± 4%, with 82% of clutch losses attributable to predation. We need to raise nest survival above 50% in order to produce sufficient fledged chicks for a stable or increasing population. Our proposal to the EU LIFE+ fund incorporated both predator exclusion measures and lethal control of fox, mink and corvids. However, we were only able to secure agreement for funding of the non-lethal measures. This left us in the difficult position of being unable to deploy the tool that we believed would be the most effective. Nevertheless, exclusion measures such as nest cages and electric or combination fencing have been deployed successfully on nature reserves. Our challenge will be to integrate such measures alongside farm operations, and any lethal control undertaken by the farmers themselves, and test and modify designs to improve their effectiveness. It is important that we quantify whether non-lethal measures can increase breeding success sufficiently and in what circumstances. We hope to monitor an extra site outside our 'hotspots' where there is interest in stepping up predator control: if this goes ahead, it would provide a valuable comparison site.

KEY FINDINGS

- Breeding waders in the Avon Valley have declined rapidly since 1990 owing to poor breeding success.
- A farmer-led initiative aims to tackle issues of habitat suitability and predation.
- A new, four-year, EU LIFE+ project will enable us to implement measures at four 'hotspots' to increase lapwing and redshank productivity. Predator and prey responses will be monitored.

Andrew Hoodless

ACKNOWLEDGEMENTS

Our monitoring to date has been part-funded by Natural England and contributors to the Breeding Waders Appeal. We are grateful to all the landowners and farmers who have allowed us onto their land during the course of the study.

Increasing the area of brood-rearing habitat with scrapes and shallow ditches will be important.
© Andrew Hoodless/GWCT

Towards an understanding of woodcock migration

The use of satellite tags and geolocators on woodcock has revealed their migration strategy and routes.
© Andrew Hoodless/GWCT

BACKGROUND

In Britain and Ireland we have a resident woodcock population of about 55,000 males in spring, but we see a large influx of migrant woodcock from Scandinavia, Finland and Russia in autumn, such that we may have up to 1.5 million birds present in winter. A good understanding of which breeding grounds these birds originate from, the timing of their migrations and their faithfulness to particular wintering sites is fundamental to producing guidelines for sustainable management. Miniature tracking devices are now enabling us to obtain this information.

The Eurasian woodcock breeds throughout western Europe, as far south as northern Spain and northern Italy and across the whole of Russia between approximately the latitudes of 50°N and 64°N. In autumn, woodcock from Russia, the Baltic States, Finland and Scandinavia migrate south and west to escape the winter freeze on their breeding sites. Between December and March, the birds are mainly concentrated in Britain, Ireland, France, Spain, Italy and Greece, with Britain and Ireland hosting in the order of 10-15% of the birds wintering in Europe. Until recently, knowledge of the origin and migration routes of the large numbers of woodcock wintering in Britain and Ireland was poor. However, sustainable population management at a European scale will depend on better estimates of numbers and an understanding of migration.

New technologies and the rapid miniaturisation of tracking devices during the last six years have finally enabled us to comprehend woodcock migration in far more detail than was possible based on ringing, the only tool previously available. Analysis of stable isotopes of hydrogen in feathers, which enables estimation of the hatching or moulting location, suggests considerable mixing amongst woodcock originating from Scandinavia, Finland, the Baltic States and Russia across the six wintering areas in the UK that we sampled. Nevertheless, there was an indication of broadly parallel links between the core breeding regions associated with each wintering area. For example, 53% of the woodcock wintering in Scotland come from central and northern Scandinavia, whereas in East Anglia and southern England a higher proportion of birds (60%) originate from southern Sweden, the Baltic States and north-west Russia.

TABLE 1

The number of satellite-tracked woodcock travelling to each breeding destination. Resident British birds and birds that failed to make a full spring migration are excluded

	Norway	Sweden	Finland	Poland	Latvia	Belarus	Western Russia	Central Russia
Northern Scotland	2				1		2	
North-east England		1		1				
East Anglia		1	1					1
Mid-Wales					1		3	
West + South-west Ireland	1				1		4	
Central Southern England			1				3	
South-west England		2				1	4	2
Total	**3**	**4**	**2**	**1**	**3**	**1**	**16**	**3**

Most exciting has been the opportunity to track individual woodcock on their migrations. The information from geolocators (tiny loggers recording light levels) and satellite tracking has been a revelation. For the first time, we have been able to determine the migration strategy and gain an insight into the behaviour of birds and the difficulties they face on migration. It is apparent that the migration strategy consists of a series of long, fast flights (average 735 km, 460 miles), broken up by stops en route typically lasting about 7-15 days. Flight speed averages about 70 km/h (44 mph), but can reach 140 km/h (88 mph). It is clear, and not surprising given that it needs to probe for its food, that the woodcock is a 'weather migrant', in which the timing of migrations is related to temperature. This was evident in the cold spring of 2013, when the majority of our satellite-tracked woodcock did not depart until the end of the first week of April, compared with mid-March in the very mild spring of 2014 (see Figure 1).

We have been deploying geolocators since 2010 and satellite tags since 2012, but each year of the project throws up new insights into different aspects of woodcock migration. Most of the birds we have tracked have flown distances of 3,000-3,500 km (1,875-2,188 miles) to their breeding sites. 'Monkey', from the first batch of satellite-tracked birds, astonished us all by flying 6,300 km (3,940 miles) to central Siberia to breed, twice as far east as the furthest ever ring recovery. We estimate that he flew at least 38,000 km (23,750 miles) during his life! In 2013, he was joined in Siberia by 'Woody II' and 'Crugith', who made spring flights of 6,980 km (4,360 miles) and 7,100 km (4,440 miles) respectively. Clearly, this part of central Russia is an important breeding area for some of the woodcock that winter in Britain, a fact that we would never have discovered without satellite tracking. 'Monkey' was the first bird to demonstrate that individuals can be extremely faithful to the same breeding and winter sites each year. However, six birds tagged in March 2013 returned to the same breeding sites again in 2014. 'Rebecca', a female tagged near Llandovery, Wales in February 2012, spent three summers at the same breeding site midway between Smolensk and Moscow. Intriguingly, in spring 2014, rather than taking the more direct route that she followed in 2012 and 2013 with a stop in central Poland, she detoured further south and stopped in Slovakia instead.

Through more detailed examination of the data, we plan to tease out the effects of prevailing weather on flight courses and speeds, which might explain unexpected deviations in route, such as that by 'Rebecca' in 2014. Many of the birds migrating to Finland, the Baltic and north-west Russia have taken routes which have minimized the time spent flying over the sea, either following the coast of Germany and Poland to then skirt south of the Baltic Sea or crossing through Denmark and southern Sweden to head around its northern end. Birds breeding in Norway and wintering in Britain have little choice but to cross the North Sea. The perils they face in doing so was clearly illustrated

KEY FINDINGS

- Stable-hydrogen isotope analysis of woodcock feathers and satellite tracking of individual birds indicate a high degree of mixing of woodcock from different breeding grounds on the same wintering sites in the UK.
- North-west Russia is an important breeding area for woodcock wintering in Britain and Ireland.
- The migration strategy consists of a series of long, fast flights of 600-1,100 km (375-690 miles), with stop-overs typically lasting 7-15 days.
- Woodcock appear to be extremely faithful to both their breeding and wintering sites each year.

Andrew Hoodless
Chris Heward

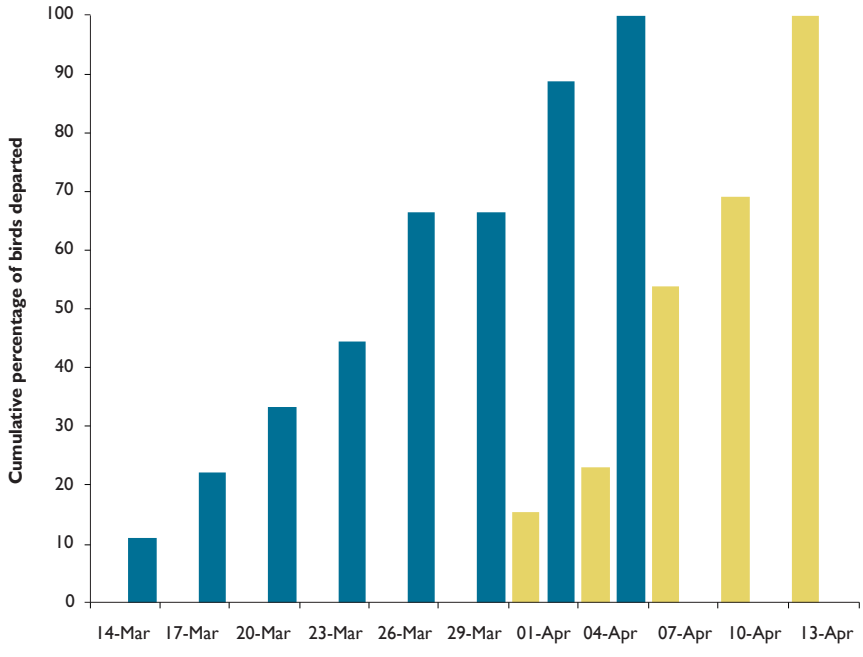
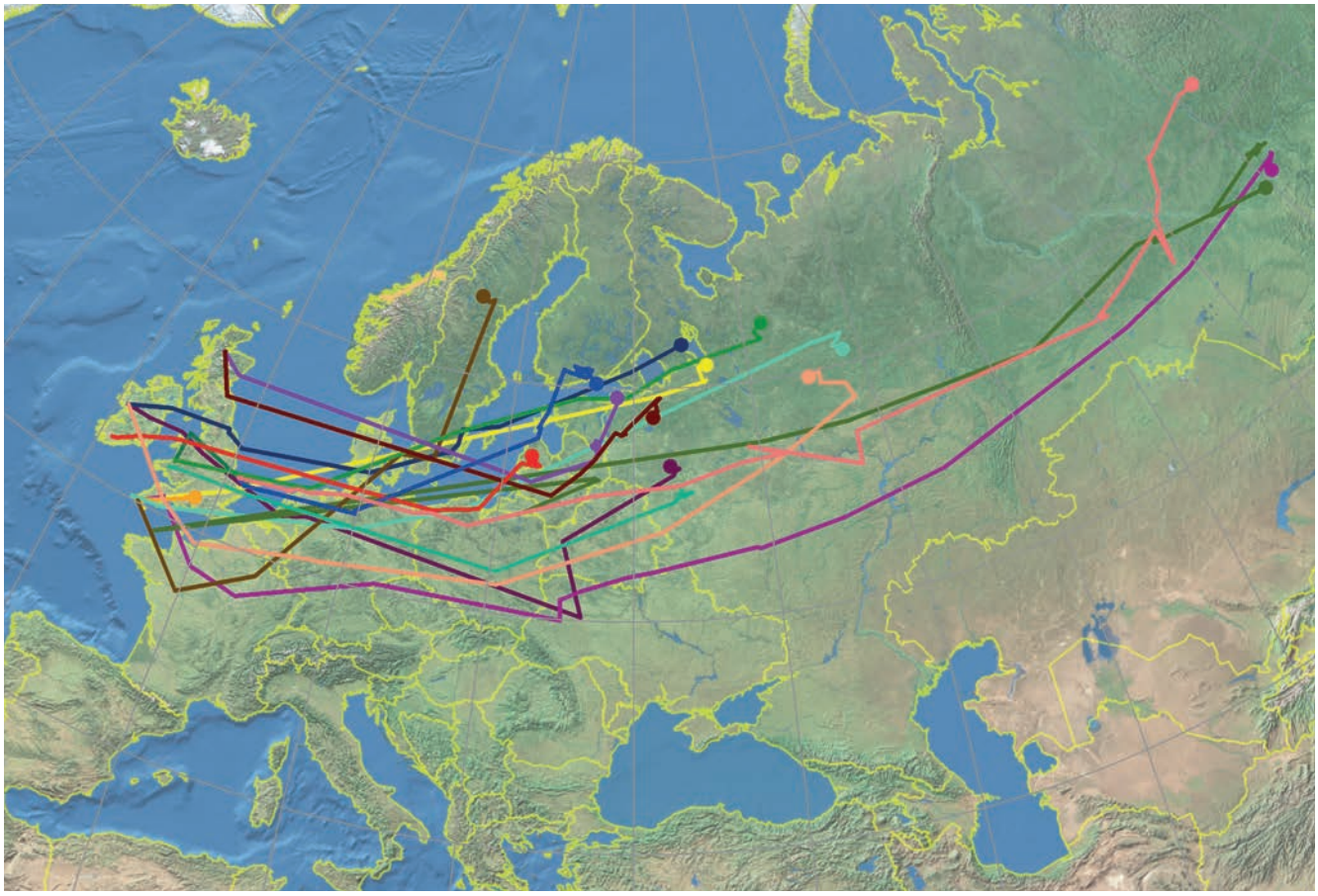
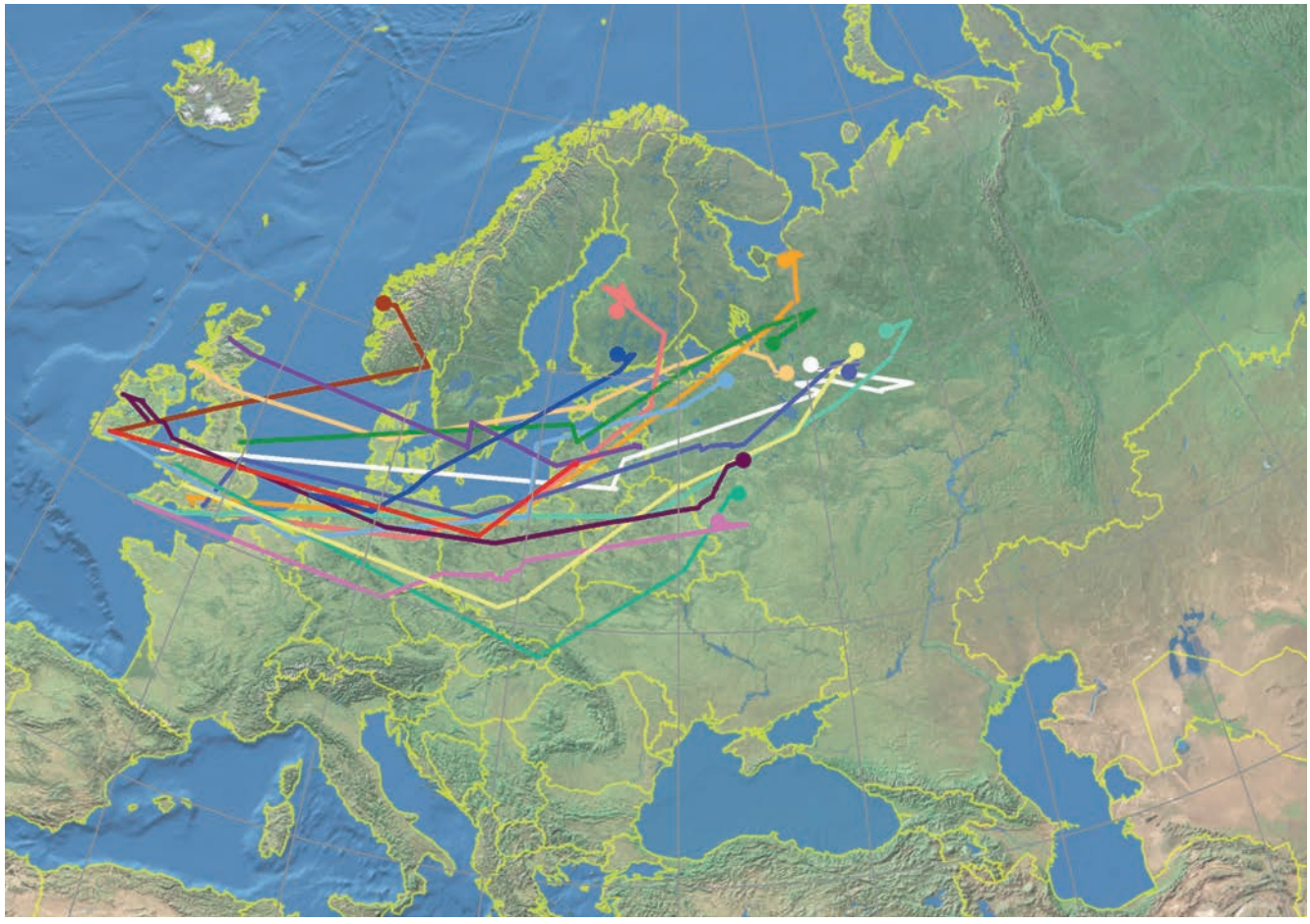


Figure 1
Difference in migration departure timing between a cold spring (2013, March temperature 2.2°C) and mild spring (2014, March temperature 6.7°C)



Spring migration routes of satellite-tracked woodcock in 2013. Birds were tagged in Britain and Ireland in February-March and dots show the breeding locations.



Spring migration routes of satellite-tracked woodcock in 2014.

We hope to learn more about the effects of prevailing weather on flight courses and speeds.
© Andrew Hoodless/GWCT

by 'Rocket' who, on the morning of 30 October 2012, flew into a storm about 115 miles off the southern Norwegian coast. Although doubling back towards land, we believe he drowned in the sea about two hours later.

Needless to say, questions remain and the answers to some will not rely on clever technology. Continued ringing of large numbers of woodcock will enable us to examine variation in winter site fidelity between different parts of Britain. Weights of birds will help us to understand how woodcock regulate body condition and their decision-making with the onset of cold weather.

To learn more about woodcock and follow the migrations of our satellite-tracked birds visit the Woodcock Watch website **www.woodcockwatch.com**

ACKNOWLEDGEMENTS

The isotope study was funded by the Countryside Alliance Foundation and the Natural Environment Research Council. We are grateful to the Shooting Times Woodcock Club and several individuals for donations towards the purchase of satellite tags. We appreciate the help of James Maunder-Taylor in fundraising for this project. We thank all sponsors who have helped fund the on-going cost of obtaining the satellite data and managing the Woodcock Watch website. The assistance of Owen Williams of the Woodcock Network with fitting tags in mid-Wales is greatly appreciated.

Woodcock appear to be extremely faithful to both their breeding and wintering sites each year.
© Andrew Hoodless/GWCT

Partridge Count Scheme

© Neville Kingdon/GWCT

BACKGROUND

Grey partridge recovery depends on the individuals on the ground undertaking land management to deliver conditions necessary to conserve this once common gamebird. The Partridge Count Scheme (PCS) asks land managers to undertake counts of grey partridge across their land in spring and autumn. In return, based on their count results, the PCS provides results to help identify what aspects of their management need to be improved or adopted, plus news and updates on our grey partridge research. County-level Partridge Groups offer meetings to discuss and demonstrate practical partridge conservation.

Members of the Partridge Count Scheme (PCS) might think that the weather is conspiring against them to make partridge conservation as difficult as possible. Although the winter of 2013/14 was mild, it was the wettest on record. Nationally, the average over-winter survival rate (OWS) of grey partridges calculated from sites that returned both autumn 2013 and spring 2014 counts was 46% (see Table 1). This was below the rates recorded in the previous four winters (between 49% and 54%); note that 49% occurred during the very cold winter of 2010/2011. Looking in more detail at the regional over-winter survival rate, the Eastern, Midland and Northern England regions equalled or exceeded the national average. Southern England experienced a lower survival rate of 41%, which appears to be the effect of the winter weather. More startling is Scotland's winter survival rate, which appears to have been particularly poor this year at 32% and is Scotland's worst over-winter survival recorded by the PCS for over a decade.

Low over-winter survival makes restoring grey partridge breeding densities to those seen in spring of 2012 more difficult. As can be seen in Table 1, there was little change in the breeding densities recorded across the country, with a 6% increase overall. PCS members in Northern and Southern England increased breeding densities by 12% and 8% respectively, while breeding densities in Scotland declined slightly (-5%); those in Wales halved, but based on only two counts.

Figure 1

Annual index of grey partridge pair density, taking into account site and year specific differences in area counted.

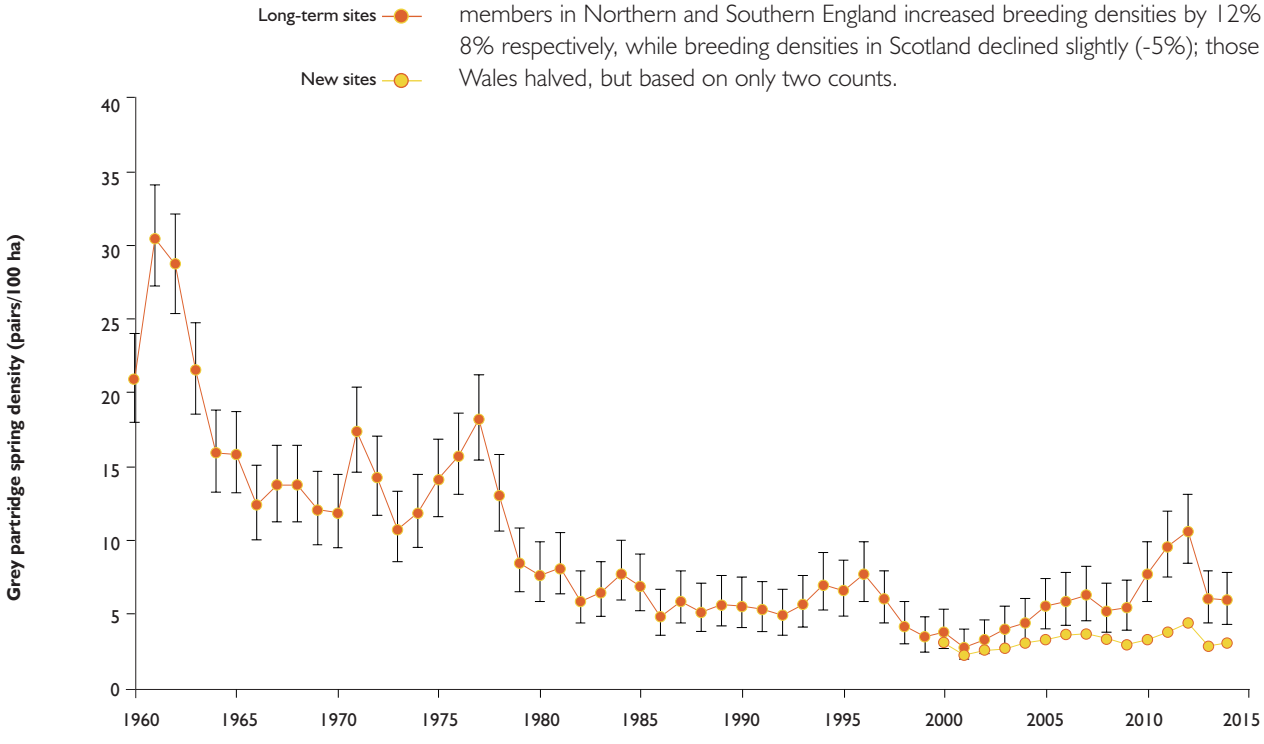


TABLE 1

Densities of grey partridge pairs in spring 2013 and 2014, from contributors to our Partridge Count Scheme

Regional over-winter survival rates (OWS) following winter 2013/2014

	Number of counts		Spring density (pairs per 100 ha)			Mean over-winter survival
Region	**2013**	**2014**	**2013**	**2014**	**Change (%)**	
South	116	100	1.3	1.4	+8%	41%
East	199	194	4.8	4.9	+2%	50%
Midlands	130	140	3.3	3.3	0%	51%
Wales	1	2	7.1	3.6	-49%	-
North	168	162	3.3	3.7	+12%	46%
Scotland	105	92	2.2	2.1	-5%	32%
Overall	**719**	**690**	**3.2**	**3.4**	**+6%**	**46%**

Both the long-term and new sites (joining the PCS since 1999) counted about half the number of pairs recorded back in spring 2012 (see Figure 1). Thankfully, both groups appear to have halted the 2013 collapse in spring pair densities. Long-term sites have prevented densities falling back to the slump of the early 2000s, while newer sites, which typically join the PCS with fewer birds, have recorded a small increase in density this year.

Chick production was good across the country (see Table 2), with all regions reporting average young-to-old ratios that exceeded the minimum of 1.6 needed for numbers to remain stable. The number of chicks produced per adult bird was lowest in Southern and Eastern England (2.1 and 2.2 respectively), while, on average, PCS contributors in the Midlands, Northern England and Scotland recorded young-to-old ratios that exceeded the national average of 2.4 chicks per adult.

All regions saw increases in autumn density, which resulted in an increase of 18% in the national average. Eastern and Northern England regions recorded an average density higher than Scotland. This notable progress is in part due to exceptional production on several farms that are making a concerted effort to benefit wild partridges as part of their farming. However, grey partridge densities in the south of England still lag behind the other English regions.

KEY FINDINGS

- Spring pair density increased 6% from 2013 to 2014 on the areas counted by members of the GWCT's Partridge Count Scheme.
- The long-term trend in grey partridge breeding density has stabilised following the poor breeding season of 2012 but numbers have not yet recovered.
- Good chick production saw autumn density increase in England and Scotland.
- The average national grey partridge autumn density was 18% higher in 2014 than in 2013.

Julie Ewald & Neville Kingdon

ACKNOWLEDGEMENTS

We are extremely grateful to Game Conservancy USA for its on-going support of our grey partridge work.

TABLE 2

Densities and young-to-old ratios of grey partridges in autumn 2013 and 2014, from contributors to our Partridge Count Scheme

	Number of counts		Young–to-old ratio		Autumn density (birds per 100 ha)		
Region	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**Change (%)**
South	104	89	1.6	2.1	9.1	14.5	-59 %
East	167	172	2.4	2.2	22.1	22.2	+5 %
Midlands	127	114	2.4	2.5	14.5	17.2	+19 %
Wales	-	1	-	0	-	4.8	-
North	167	153	2.7	2.5	21.2	26.4	+25 %
Scotland	91	86	3.2	3.2	12.0	13.1	+9 %
Overall	**656**	**615**	**2.5**	**2.4**	**16.9**	**19.9**	**+18 %**

The Rotherfield Demonstration Project

Dust-bathing greys. © Eckhard Gottschalk

BACKGROUND

The project started in 2010 and demonstrates grey partridge recovery from zero together with the benefits for other wild game and wildlife. It aims to be applicable to a wide range of landowners and other stakeholders wishing to recover grey partridges where they have gone extinct. Grey partridge reintroduction is based on GWCT guidelines which follow international principles.

The Rotherfield Demonstration Project was launched in 2010 with the ambitious aim to re-establish grey partridges where they had become extinct and to demonstrate how this can be achieved on semi-optimal partridge land that is typical of large parts of lowland Britain. Five years into the project grey partridges on the project area are making a comeback, thanks to all the measures implemented to restore them: 1. Habitat restoration – in particular the amount and quality of nesting, foraging, winter and escape cover; 2. Intensive predator management – in particular wild bird keepering focused on March-July, together with winter feeding; 3. Suitable release strategy – the use of good-quality founder birds that are able to breed successfully, allowing the establishment of a self-sustainable population without the need for continuing release.

Before the project began (2004-2009), the Rotherfield estate provided only 3.2% of suitable partridge habitat (see *Review of 2010*). Additionally, only one keeper controlled predators across the estate (1457 hectares or 3600 acres). The reintroduction strategy initially focused on bantam-reared family groups released as autumn adults (five coveys per year from 2004-2008 and 14 coveys in 2009) or chicks fostered to barren pairs (2-5 groups per year) in August. We gradually switched to parent-reared birds from 2006 onwards with the aim of improving the quality of release stock (see Figure 1). This improved winter survival rates but not breeding success. The first successful broods were not recorded until 2008, all hatched by parent-reared birds. These produced nowhere near enough offspring to increase the re-established founder stock to 100 birds, the number believed to be needed to sustain a reintroduced population (see Figure 2).

In 2010, we installed the GWCT's gamekeeper, Malcolm Brockless, on half of the estate (the Trust side) and concentrated the estate's keeper's efforts on the remaining land (the Estate side). The whole estate entered an HLS scheme in 2011, tailored to suit grey partridge recovery (see *Review of 2013*). In December 2011 we decided to translocate 20 wild partridges, and another five spring pairs in January 2012, to boost the by then predominantly parent-reared release stock on the Trust side (see Figure 1). Unfortunately, 2012 was one of the wettest summers on record and only one of the

KEY FINDINGS

- In 2014, the autumn stock of grey partridges at Rotherfield surpassed 100 birds for the first time since extinction in the 1990s.
- Across the whole estate, 11 pairs fledged 74 young. On the Trust side, 75% of all spring pairs fledged 71 young; on the estate side 18% fledged three young.

Francis Buner
Malcolm Brockless
Nicholas Aebischer

TABLE 1

Game recovery at Rotherfield, split between the Trust and Estate side

Year	Spring pairs			Autumn stock		
	Trust	Estate	Total	Trust	Estate	Total
Grey Partridge						
2014 (2013)	13 (8)	11 (10)	24 (18)	94 (44)	14 (14)	108 (58)
Red-legged Partridge						
2014 (2013)	26 (24)	27 (10)	53 (34)	79 (50)	90 (38)	169 (88)
Pheasant*						
2014 (2013)	241 (191)	123 (63)	364 (254)	309 (354)	170 (171)	479 (525)

** For pheasants, spring pairs is the number of wild females encountered; autumn stock is the number of wild adult females and young. On the Trust side, 600 cock pheasants are released each year since 2011.*

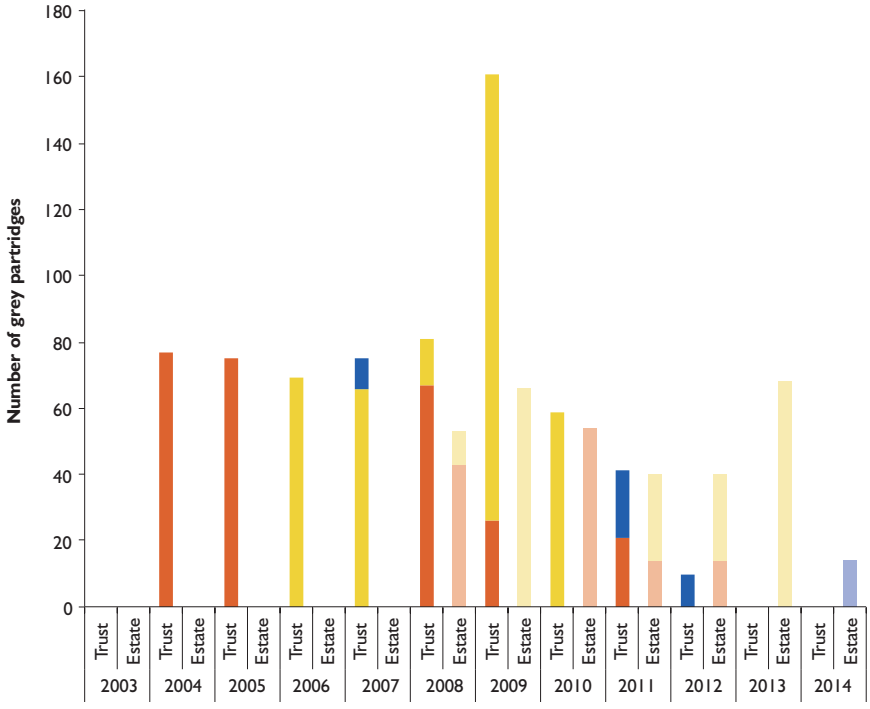


Figure 1

Number of reared-released and translocated wild grey partridges at Rotherfield. Parent-reared = partridge chicks hatched and reared in captivity by own parents, bantams = partridge chicks reared by bantam chickens.

translocated pairs managed to produce a small brood of six chicks. In the same year, autumn stock on the Trust side was only 25 birds. Nevertheless, we stopped releasing birds as, by then, the majority of these partridges were wild (either hatched on the estate or translocated). 2013 saw 35 juveniles fledged, and in 2014, eight out of 13 pairs produced 71 fledged young. Two of these successful pairs consisted of a parent-reared female and a wild cock, and one pair of a parent-reared cock and a wild hen. The total autumn stock on the Trust side was 94 birds, just under the 100-bird target.

On the Estate side, we started to release bantam and parent-reared birds in 2008, using the same release strategies as on the Trust side. However, every year since 2009 only one brood managed to fledge; in 2012 none at all. Whether this is because the reared released stock is incapable of fledging enough young due to a lack of natural brooding behaviour or because external factors such as high predator pressure are the reason is currently still unclear.

Across the whole estate, grey partridge autumn stock was a minimum of 108 birds, of which 15% were survivors of reared-released birds before autumn 2013 and 85% wild. Owing to the extent of extinction within the area, immigration of dispensing partridges has not been recorded to date.

A cultivated uncropped margin under HLS alongside a beetle bank at Rotherfield.
© GWCT/Francis Buner

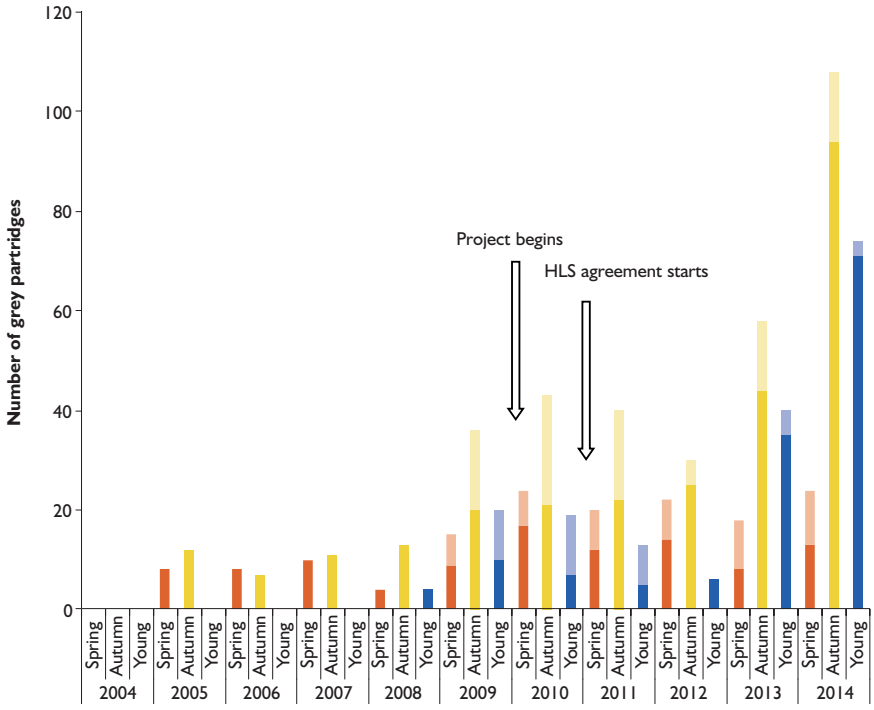


Figure 2

Number of grey partridges counted at Rotherfield. Spring = number of pairs in spring, Autumn = number of individuals in autumn (reared individuals released in the same year are excluded), Young = number of juveniles fledged in the wild.

Pesticide use and chick-food abundance

© Peter Thompson/GWCT

BACKGROUND

The GWCT's Sussex Study is the longest-running cereal ecosystem monitoring exercise in the world. The study has monitored both the farming decisions and the cereal ecosystem on 3,200 hectares of the Sussex Downs since 1970, collating information on cropping, pesticide use, cereal weeds and invertebrates. This unique dataset allows the long-term changes in crop management and the effects of these changes on cereal ecosystem biodiversity to be assessed. This is currently a topical issue owing to both recent innovation in agrochemical development and limits on pesticide availability due to legislation. The use of neonicotinoid-based seed dressings on arable crops and their possible involvement in the decline of pollinators (both honey bees and bumble bees) has raised international concern, resulting in an EU moratorium on their use in some crops. The Sussex Study is unique in providing the means to look at the effect of these seed dressings while controlling for the effect of other pesticide applications. Here we examine the long-term changes in pesticide use, consider the effect of foliar applications on chick-food insects, and look at the effect of neonicotinoid seed dressings on invertebrate chick-food resources.

Investigations into the effect of pesticides on invertebrate chick-food resources for farmland birds has dominated farmland ecology research for some time, with recent concern about the effect of neonicotinoid seed dressings. Concerns have been raised over how their use has contributed to recent declines in pollinators, particularly bees. This concern has led to a two-year EU moratorium on the use of some neonicotinoid seed dressings on certain arable crops as well as much scientific work on their effect on pollinators.

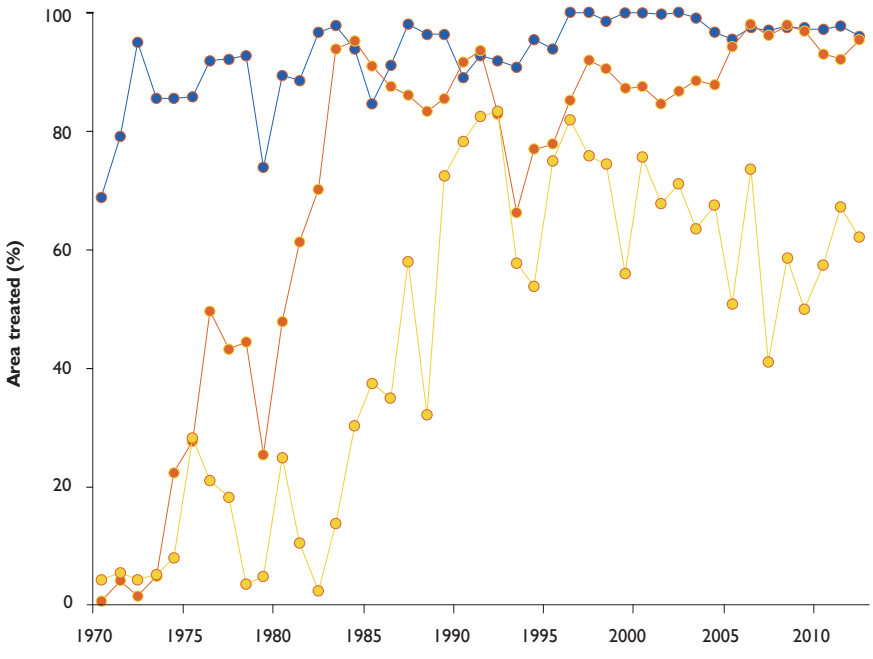


Figure 1
Annual usage of foliar herbicides, fungicides and insecticides in arable crops on the Sussex study area, 1970-2012.

Previous work on the GWCT's Sussex Study (reported in *Review of 2005*) has identified the negative effects of foliar pesticides, particularly insecticides, on the abundance of chick-food invertebrates found in cereal fields. This year, with funding from Natural England for data analysis, we were able to update this work and include a first look at the effect of neonicotinoid seed dressings on chick-food insect abundance. This work is unique, as the detailed data collection undertaken in the Sussex Study allows us to control for the effect of foliar pesticides in the analysis. Analysis of the effect of neonicotinoid seed dressings on chick-food abundance is timely, as little is known about the effect of these products on chick-food resources for grey partridges and other farmland birds. The Sussex Study is the longest-running cereal monitoring project in the world. Invertebrate collection and analysis began in 1970 and this summer marked its 45th year. The monitoring that takes place includes both pesticide use and cereal invertebrate abundance. Over the whole of the Sussex Study, the percentage of arable area treated with foliar herbicides, fungicides and insecticides has increased (see Figure 1). Since the 1980s, herbicides and fungicides have been used on nearly all cereal fields, whereas foliar insecticide use peaked in the early 1990s at 80% of cereal fields and gradually declined since. As was found in earlier work, the abundances of chick-food invertebrates were lower where foliar insecticides were used than where they were not used (see Figure 2). Insecticides containing organophosphates and pyrethroids were more damaging to chick-food invertebrates than those containing pirimicarb.

In addition to foliar pesticide use, we considered the use of neonicotinoid seed dressings. We found little effect of such seed dressings on the abundance of chick-food invertebrates: of the six chick-food groups examined, the abundance of only one, aphids, was found to be negatively related to the use of neonicotinoid seed dressings. It is suggested that using seed dressings protects the plant so well that subsequent use of protective sprays may not be necessary. We found that winter cereal crops with neonicotinoid seed dressing were more likely, not less likely, to be treated with an autumn foliar insecticide than undressed crops. Neonicotinoid-dressed winter wheat was also more likely to be treated with a spring foliar insecticide. But neonicotinoid-dressed spring break crops were less likely to be treated with a spring foliar insecticide than undressed crops, with no difference in the use of foliar insecticides on winter-sown break crops.

These results indicate that foliar applications of insecticides are likely to be more damaging to the insect foods of grey partridge chicks and other farmland birds than neonicotinoid-based seed dressings. To provide sufficient food for grey partridge chicks, farmers should therefore minimise foliar insecticide applications. Conservation headlands and reduced-input cereals are a means of doing this.

KEY FINDINGS

- Since the 1980s, herbicides and fungicides have been used on nearly all cereal fields, whereas insecticide use peaked at 80% in the early 1990s and gradually declined since.
- Of all pesticides studied, foliar insecticides are the most damaging to chick-food invertebrates.
- Of the invertebrate groups examined, only aphid abundance declined where neonicotinoid seed dressings were used.

Julie Ewald, Chris Wheatley, Neville Kingdon and Nicholas Aebischer

ACKNOWLEDGEMENTS

The analysis for this work was funded by Natural England.

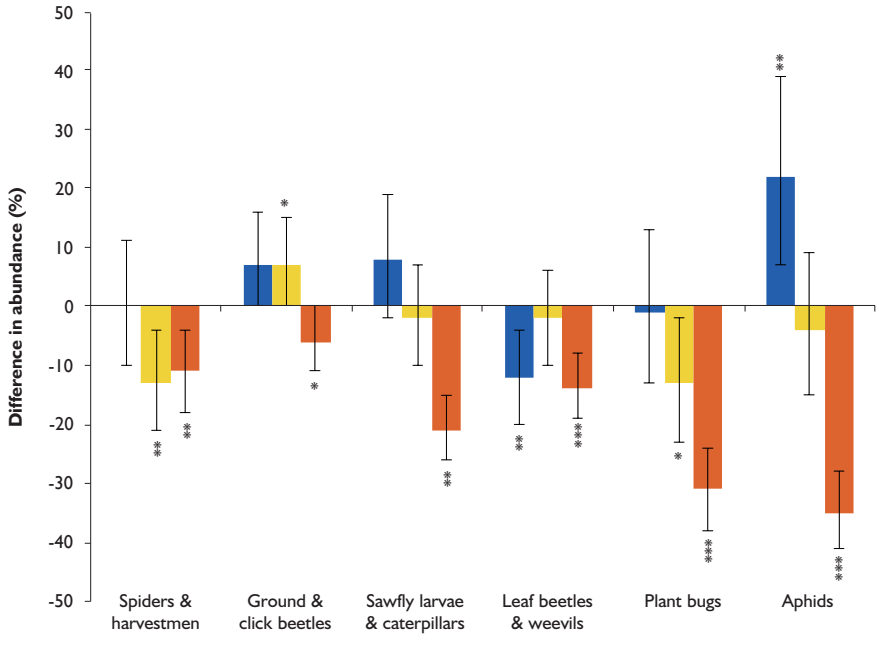


Figure 2

The effect of foliar/residual herbicide, foliar fungicide and foliar insecticide applications (controlling for crop, year and the use of other pesticide types) on invertebrate densities on a field-by-field basis for 1970-2012. Bars below the zero line indicate decreases, bars above the line indicate increases following use; stars indicate levels of statistical significance; * P < 0.05 means that the chances of this result being caused by random chance is one in 20; ** P < 0.01 means one in 100; *** P < 0.001 means one in 1,000.

Partridges on the Sussex Study

© Neville Kingdon/GWCT

BACKGROUND

The GWCT's Sussex Study has monitored the cereal ecosystem on 32,000 hectares of the South Downs in Sussex from 1970. The Study was originally designed to investigate declines in numbers of grey partridges across this area of mixed farmland. We monitor not only grey partridge numbers but also the food and nesting resources available for them (invertebrate chick-food, adult food resources, nesting cover) and the farming decisions that affect these resources (crop rotations, pesticide inputs). The Sussex Study is now the longest-running cereal ecosystem monitoring exercise in the world, and provides a unique understanding of cereal ecosystems and their management. Here we report on changes in grey partridge numbers on one part of the Sussex Study, the Norfolk Estate, where the landowner and his team have restored a wild grey partridge shoot. (See also article on page 28).

It has been six years since we last reported on the grey partridge numbers in our Sussex Study area. In the *Review of 2008* (pages 26-27), we reported on management for a wild grey partridge shoot taking place on approximately 1,000 hectares (2,500 acres) of the Norfolk Estate in Sussex. This project began in 2004 and is now providing densities of grey partridges high enough to sustain shooting, increase spring stocks and generate revenues to offset some of the cost of management not met by agri-environment schemes. Importantly, the management for partridges provides substantial benefits for wider biodiversity. We use information from our annual Sussex grey partridge counts to illustrate how the landowner and his team have overcome many of the challenges that face those managing farmland for wild grey partridge recovery in Britain.

Management on the Norfolk Estate is designed around the GWCT's three-legged stool: 1. A plentiful supply of the right kind of insects; 2. Quality nesting cover and; 3. Effective seasonal legal predator control and provision of grain and cover for adults. Effective grey partridge management requires all three elements in order to succeed, a fact long advocated by the Trust. On the Norfolk Estate habitat improvements included the provision of conservation headlands and under-sown spring barley, both of which provide chick-food insects (see Table 1). Nesting cover has been increased with the provision of beetle banks, many planted with hedges and thorns.

Increasing the abundance of chick-food insects has resulted in increased chick production (see Figure 1). In most years since grey partridge management began, the young-to-old ratio has far exceeded the 1.66 chicks per adult needed to maintain numbers. The exception was the summer of 2012, when high rainfall, especially in June, resulted in low chick-food availability. With productivity below one chick per adult bird

TABLE 1

Habitat provision for grey partridge across the Norfolk Estate area in 2014, funded in part through agri-environment schemes

Habitat provided	Area/length	Key Information
Conservation headlands	97 ha	9% of farmed area, 1/3 unharvested option
Beetle banks and hedges	25 km	Cock's-foot with thorns
Under-sown spring barley	86 ha	40% of the spring barley area
Overwinter stubble	121 ha	22% of harvested cereal area
Wild bird cover	21 ha	Kale, chicory, canary grass
Feeders	~ every 70 m	One feeder per grey partridge pair

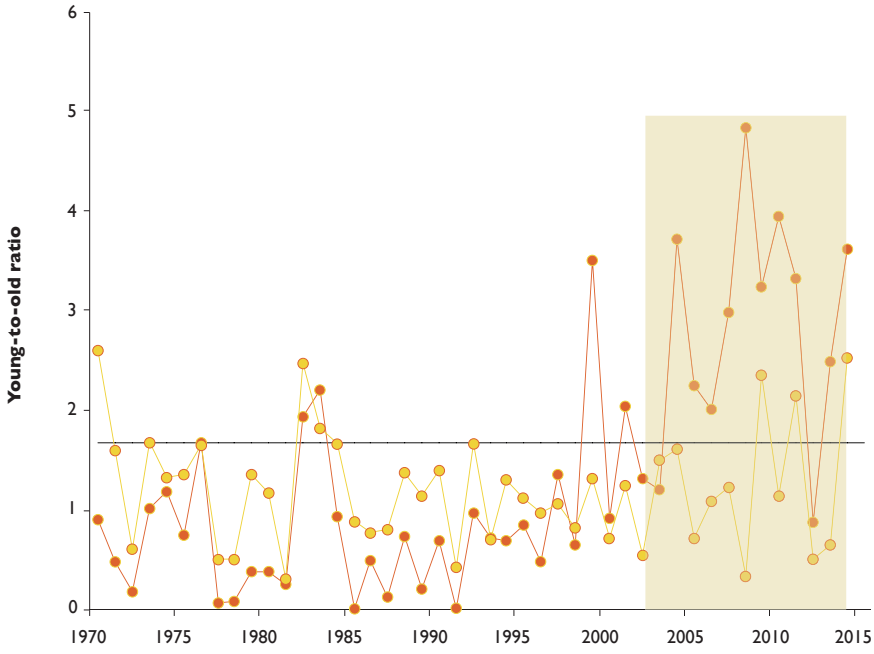


Figure 1

Annual young-to-old (YTO) ratio on the Sussex Study area, 1970-2014. The young-to-old ratio of the Peppering Project area is in orange while that from the remainder of the Sussex Study area is in yellow. The black line indicates the YTO value (1.66 chicks per adult bird) needed to maintain grey partridge numbers. The shaded background indicates the time when partridge management has been undertaken.

Managed area

Remainder

the landowner and his team decided not to shoot in autumn 2012. Chick production has increased since then, with over 3.5 chicks per adult bird produced in 2014, allowing sustainable shooting to recommence.

Legal, targeted predator control during the nesting period has resulted in more broods being produced (see Figure 2). On the project area, since 2005, an average of 80% of the spring pairs counted in the autumn produced broods, compared to less than 45% of the spring pairs on the unmanaged area. Foxes, mustelids and corvids are controlled using all legal means in the nesting period when grey partridges and their nests are most vulnerable to predation.

The breeding density of grey partridges on the managed area, calculated from our autumn counts, is higher than it was in the early days of the Sussex Study, with an average of over 17 pairs per 100 hectares over the past 10 years (see Figure 3). Low chick production in 2012, due to poor weather conditions led to decreased breeding density in the spring of 2013 of approximately 13.5 pairs per 100 hectares. In 2014 this has improved to the pre-2013 level of nearly 20 pairs per 100 hectares in 2014. The success of the project is illustrated by comparing the results of the 2003 partridge count (see Figure 4) with those from the 2014 count (see Figure 5).

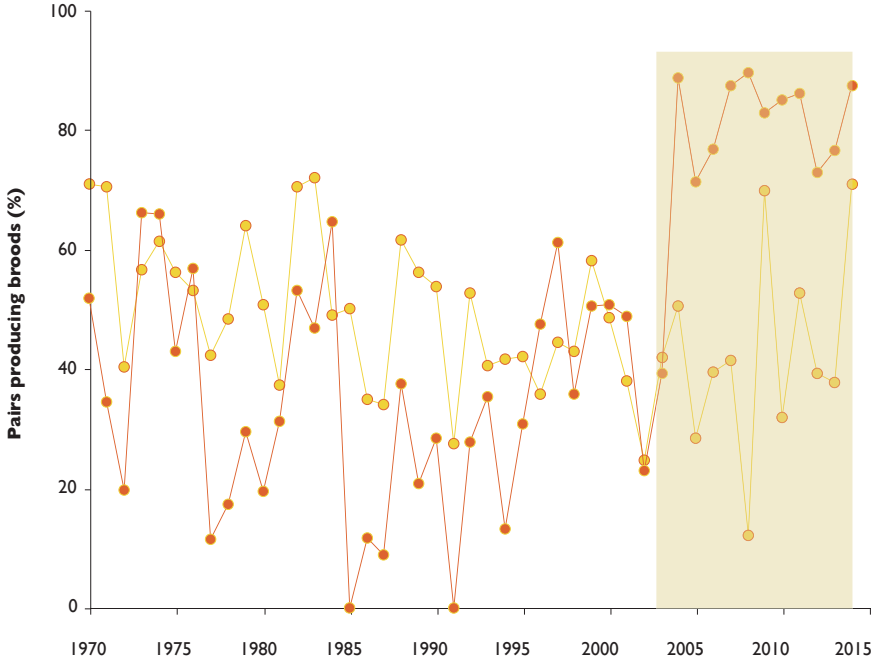


Figure 2

Brood production rate (percentage of pairs that produce a brood) on the Sussex Study, 1970-2014, measured from autumn counts. The brood production on the Norfolk Estate is in orange that on the remainder of the area is in yellow. The shaded background indicates the time when partridge management on the Norfolk Estate has been undertaken.

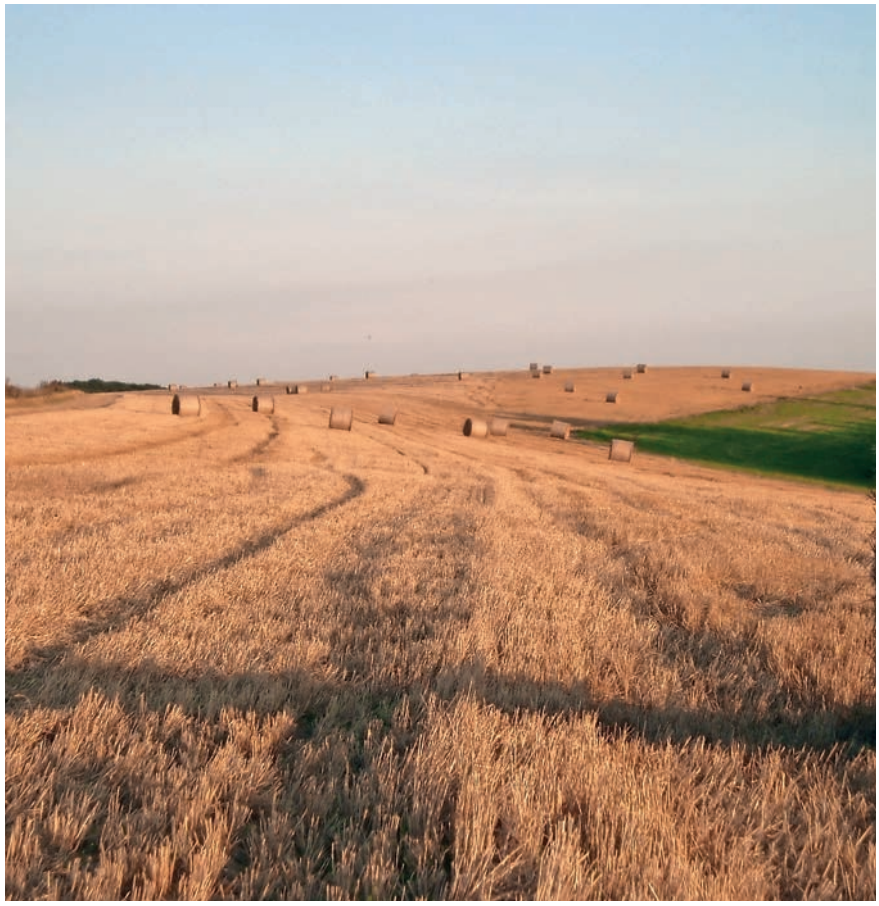
Managed area

Remainder

KEY FINDINGS

- Successful management for grey partridges requires sufficient chick-food resources, the provision of nesting cover, and legal predator control during the breeding season.
- Under modern farming conditions, chick-food supply is usually too low to allow chicks to survive and management, particularly low-input cereals, undersown cereals and conservation headlands, is needed to address this.
- Legal predator control resulted in 80% of grey partridge pairs producing broods, compared to 45% on areas without predator control.
- Cold and very wet weather during the breeding season can decrease chick survival rates but this has only happened once since 2004.
- If shooting levels are carefully adjusted, partridges have the capacity to dramatically increase in numbers provided the requisite food and predator management are in place.
- The key to the success of these measures is in the way they have all been used in an integrated fashion.

Julie Ewald & Dick Potts



© Neville Kingdon/GWCT

The success of the partridge project is down to the dedication and hard work of the landowner and his team. The project is not immune to the effects of inclement weather, especially during the breeding season, as was made clear by the effect of the summer of 2012. However, a pragmatic approach to the shooting of grey partridges and the implementation of necessary habitat and predator management regimes has meant grey partridge numbers can quickly recover after a poor summer, resulting in a sustainable harvest in subsequent years.

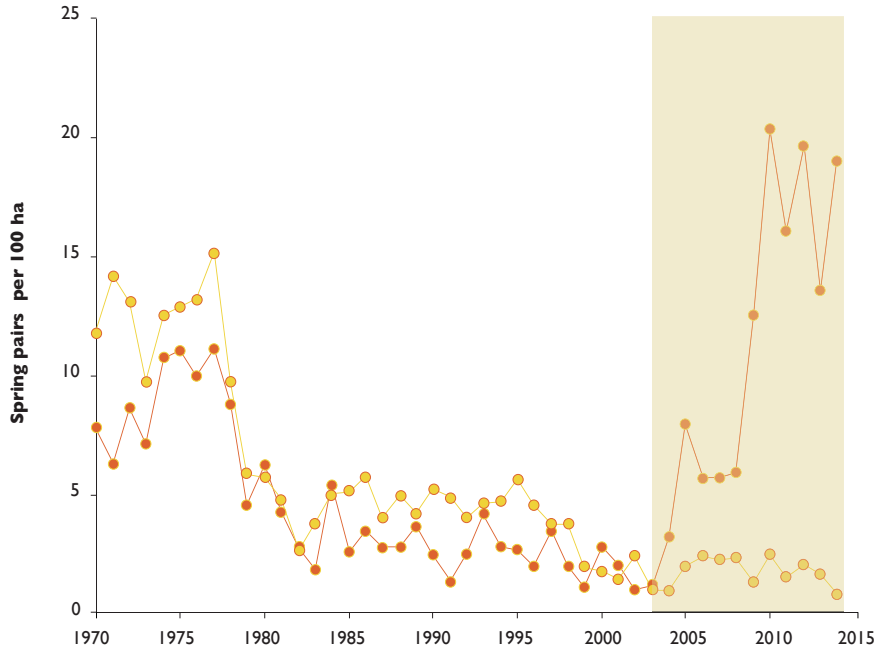


Figure 3
Breeding density (pairs/100 hectares) on the Sussex Study, 1970-2014, measured from autumn counts. The breeding density of the Norfolk Estate is in orange, the density on the remainder of the area is in yellow. The shaded background indicates the time when partridge management on the Norfolk Estate has been undertaken.

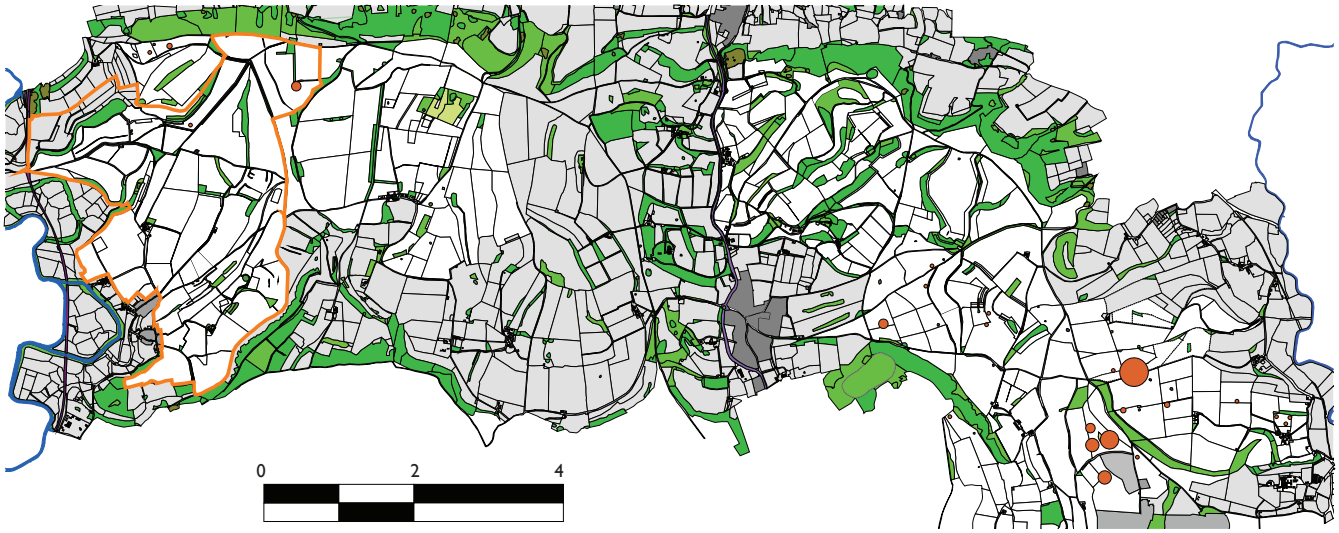
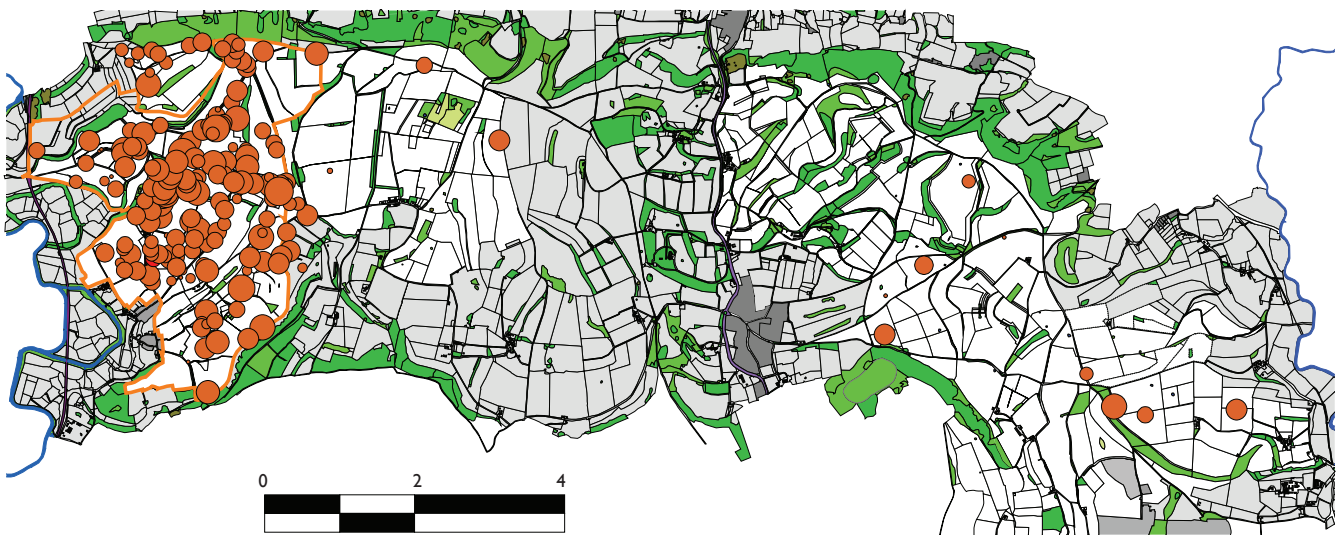


Figure 4

Grey partridge coveys from counts done in the autumn of 2003. Each circle represents a grey partridge covey, with the size of the circle representing the number of young birds in the covey. The area managed by Norfolk Estates is outlined in orange. Ordnance Survey Crown copyright # 100039439



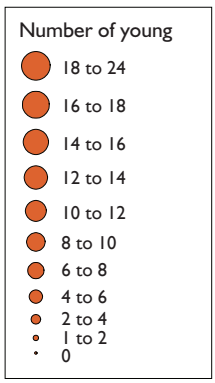


Figure 5

Grey partridge coveys from counts done in the autumn of 2014. Each circle represents a grey partridge covey, with the size of the circle representing the number of young birds in the covey. The managed area is outlined in orange. Ordnance Survey Crown copyright # 100039439

Scottish Grey Partridge Recovery Project

SNH and RSPB policy meeting at Whitburgh. From left: Graham Rankin (Whitburgh gamekeeper), Jerry Wilson (Head of RSPB Research, Scotland), Ian Ross (SNH chairman), Alastair Salvesen (GWCT member and Whitburgh owner), Stuart Housden (RSPB Director Scotland), Jim Nichol (Whitburgh farm manager), Adam Smith (GWCT Director Scotland) and Dave Parish (GWCT senior scientist).
© Hugo Straker/GWCT

BACKGROUND

The team at Whitburgh Farms has been investing in grey partridge management for many years and GWCT joined the effort in 2011 when we began monitoring partridge behaviour and ecology, along with that of many other species sharing the site. Whitburgh has also become a key demonstration site in Scotland, illustrating to practitioners and policy makers what can be done to assist grey partridge and other wildlife.

This has been an exciting year of developments for the Scottish Grey Partridge Recovery Project, not least because it marked a crucial time at one of our key sites at Whitburgh Farms in Midlothian. Grey partridge management is given a high priority here and we have been helping to monitor the impacts of this programme and use the site to demonstrate partridge management to others. 2014 was our penultimate year and our last chance to adjust the monitoring programme. With excellent warm summer weather, progress has been good. A total of seven students conducted research projects at Whitburgh at various times in 2014, studying raptors, songbirds and hares, alongside our 'core' work on these groups plus grey partridge, invertebrates and vegetation.

The grey partridge seems to have done very well, presumably in response to the fine weather. We started in spring with 26 pairs or 2.6 pairs per 100 ha and at the time of writing the keeper's counts so far have revealed a total of somewhere around the 350 bird mark or 35 birds per 100 ha (four large coveys still haven't been counted properly as they are always in cover). This is the best level of productivity at Whitburgh since 2011, and if the stock can be maintained, it could mean that a day's shooting might be possible in 2015. Despite relatively low invertebrate counts in cereal fields

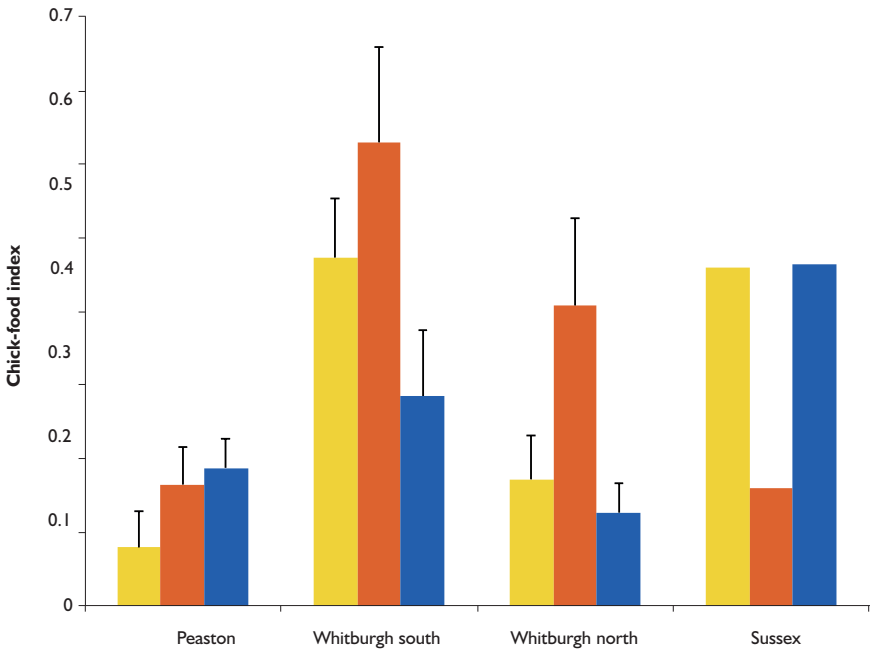


Figure 1
Invertebrate abundance in cereal crops at the three main sampling blocks within Whitburgh. (Many thanks to Steve Moreby for processing all Scottish samples once again.) Abundance seems to be increasing marginally at Peaston where some new headlands were sown in 2012, but overall invertebrate numbers were low in 2014.

Pheasant chick in headland, Whitburgh. © GWCT

ACKNOWLEDGEMENTS

The GWCT team would like to thank Mr Salvesen for his generous support of this work and to Graham for his help throughout the year. The Mains of Loriston Trust also supported the Scottish Grey Partridge Recovery Project.

at Whitburgh for 2014 (see Figure 1), chick-food availability does not appear to have limited productivity, which may reflect the impressive amount of game cover available where broods could have been taken to forage for insects (around 10% of the arable area). Much of this cover was resown this year, with varying success, so it is not clear exactly how abundant invertebrates were or where they came from. This cover was not sampled in 2014.

The other birds at Whitburgh seem to have had an equally good year. Two MSc students were focusing specifically on songbird breeding success and how this might be affected by the amount of various habitats. They found that at Whitburgh two factors best explained the number of songbird territories: the width of game cover alongside hedgerows containing bird territories, along with the nature of the hedge. Wider headlands and hedges that were larger in cross-section and less 'gappy' supported more productive songbird territories than elsewhere.

With the help of another MSc student, we put more effort into estimating the raptor numbers in 2014. Sparrowhawks were rarely seen this year and no breeding sites were found. However, buzzards were extremely abundant, with seven nests confirmed and two more suspected, averaging 0.8 nests per 100 ha.

In addition to the research activity, we hosted one of the GWCT's partridge reintroduction courses early in the year, and a visit from SNH's Chairman along with the RSPB's Director for Scotland and its Head of Research. The latter were impressed with the investment in conservation taking place at Whitburgh – much of it privately funded – and all parties agreed to work more closely together in future to tackle some of the practical problems associated with the agri-environment scheme in Scotland.

KEY FINDINGS

- Finally, 2014 was a successful year for grey partridge with a productive breeding season, despite apparently low invertebrate abundance.
- A high density of breeding buzzards (0.8 nests per 100 hectares) was confirmed this year.
- Songbird breeding success was positively associated with hedge volume and headland width.
- The year was rounded off with a visit from senior SNH and RSPB officials.

Dave Parish

© Peter Thompson/GWCT

National Gamebag Census: grouse, snipe and hares

© *Laurie Campbell*

KEY FINDINGS

- Red grouse bags are at their highest levels for 50 years in England, with good increases also in Scotland, owing to the effectiveness of medicated grit.
- Since 1962, common snipe bags have remained low in England. In Scotland, long-term fluctuations have given way to a consistent downward trend since 1990.
- Mountain hare bags show long-term cycles of 7-10 years, and a 150% rise over the last five years conforms in timing to the up phase of the current cycle.
- Brown hare bags declined 15 years later in Scotland than in England, but the slow recovery in England since the mid-1980s is absent from Scotland.

Nicholas Aebischer

Since 1961, the Trust's National Gamebag Census has monitored the abundance of a large range of game and other species through the use of bag records. We collect the data by mailing questionnaires to some 900 shoots each year, and treat all information received as confidential. Participation is voluntary, and we are always immensely grateful to all our contributors for taking the trouble to send in their returns. Over time, the accumulated records provide an insight into major changes in species numbers and shooting practices that no other monitoring scheme can offer.

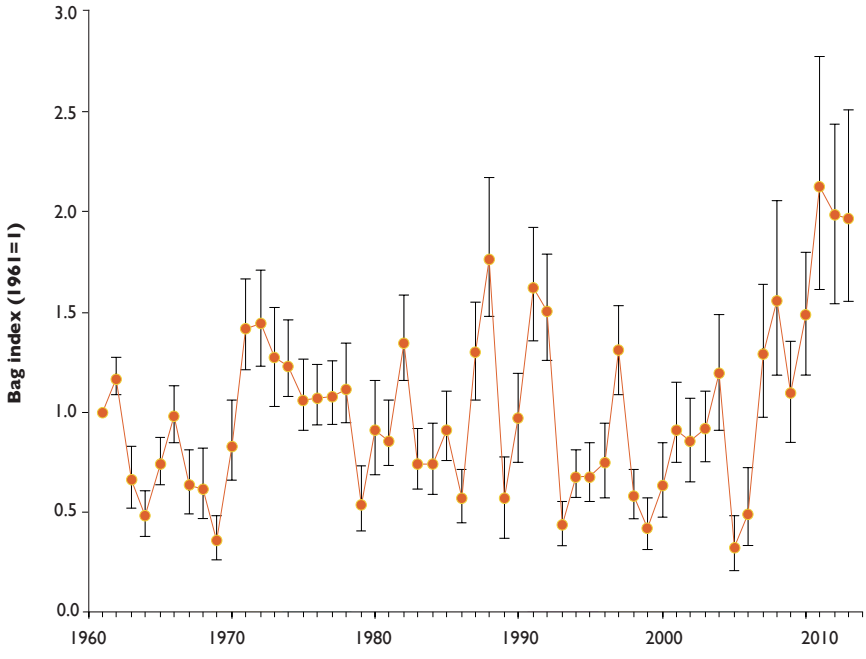
This time our focus is on four species of wild game – red grouse, common snipe, mountain hare and brown hare – with a comparison between England and Scotland where relevant. For all four species, we can generate trends over more than 50 years, from the 1961/62 season to the 2013/14 one. For each species, we base the analysis on sites that have returned bag records for at least two years. The analysis standardises the bag data to unit area to allow for differences in shoot size, then summarises the year-to-year change within sites relative to the start year. This gives a series of annual bag indices that begins with a value of 1. Subsequent indices show the relative change over time, so an annual value of 2 represents a doubling of bag size since 1961.

Red grouse (Figure 1, 2)

The English bag indices from 1961 to 2013 (see Figure 1) are based on returns from 142 shoots, the Scottish ones (see Figure 2) from 320 shoots. Up to 2007, bags in England displayed a typical saw-tooth pattern, with alternating highs and lows over periods of 3-5 years. GWCT research established that these 'quasi-cycles' are caused by the interaction between the bird and its gut parasite *Trichostrongylus tenuis*. To combat the disease, we developed medicated grit (a quartz grit coated in a fat layer containing an anthelmintic drug) and a system of delivery using grit boxes. The first version of the medicated grit weathered badly and lost its effectiveness. In 2007, we tested a new formulation with a more persistent coating, which retained 70% of the drug after nine months. The improved medicated grit was rapidly adopted by grouse moor managers, resulting in record bags in 2011, 2012 and 2013. In Scotland, where grouse densities (and bags) are

Figure 1

Red grouse index (± 95% confidence intervals), England, from NGC bags 1961-2013.



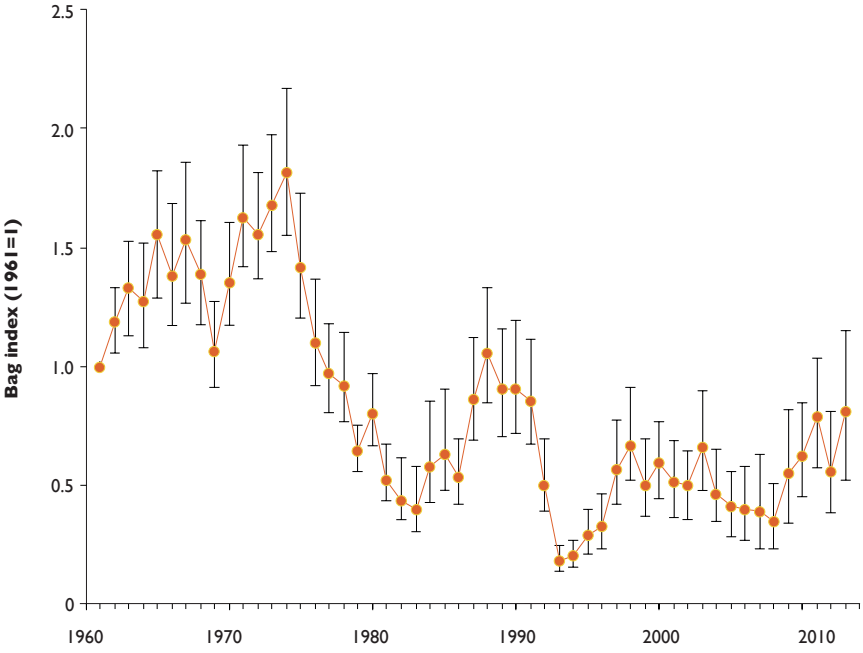


Figure 2
Red grouse index (± 95% confidence intervals), Scotland, from NGC bags 1961-2013.

© *Laurie Campbell*

considerably lower than in England, the impact of strongylosis is less marked, leading to less year-to-year variation in the bags. Here too, the deployment of medicated grit is responsible for increasing bags over the last five years, after a ten-year period of decline.

Common snipe (Figure 3, 4)

The number of shoots contributing snipe records from 1961 to 2013 were 715 in England and 331 in Scotland. The snipe that are shot in the UK are taken from a large pool of wintering birds, which arrive primarily from northern and eastern continental Europe. In England, snipe bags fell by more than half after 1962 and have remained broadly stable at a low level ever since (see Figure 3). In historical terms, the graph captures the end of a decline that began at the end of the 1930s (see *Review of 2004*), and reflects the permanent loss of habitat as wetlands and damp meadows were drained and cultivated as part of early agricultural intensification during and after the Second World War. In Scotland, where much greater areas of suitable habitat remain, the pattern is different, with alternating periods of high and low bags (see Figure 4). Since a high point in 1990, though, the trend has been consistently downward. The tendency during this period has been towards milder winters, and it is possible that European visitors have shifted their distribution in response, now being able to overwinter east of Britain and closer to the breeding grounds.

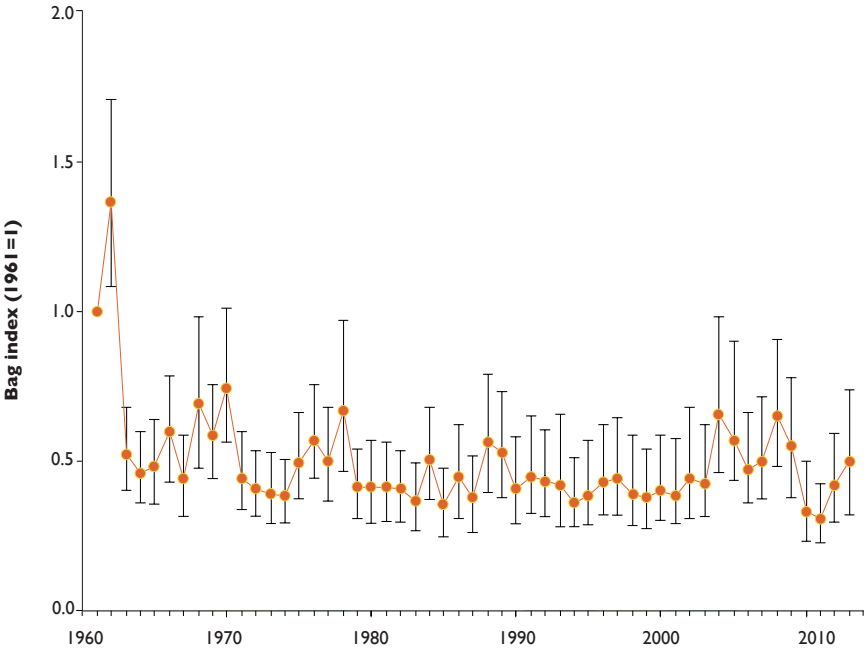
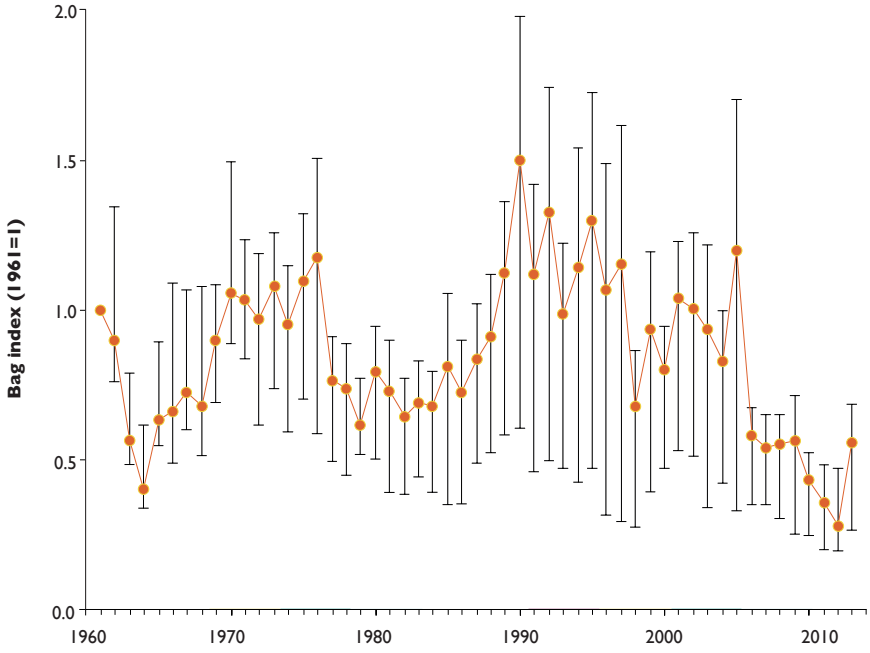


Figure 3
Common snipe index (± 95% confidence intervals), England, from NGC bags 1961-2013.

Figure 4

Common snipe index (± 95% confidence intervals), Scotland, from NGC bags 1961-2013.

© *Laurie Campbell*

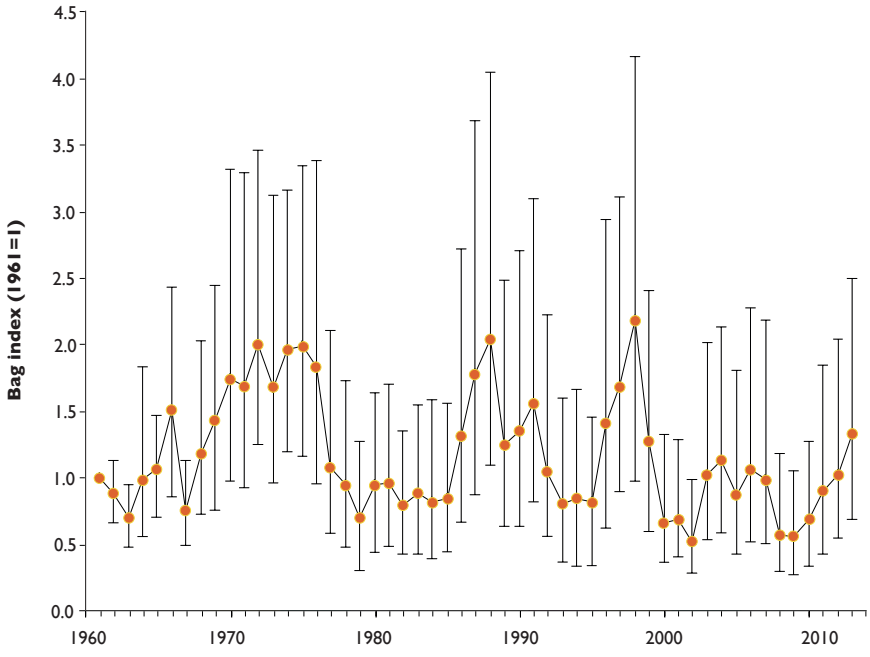


Mountain hare (Figure 5)

Very few mountain hares in Great Britain occur outside Scotland, so we have restricted ourselves to Scottish bag returns only, received from 202 shoots. Over the last 50 years, the bags have risen and fallen periodically over the space of 7-10 years. This cyclical pattern reflects underlying changes in abundance that are thought to be caused by the gut parasite *Trichostrongylus retortaeformis*, similar to the way that *T. tenuis* affects red grouse. Because the mountain hare is listed on Annex V of the EC Habitats Directive (1992), the government must ensure that its UK conservation status is favourable and that it is managed sustainably. This is particularly difficult to determine when natural cycles can lead to a 10-fold change in abundance, because the bottom of a cycle looks like a decline. A joint survey carried out in 2007 by the GWCT, the Macaulay Institute and the Scottish Gamekeepers Association found that the main reason for shooting mountain hares might have changed over time, with 50% culled for tick control rather than for sport. Without information on population size, it is difficult to judge whether changes in bags result from changes in shooting effort or track the changing density of live animals. The increase in bags over the last five years may reflect large-scale culling of mountain hares for tick control, but such culls were already taking place at the time of the survey and immediately after, when bags were falling. It is more likely that the trough and subsequent recent increase are the manifestation of the latest natural cycle, for which the pattern and timing fit perfectly.

Figure 5

Mountain hare index (± 95% confidence intervals), Scotland, from NGC bags 1961-2013.



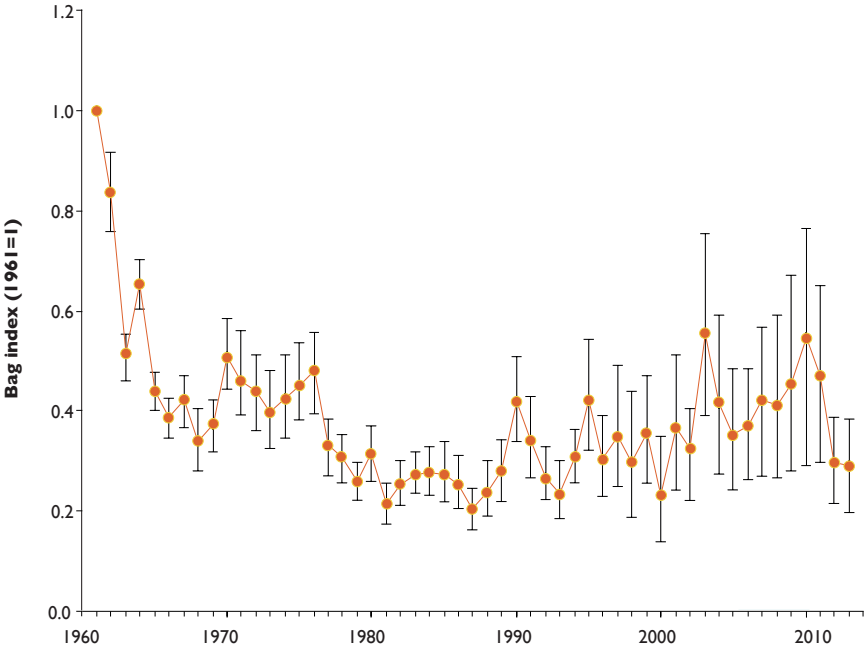


Figure 6
Brown hare index (± 95% confidence intervals), England, from NGC bags 1961-2013.

Brown hare (Figure 6, 7)

From 1961 to 2013, we received returns from 955 English shoots and 257 Scottish ones. The brown hare was declared a priority species under the UK Biodiversity Plan in 1995 because of a long-term decline in abundance. This is reflected in the bags, with the number of brown hares shot in England declining by 70% between 1961 and the mid-1980s (see Figure 6). A similar decline has taken place in Scotland, although it started 15 years later than in England (see Figure 7).

Since the mid-1980s, a slow but steady rise in English bags suggests a gradual recovery, with numbers around 2010 being approximately twice as high as in the mid-1980s. This change coincides with the deployment of set-aside and agri-environment schemes. The last two years, however, have been poor, possibly because of poor breeding in 2012 and very wet weather in early 2014.

In Scotland, although bags have stabilised since the mid-1980s, there is no evidence of a recovery. This may be because Scottish agri-environment schemes are more geared towards grassland than arable management.

Appropriate farming practices for brown hares are outlined in our leaflet Conserving the brown hare, available online at www.gwct.org.uk/advisory/conservation-guides/.

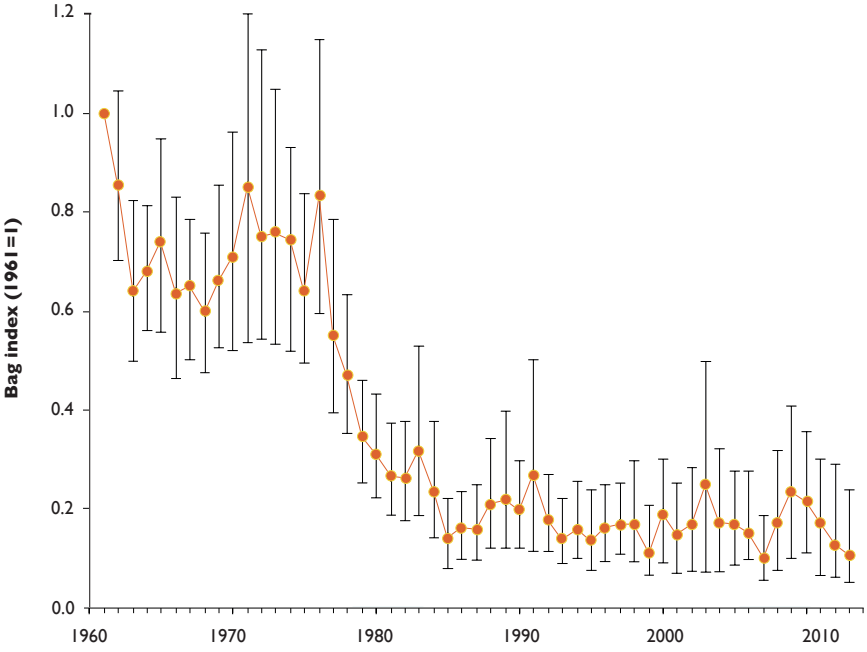


Figure 7
Brown hare index (± 95% confidence intervals), Scotland, from NGC bags 1961-2013.

© Laurie Campbell

Uplands monitoring in 2014

Red grouse densities continued to rise in 2014.
© Dave Kjaer

BACKGROUND

Each year, the Uplands Research Team conduct counts of red grouse in England and Scotland to assess their breeding densities and productivity. They also count black grouse cocks at their leks and estimate productivity for black grouse and capercaillie.

These data enable us to plot 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.

KEY FINDINGS

- Highest ever red grouse densities in July averaging 370 birds per 100 hectares were recorded on English moors.
- In Scotland average summer densities of red grouse have increased by 177% since 2008.
- In England, black grouse numbers increased from 773 males in 1998 to 1437 males in 2014.

DavidBaines,DaveNewborn,
DavidHowarth,KathyFletcher
&PhilipWarren

Red grouse in northern England and Scotland

The weather in 2014 proved to be very favourable for grouse breeding. The winter had been mild and very wet, and grouse spring stocks were high despite record levels of shooting in the 2013 season. Historically, this combination of factors would have been a problem. In past years, high grouse densities and mild, wet conditions would have combined to produce high strongyle worm infestations that would have severely reduced grouse survival and breeding success. However, with medicated grit being used on 95% of moorland managed for red grouse shooting, worm levels were suppressed. Mild spring weather enabled us to complete all our annual spring counts on time. As in previous years, counts are conducted on 100-hectares (ha) blocks of heather-dominated moorland, undertaken by a field worker and trained pointing dog.

Densities of red grouse in England in the spring of 2014 had risen by 14% from the previous year to reach a record high of a mean of 114 grouse per 100 ha. Conditions were relatively dry during incubation and the brood-rearing period, with few prolonged periods of rain to cause problems. Although breeding success was slightly lower in

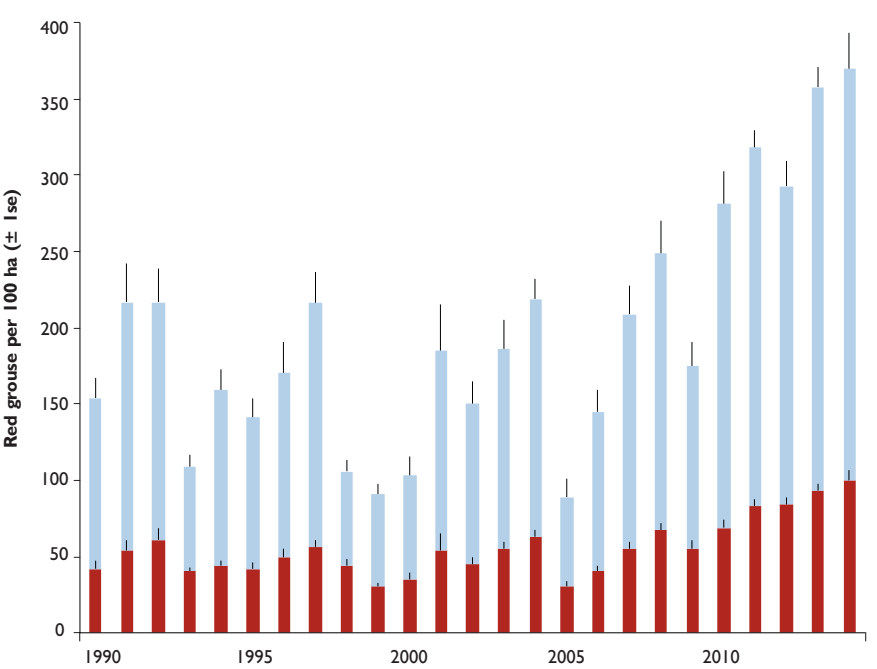


Figure 1
Average density of young and adult red grouse in July from 25 sites across northern England, 1990-2014.

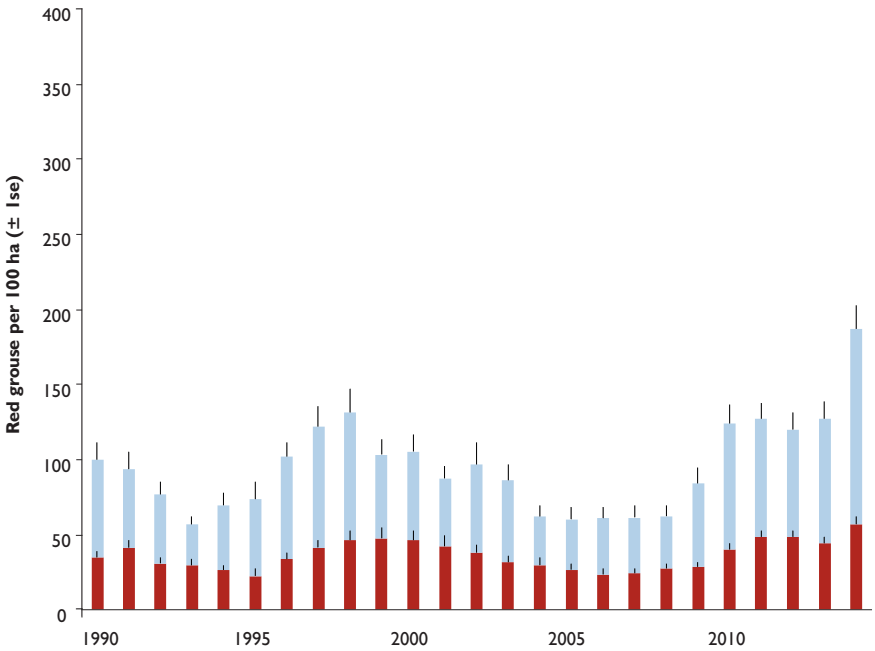


Figure 2
Average density of adult and young red grouse in July from 24 sites on Scottish moors, 1990-2014.

Young

Adult

2014 than in 2013, with an average of 2.7 chicks per adult compared to 2.8 chicks per adult in 2013, this still represents excellent productivity. With higher spring densities July densities again rose this year to a mean of 370 birds per 100 ha, the highest ever, up from the previous record of 358 per 100 ha in 2013 (see Figure 1). This increase was not universal, and in parts of the North York Moors breeding success was quite low, with many chicks in poor condition and some diagnosed by local vets as having starved to death, especially on some of the lower-lying moors.

These ever-increasing grouse numbers producing record bags in England highlight the phenomenal effectiveness of the new, improved medicated grit. Grouse population cycles appear to be a thing of the past, with 2013 statistically being a strongyle-driven crash year, but no crash in grouse numbers occurred (see Figure 1).

These year-on-year escalating grouse densities are not without their problems, as harvesting strategies may have to be reconsidered to reduce abundance and help deal with new diseases that are on the increase.

In spring 2014 in Scotland, densities averaged 58 grouse per 100 ha, an increase of 4% compared with 2013. This year red grouse bred better than in the previous three seasons at 2.3 young per adult compared to 1.9 in 2013. This rate of breeding resulted in an average density in July this year of 191 grouse per 100 ha, showing an increase from the value of 127 in 2013 (see Figure 2). This means that average July densities have increased by 177% since 2008, allowing some Scottish estates to shoot well into November.

Strongyle worm burdens in northern England and Scotland

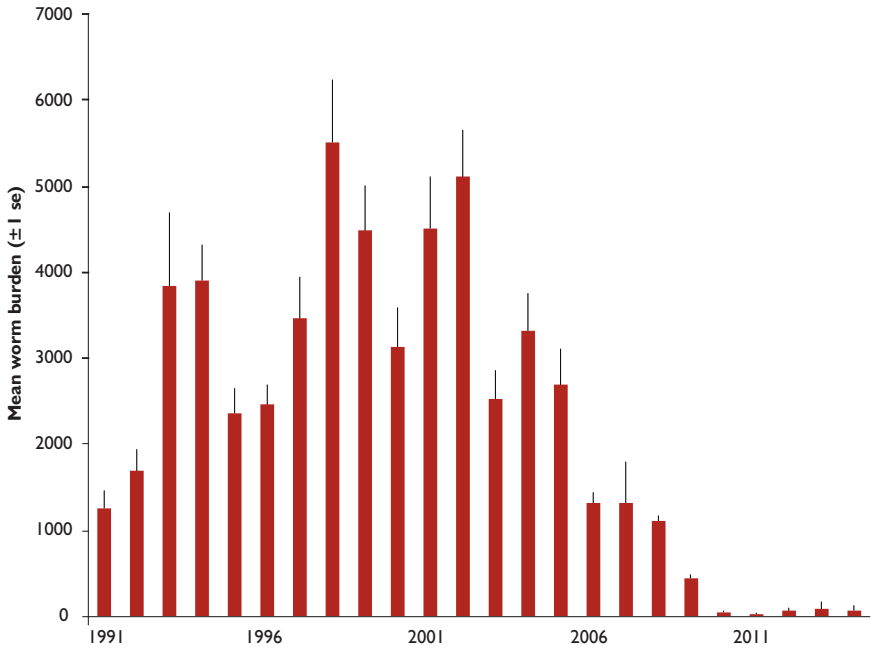
On the core sites that we monitor annually, strongyle worm levels in 2014 in northern England are once again very low owing to the new form of medicated grit being such an effective killer of worms. Worm levels have fallen year-on-year since its introduction in 2007 as more estates used the improved medicated grit in the prescribed manner (see Figure 3). Levels have now plateaued at a mean of around 100 worms per bird. The levels of strongyle worms have become so low in shot grouse that since 2010 we now only sample and count worms in adult grouse.

Historically we always found strongyle worms in adult grouse, but since the use of improved medicated grit we commonly find zero worm counts in adult grouse. The number of zero worm counts reached a peak in 2010 when 45% of adult grouse did not contain any worms. The percentage of zero worm counts has fallen to 23% of adults containing zero worms in 2013 and 2014. Well over 95% of moors managed for grouse shooting now use the improved medicated grit in the prescribed manner.

Similar trends in worm burdens have been found in Scotland, with an annual average of less than 200 worms per bird being reported since 2010 and 32% of the samples having zero worms in 2014.

© Dave Kjaer

Figure 3
Average annual worm burdens for autumn shot adult grouse from between 8 – 18 sites across northern England 1991 to 2014.



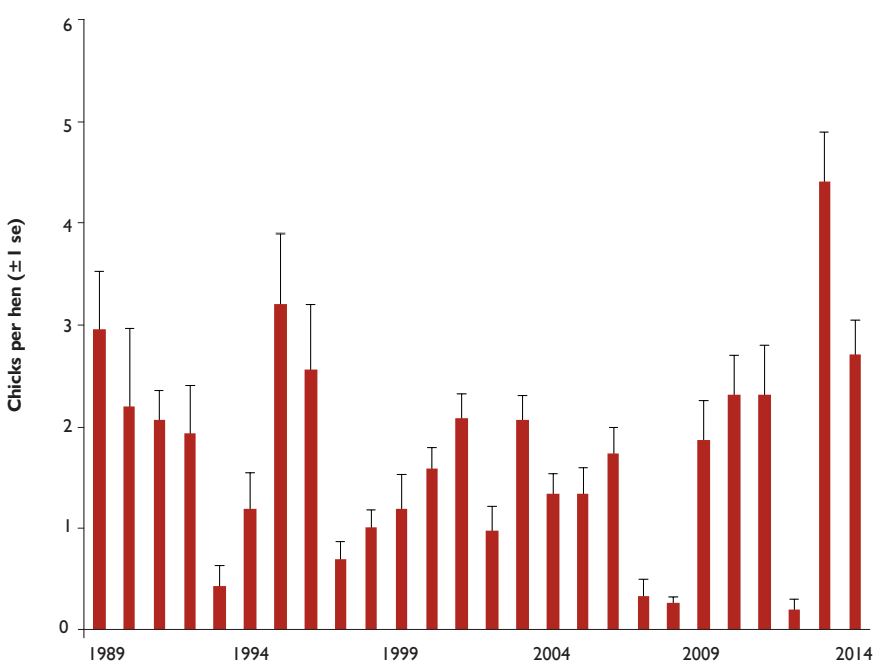
Black grouse

In spring 2014 in England we completed the fourth national black grouse survey, which was previously completed in 1998, 2002 and 2006. Overall, numbers increased from 773 males in 1998, to 895 in 2002, 1,029 in 2006, to 1,437 in 2014 and the range from 74 to 108 occupied 5x5 km grid squares. Despite the overall increase in numbers and occupied range, we have observed contrasting fortunes at the southern and northern fringes of their range. In the north, in north-west Northumberland, black grouse have practically disappeared, with numbers declining from 68 males in 1998 to only two males this spring. This is in direct contrast to the southern edge of the range in the Yorkshire Dales, where we have seen a three-fold increase in numbers from 58 males in 1998 to 193 males and corresponding range expansion.

The increases in numbers are very encouraging, particularly, as in spring 2010 numbers were down to only c500 males following the severe winter of 2009/10. A major factor in the recovery has been last year's excellent breeding productivity (see Figure 4) of 4.4 chicks per hen, which has led to a 77% increase in the numbers of males attending leks since last spring.

We carried out breeding surveys in northern England this summer using pointing

Figure 4
Black grouse breeding productivity in northern England (1989-2014).



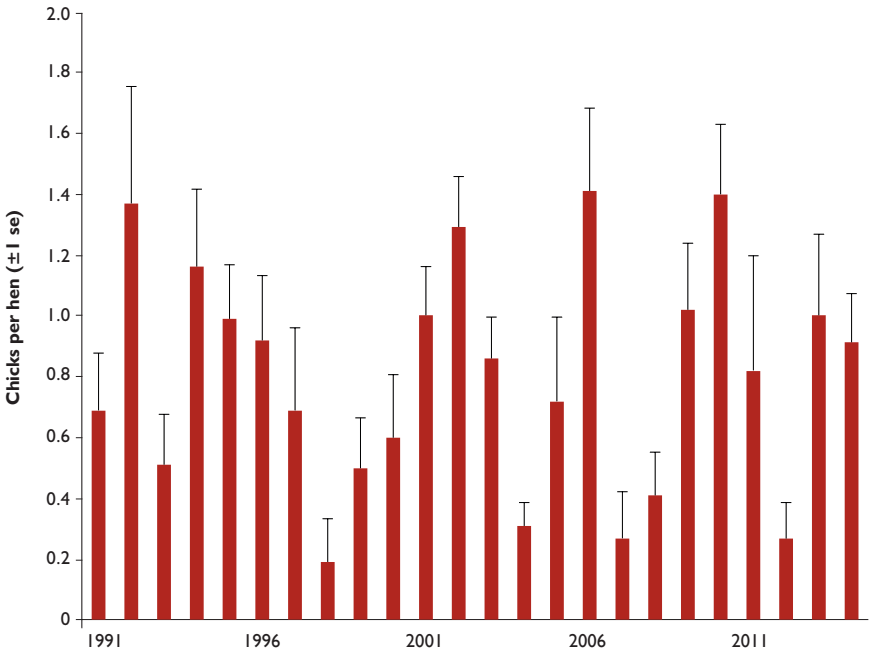


Figure 5

Capercaillie breeding success between 1991 and 2014 sampled from up to 20 forests per year in Scottish Highlands.

Please note that only data for 2003 to 2009 are directly comparable as capercaillie breeding success was derived from a different subset of forest areas each year before this, and since 2010 the number of forest areas surveyed has been reduced to between two and four per year.

dogs and found 57 greyhens, of which 43 had broods, with a total of 155 chicks, an average of 2.7 chicks per hen (see Figure 4). This was another good breeding year for black grouse in northern England, and subject to weather conditions this winter further increases in numbers are expected next spring.

In the Scottish Highlands, numbers of males at leks that we help count within Strathspey and Perthshire were up on 2013. In Perthshire, numbers have increased by 43% and in Strathspey by 30%. These increases are likely to be due to the improved productivity in 2013, with birds reported as lekking in new locations this spring.

Capercaillie

Our counts were restricted to three of our long-term study forests, all in Strathspey. Across these sites, capercaillie had a reasonable breeding year and averaged about 0.9 chicks per hen (see Figure 5). Although brood sizes were high in 2014, we still found 62% of hens without a brood. Almost three quarters of the Scottish population is now restricted to Strathspey. This contraction of the range is of huge concern because it makes the population vulnerable to a run of poor breeding years in the future.

Although brood sizes of capercaillie were high in 2014, we still found 62% of hens without a brood.
© Dave Kjaer

Langholm Moor Demonstration Project: year seven

Hen harrier chicks. © Sonja Ludwig

BACKGROUND

The Langholm Moor Demonstration Project (LMDP) has been underway since 2008 and seeks to demonstrate conflict resolution between a secure conservation status for hen harriers and other raptors and the continuation of driven grouse shooting. It is the latest attempt to seek conflict resolution for this particularly difficult issue in which the Trust has been engaged since the 1980s.

KEY FINDINGS

- In 2014 10 female hen harriers fledged 47 young.
- An overall higher abundance of raptors and short-eared owls in 2014 than in 2013 was associated with high numbers of voles and meadow pipits.
- Red grouse breeding success and adult survival were below average.
- Two out of four project objectives have been achieved to date.

SonjaLudwig
DaveBaines

The Langholm Moor Demonstration Project aims to reconcile grouse moor and raptor conservation interests with the core objective of re-establishing Langholm Moor as a driven grouse moor while maintaining a viable population of hen harriers under Special Protection Area (SPA) guidelines. Since 2008, the 10-year project has employed a team of five gamekeepers to manage the 12,000-hectare moor. In addition to predator control, heather management and the provision of medicated grit to control strongyle worms, all harriers that nest on the moor are provided with diversionary food.

This year has been very successful for hen harriers at Langholm, with 12 females breeding on the moor, of which 10 successfully fledged a total of 47 young. Harriers were not the only species to be present in higher numbers when there were more voles (5.3 voles caught per 100 trap nights in 2014, compared to 0.6 in 2013) and meadow pipits (24.6 birds per km during late Breeding Bird Survey, compared to 16.0 in 2013).

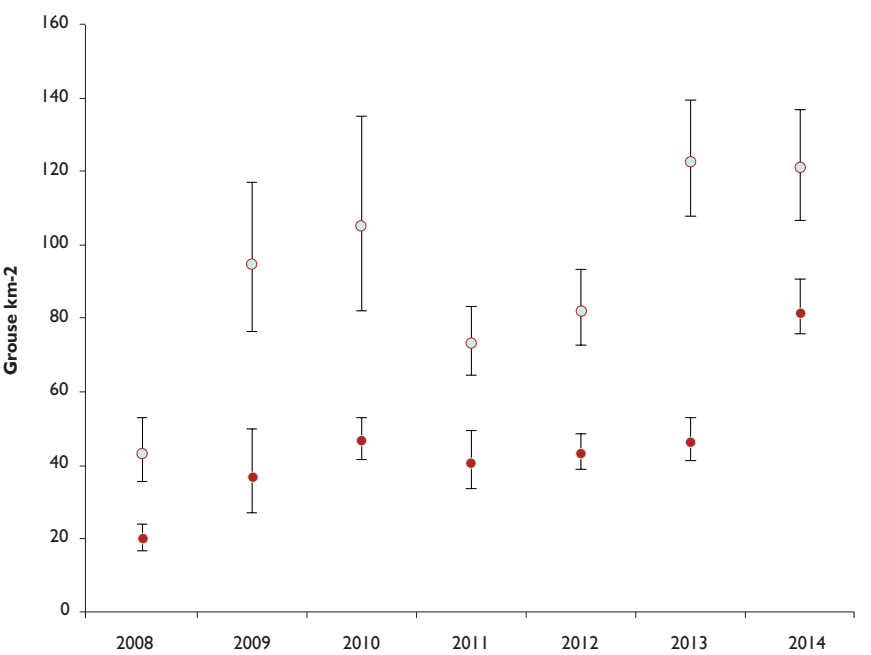


Figure 1
Mean densities of red grouse at Langholm in spring and July derived from distance sampling. Error bars represent 95% confidence limits.
Spring
July

TABLE 1

Raptor and corvid abundance (sightings/100 scans) during summer vantage point watches (May-July) in 2013 and 2014

	Buzzard	Hen harrier	Peregrine	Merlin	Short-eared owl	Raven	Carrion crow
2013 (N=6037 scans)	6.45	2.14	0.26	0.24	0.20	7.05	1.55
2014 (N=6510 scans)	15.65	7.43	0.68	1.44	1.74	2.27	1.35

The number of confirmed short-eared owl breeding pairs increased from three pairs in 2013 to 12 in 2014. Overall, we have seen a higher abundance of raptors during vantage point watches, whereas raven sightings decreased (see Table 1).

This breeding season has been less successful for red grouse. Despite a near doubling of spring density since 2013 (see Figure 1), the July density was comparable to last year with 121 grouse per km^2. This was due to a combination of increased adult mortality and low productivity, and deemed insufficient for driven grouse shooting.

To obtain more information on the main causes of clutch failure and chick mortality, we continued the more intensive monitoring of grouse nests and chicks that we started in 2013. With the help of Kathryn Fingland, an MSc student from the University of Reading, we fitted 17 grouse nests with thermologgers (to record whether clutch predation or desertion occurred by day or night) and dummy eggs (which show diagnostic teeth or bill marks) to identify the type of predator. Fourteen nests were additionally fitted with a nest camera. To monitor chick survival in the critical first three weeks after hatching, we fitted 30 chicks with small radio transmitters soon after hatching. Chick survival was monitored at regular intervals using a pointer dog.

Nesting success of radio-tagged hens was lower than in 2013 (see Table 2). Four hens were predated during incubation (two by raptors, for the other two no carcass could be retrieved) and one hen adopted the chicks of another hen and abandoned her own clutch. Two out of these five abandoned clutches were found predated by corvids after three and six weeks respectively; the other three clutches were still untouched by the end of June (approximately six to seven weeks after failure). Two further hens were predated by raptors during the chick-rearing period. Thus, overall survival of radio-tagged hens from egg-laying until July was reduced to 65% compared with 95% in 2013.

We lost eight of the 30 radio-tagged chicks during the life-time of the transmitters (battery lasts approximately 21 days). Two were found predated (both showing signs of being killed by raptors) and for six we lost the signal before the end of the battery life, indicating that they were either predated and carried off, or that the tag failed. Five chicks were monitored until the end of their tag life, and 17 chicks lost their tag. The probability of radio-tagged chicks surviving the first 10 days (lost chicks were assumed dead, as no tagged chicks present in broods upon recapture) was 0.68, which dropped to 0.26 after 20 days. This was lower than in 2013, where the survival probability was 0.80 and 0.50 respectively. As no chicks were found dead with signs of exposure, predation appears to be the most likely cause of death. In both years combined, 17 out of 56 tagged chicks were presumed predated. However, only five were found dead (four killed by raptors, one by mustelid) and thus there remains some uncertainty about the main predators involved.

After seven years, the project has achieved two out of its four main objectives, which are (A) to extend and improve the heather moorland habitat beyond its state in 2002, and (B) to maintain the hen harrier population as a viable component of the SPA (the qualifying target is 1% of the UK population; for Langholm it was set as seven breeding females). The other two objectives are (C) that the number of red grouse harvested through driven grouse shooting would be sufficient to ensure that the moor reaches a financially viable state (the target was set as 1,000 brace), and thus (D) to demonstrate compatibility between moorland management for raptors and red grouse. Neither of these two critical objectives have been met so far.

TABLE 2

Estimates of reproductive success and survival of radio-tagged red grouse hens and estimates derived from July counts at Langholm 2013/14

	2013	2014
Radio-tagged birds		
Number of hens	20	17
Clutch size	10.1	8.7
Hatching success	0.81	0.88
Nesting success	0.90	0.71
Hen survival until July	0.95	0.65
Chicks/hen in July*	4.3 (17)	2.9 (9)
Brood size in July*	5.2 (14)	4.3 (6)
Hens with broods*	0.82 (17)	0.67 (9)
July counts		
Number of hens	115	126
Chicks/hen	4.5	3.7
Brood size	5.4	4.6
Hens with broods	0.80	0.73

**Sample size given in brackets (N hens/broods)*

ACKNOWLEDGEMENTS

The Langholm Moor Demonstration Project is a partnership between the Game & Wildlife Conservation Trust, Scottish Natural Heritage, Buccleuch Estates, RSPB and Natural England.

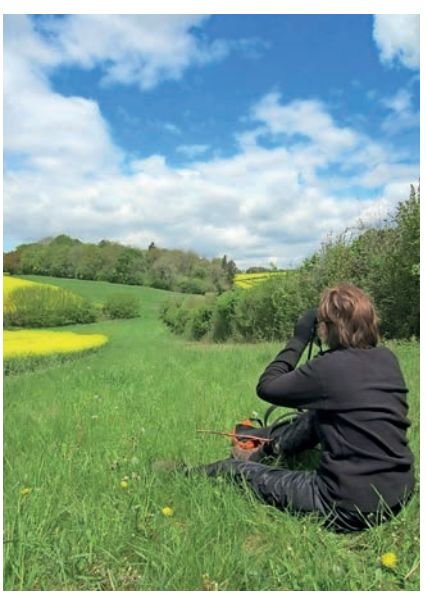
We would also like to thank the Duke of Northumberland and other moor owners.

Farmland birds and AES habitats

© Peter Thompson/GWCT

BACKGROUND

Today, farmland makes up about 70% of the total land area in the UK. Its dominance on a landscape scale means that much of the UK's wildlife is dependent on farmland. However, a number of farmland bird species have been unable to adapt to rapid changes brought about by increased agricultural intensification. Despite efforts to improve management for nature via agri-environment schemes, some farmland bird populations have continued to decline.



Yellowhammer transect territory mapping.
© Niamh Mc Hugh

Since the early 1970s a number of breeding farmland songbirds including tree sparrow, yellowhammer and corn bunting have declined. These declines were linked to the intensification of agriculture and led to the development of the Agri-environment schemes (AES) targeted at farmland bird conservation, with wild bird seed mixtures, wildflower margins, winter stubble and sympathetic hedgerow management among the options available to farmers to put into practice on their farms.

The aim of this project was to assess how farmland birds use insect-rich AES foraging habitats during the breeding season and how such birds might benefit from them. It is particularly focused on how the coverage and quality (measured by insect food levels and food accessibility) of AES habitats influences territory selection, foraging and breeding success. This work helps identify whether AES options are fulfilling their conservation potential.

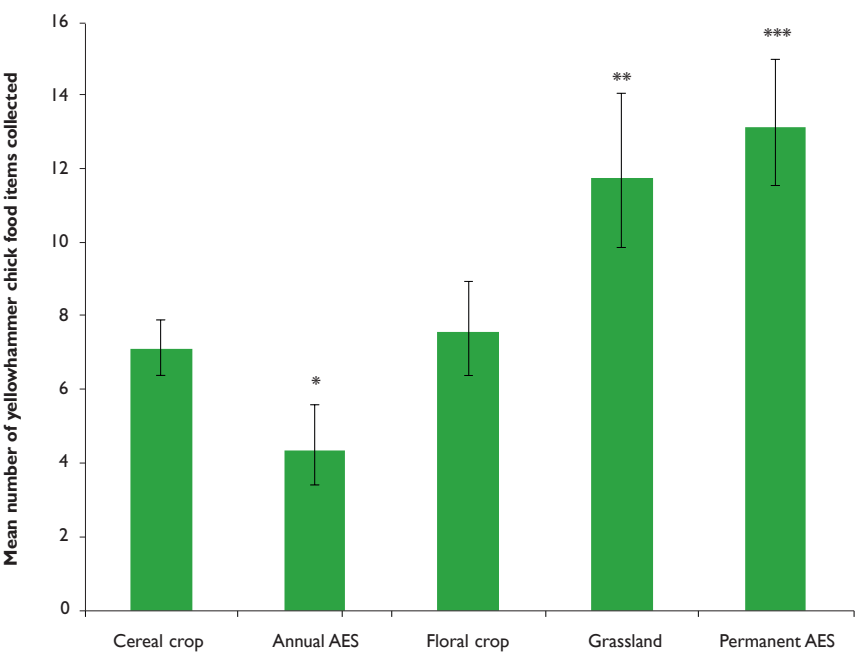


Figure 1
The total number of yellowhammer chick-food invertebrates (mean ± SE) recorded (n=160) in five types of brood cover. Stars above bars indicate a significant difference from cereal crop.* <0.05, **<0.01, ***<0.001. Cereal crop – wheat, barley, oats; Floral crop – oilseed rape, poppy, beans; Annual AES – wild bird seed mix; Permanent AES – grass margin, wildflower margin, field corner.

Use of grass-only and wildflower margins as foraging habitat by farmland passerines

This study explored whether the addition of wild flowering plants to grassy margins increased their value as a foraging resource to breeding farmland passerines. Grass-only margins and wildflower margins were selected for bird foraging observations on three farms. 25 replicates of each margin type were selected as survey points. Bird activity on margins was recorded during 30-minute point counts taking place between June and July.

A Vortis suction sampler was used to take three insect samples per margin. Surveys could only be conducted when weather permitted, ie. light or no rain, calm or no wind. This study ran for one summer, in which poor weather limited the number of visits that could be made to sites; for this reason only two foraging watches took place on each margin. We found that bird numbers on grass-only and wildflower margins did not differ significantly. However, the more insects a margin contained, the greater its use by farmland birds. Previous studies have shown that insect abundance was related to floral abundance, therefore similarities in the use of these habitat types by songbirds highlights the challenges associated with the establishment and maintenance of wildflower margins, as they are commonly taken over and eventually dominated by grasses.

Yellowhammer territory location in relation to AES habitat and boundary quality measurements

In this study we asked what was most important for yellowhammers in influencing territory site location: was it accessible AES summer foraging habitats or sites that are suitable for nesting and/or attracting a mate? The study was conducted during the summers of 2012 and 2013 on 21 lowland arable farms. On each site, 4-km survey transects were selected along field boundaries as they provide nesting habitat for breeding yellowhammer. Buffer zones of 100 metres were applied to transects to account for the average distances yellowhammer are known to forage during the breeding season. Habitat types present within this area were recorded. Data on

KEY FINDINGS

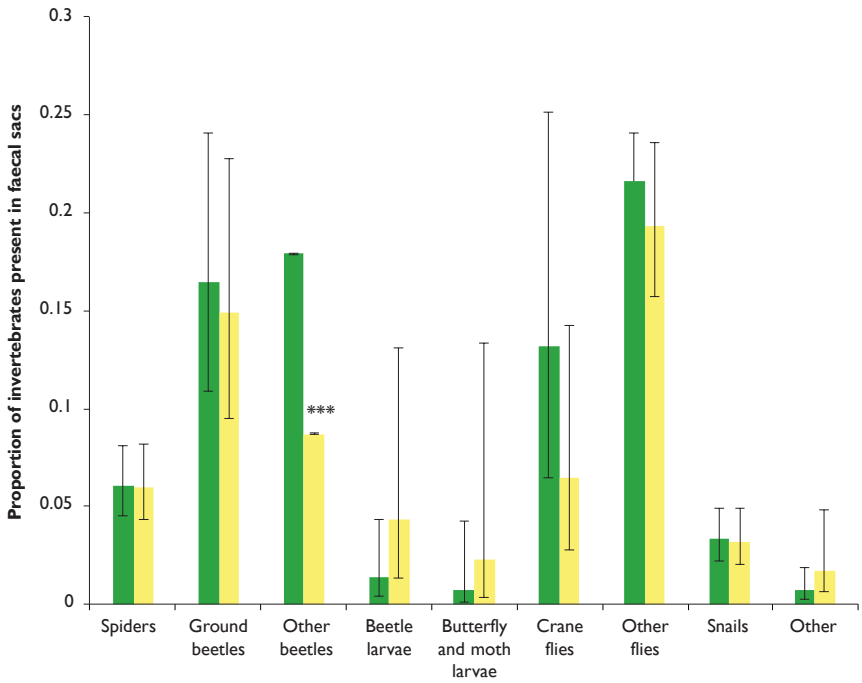
- There was a positive relationship between songbirds using margins and their insect abundance; the greater the abundance the greater the use.
- Yellowhammer territory selection was strongly related to the presence of suitable nesting habitat.
- There was little difference in tree sparrow chick diet on agri-environment scheme land and control sites.
- Tree sparrow fledging success increased with the area of agri-environment scheme grass cover (habitats including grass buffer strips and wildflower margins).

NiamhMcHugh
JohnHolland

Agri-environment scheme grass cover, such as wildflower margins, was found to increase tree sparrow fledging success. © Peter Thompson/GWCT

Figure 2

The total number of several invertebrate groups (mean ± one SE) recorded in faecal sacs of tree sparrow chicks from control and AES sites. Stars above bars indicate a significant difference from the control site.* <0.05, **<0.01, ***<0.001.



Tree sparrow chick. © Niamh Mc Hugh

Winter stubble is one of many AES options available to farmers. © Peter Thompson/GWCT

permanent field boundary features along transects were also collected. These were boundary type (hedgerow, shrubby hedge with trees, line of trees and fence lines), width, height, the presence/absence of songposts, and whether the hedge had been cut before the breeding season began. Over two field seasons 131 yellowhammer territories were observed across the 84 km of boundary habitat surveyed. Territory location was strongly related to the presence of suitable nesting features such as hedgerows and song posts, and territories were more likely to be located where hedges had been cut prior to breeding. Consequently, when trying to encourage farmland birds such as yellowhammers it is important to provide the insect-rich foraging habitats alongside important nesting habitats. Significantly more yellowhammer chick-food insects were found in permanent AES strips compared to the conventional cereal crop (see Figure 1).

Tree sparrow nestling diet and AES

The tree sparrow is a hole-nesting farmland species that has declined by over 94% since the 1970s. AES prescriptions contain several options that should boost tree sparrow chick-food availability, including ungrazed grass margins, field corners and arable options such as winter stubble and wild bird seed mixtures. This study aimed to compare the abundance and diversity of tree sparrow chick-food items between nests in boxes with and without access to AES habitats provided for foraging birds. During the breeding season tree sparrows are central place foragers; this means they are restricted in the distance they can travel in search of insects for their chicks (approx. 200 metres). Nestboxes were assigned to AES or control groups based on the presence/absence of AES habitats within this area. In 2013, faecal samples were collected from the second brood of chicks that were between 7 and 10 days old (over this period sparrow nestling survival is highest). At this time chicks are investing a large amount of their energy in feather growth and development. A total of 83 faecal sacs were collected representing 41 second broods. Little difference between the two treatments investigated was found, but chicks at control sites ate significantly more Coleoptera (representing 18% of chick diet versus 10% on control sites) (see Figure 2). This illustrates how adaptable this species is; across Europe tree sparrow chick diet is also known to vary in its taxonomic composition between habitat types and broods.

Next we used the dietary information collected to assess chick-food abundance in different AES and crop habitats. We found that tree sparrow chick-food abundance was over 55% higher in grass AES habitats when compared to oil-seed rape, spring cereals, WBS and winter cereals (see Figure 3). Adult tree sparrows living without access to AES sites may have to sacrifice their own condition by working harder to feed chicks.

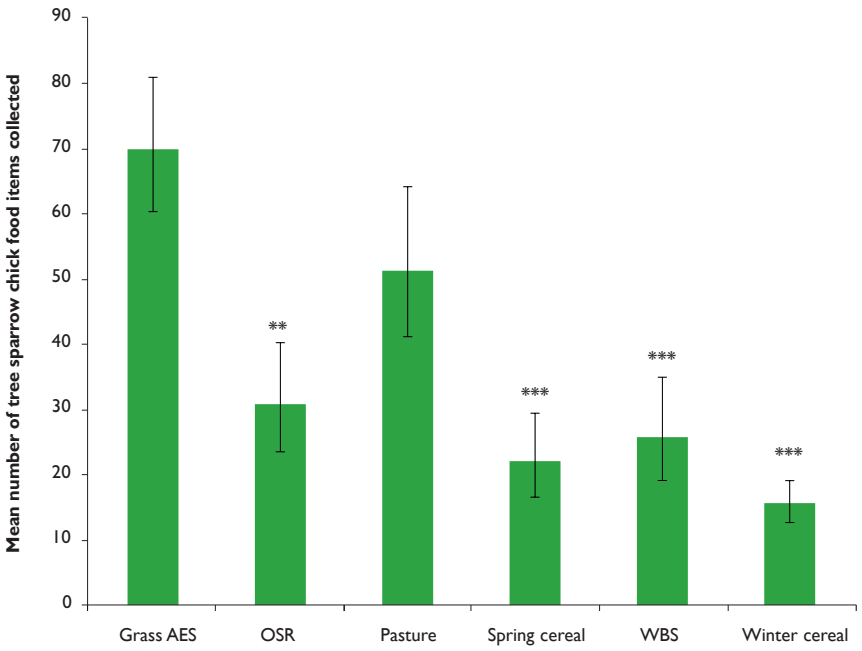
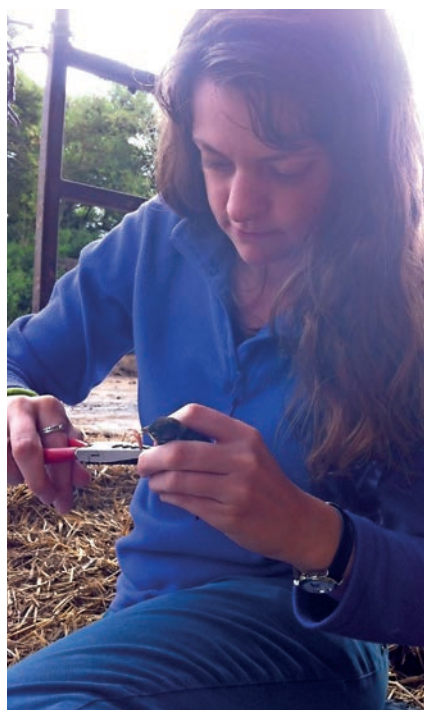


Figure 3

The total number of tree sparrow chick food invertebrates (mean ± SE) recorded (n=212) in six types of brood cover. Stars above bars indicate a significant difference from Grass AES. * <0.05, **<0.01, ***<0.001.
OSR – Oilseed rape, WBS – Wild bird seed,

Breeding performance of tree sparrows

The study aimed to document whether the productivity of the tree sparrow was limited by the availability of invertebrate-rich foraging habitat. Data collection involved checking nest boxes every two to three days to obtain information on reproductive success; this was done for first, second and third broods in 2013 and 2014. The coverage of grass AES, oilseed rape, pasture, spring cereals and winter cereals within 200 metres of the nest boxes was then calculated. This information was used to investigate whether higher annual productivity was more frequently associated with habitats that support a high diversity of invertebrate taxa. Fledging success (n=429) was found to increase by 10% when the observed amounts of AES grass cover (eg. grass buffer strips, wildflower margins, grass corners) were located within their foraging range.



Tree sparrow nest box monitoring involved ringing pulli. © Chris Heward

Fledging success of tree sparrows increased when the observed amounts of AES grass cover were located within their foraging range. © Peter Thompson/GWCT

ACKNOWLEDGEMENTS

We are grateful to the BBSRC and Natural England for providing funding for this project. The assistance of Matt Prior, Cecily Goodwin, Sophie Hughes and Jacqui Machin over the course of this project is appreciated. In addition we would like to thank all landowners that allowed us permission to work on their land.

Managing New Forest heaths

New Forest ponies graze freely in the Forest.
© Barbara Smith/GWCT

BACKGROUND

The study was carried out in the New Forest National Park, which is the largest area of lowland heath in the UK and contains approximately 14,600 ha of heathland and similar habitats. It is a key strategic area for UK Biodiversity delivery, which is facilitated via a local partnership of: the National Park Authority; the Forestry Commission, managing crown lands within the Forest; the Verderers, who administer the New Forest's agricultural commoning practices; the Commoners Defence Association, who represent the commoners' grazing interests; and Natural England. Together they manage the Forest and it is important that good evidence is available to support them in targeting management appropriately.

Insects were collected using sweep nets.
© Barbara Smith/GWCT

The UK has approximately 18% of the world's dry heathland, of which 11% is lowland heath. It is a UK priority habitat and supports specialised wildlife communities found in no other habitats. The largest area of lowland heath in the UK can be found in the New Forest National Park. Although the UK Biodiversity 2020 strategy aims to deliver 'better wildlife habitats', recent assessments suggest that less than 22% of lowland heathland sites are in favourable condition. Managers need evidence to support them in developing heathland recovery plans.

The New Forest as a whole is characterised by a mosaic of heathland, unimproved grassland and woodland. The structure of the heathland is maintained through extensive grazing and heathland management in the form of managed burning or cutting. Management prevents heathland from maturing to scrub or woodland and also promotes grazing by maintaining heather in the 'building' stage during which it produces the most vigorous and nutritious growth. There is some debate over which form of management is most appropriate for heathland but there is little evidence to show whether burning or cutting is most beneficial.

This study evaluated the impact of two management techniques, burning (controlled burns carried out in late winter) and swiping (cutting with a flail and leaving the litter), on heathland condition, heathland vegetation and selected invertebrate taxa, over time (0-20 years). We surveyed 90 sites across the New Forest, recording vegetation

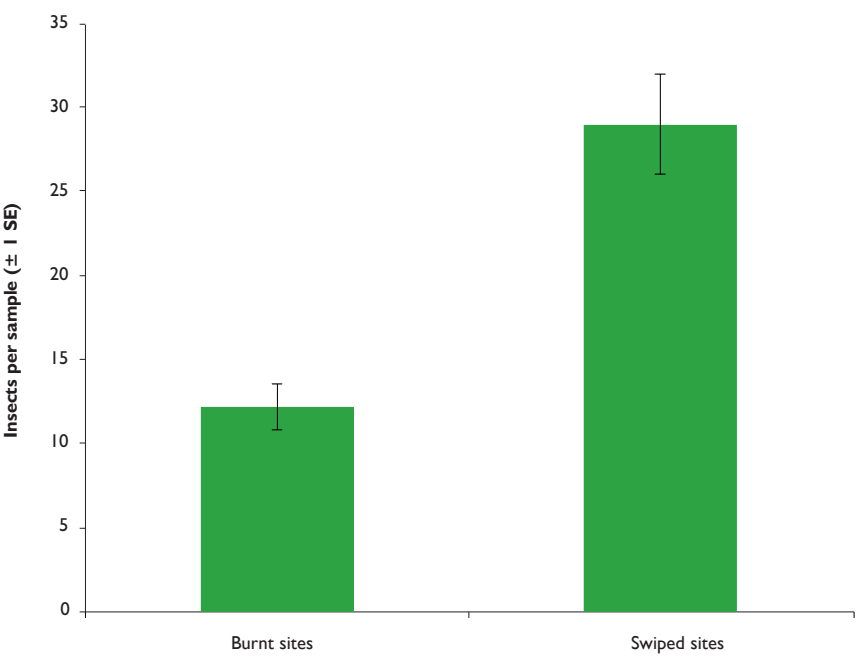


Figure 1
Abundance of Dartford warbler invertebrate prey on burnt versus swiped areas.

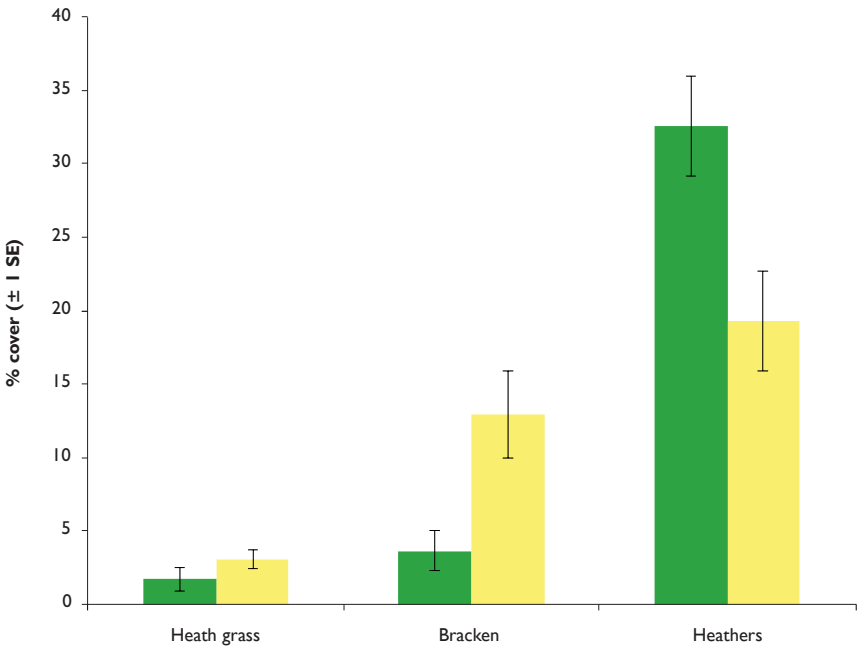


Figure 2
Vegetation cover on burnt versus swiped areas.

Burnt sites

Swiped sites

structure and species composition in quadrats and sampling invertebrates using pitfall traps and sweep nets. Our aim was to provide ecological evidence for managers. We found that burnt sites were more likely to support classic heath, with 1.7 times more heathers and dwarf shrubs than swiped sites, with the majority of heather being in the early growth phases. Burning also suppressed bracken more effectively than swiping. Swiped sites had 72% more bracken cover than burnt sites. Although bracken is a typical component of heath, dominance by bracken is considered undesirable. The vegetation on swiped sites comprised 44% more heath grass with 75% higher cover of broad-leaved plants than the burnt areas (see Figure 2). Irrespective of management, heathland vegetation changed over time, with the dwarf shrub:grass ratio improving in the early years and stabilising six years after management.

Some invertebrate species were strongly associated with burnt sites such as the small heather weevil (which is dependent on heather) and the green tiger beetle, which is a species of open areas and was likely to have been encouraged by the greater proportion of bare ground. No tiger beetles were recorded on swiped sites. However, swiped sites supported greater numbers of grass-feeding species such as meadow grasshoppers (92% more on swiped sites) and bracken bugs (86% more). Overall the invertebrate fauna of the swiped sites was more typical of grassland and arable habitats, but these areas could play an important supporting role by providing resources to heathland specialists. Swiped areas supported a greater abundance of insects eaten by both Dartford warblers (58% more) and nightjars (43% more) (see Figure 1). Dartford warblers are restricted to heathland habitats and nightjars are frequently found on heathlands; both are threatened by habitat loss. This underlines the importance of maintaining the mosaic of habitats in the New Forest. It is not possible to recommend a one-size-fits-all management tool but it is possible to use the ecological evidence that we gathered to target management to best benefit wildlife on a patch-level scale.

Volunteers surveyed vegetation on 90 sites.
© Barbara Smith/GWCT

KEY FINDINGS

- We compared two heathland management techniques, managed burning and swiping (cutting with a flail).
- Burnt areas comprised 1.7 times as many heathers and dwarf shrubs as swiped areas, and were favoured by insects such as green tiger beetle. Burning suppressed bracken more effectively than swiping.
- Swiped sites supported a more diverse flora and greater abundance of the invertebrate food items selected by the Dartford warbler and the nightjar, both New Forest SPA bird species.
- Management had a significant impact on heathland communities and optimum management practice in a heathland mosaic like the New Forest is patch-scale dependent.

BarbaraSmith

ACKNOWLEDGEMENTS

The project was part-funded by the New Forest National Park Authority's Sustainable Development Fund in partnership with the Verderers of the New Forest through Environmental Stewardship as part of the Rural Development Programme for England and with the National Trust. The research partners were the Game & Wildlife Conservation Trust and the Natural History Museum.

Allerton Project: game and songbirds

Released pheasant shooting is in its fourth year.
© Laurie Campbell.

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 impacts of predator control and winter feeding.

KEY FINDINGS

- Released pheasant shooting is in its fourth year, following nine years without game management.
- Numbers of wild pheasant, hares and songbirds remain low.
- Grey partridge numbers have increased.

ChrisStoate
JohnSzczur

We are in our fourth year of released pheasant shooting at our Allerton Project demonstration farm at Loddington, following a nine-year period in which there was no game management or shooting. 3,400 cock pheasant poults were released in 2014, providing 13 days of driven pheasant shooting and a return rate of 54%. Five 'species days' were held on which other quarry species were shot, in addition to pheasants. Most shoot days are auctioned nationally, while others are sold locally, ensuring that a wide range of people are able to learn about our farm management and research as well as enjoying a shoot day.

Although we have provided a sequence of successful shoot days, the number of wild pheasants recorded in autumn is not much higher than in the 2007-2010 period without predator control or winter feeding (see Figure 1). Although showing a slight increase, hare numbers also remain low. Both species remain some 80% below the numbers achieved during the game management phase in 1993-2001. Both species are highly susceptible to predation by foxes during the breeding season; the focus on the release of reared pheasant poults, and the management of them, may be at the expense of the control of foxes when birds are nesting.

In contrast to the trend for wild pheasants and hares, grey partridge numbers have been increasing (see Figure 2). Following a long period of absence, this species appears

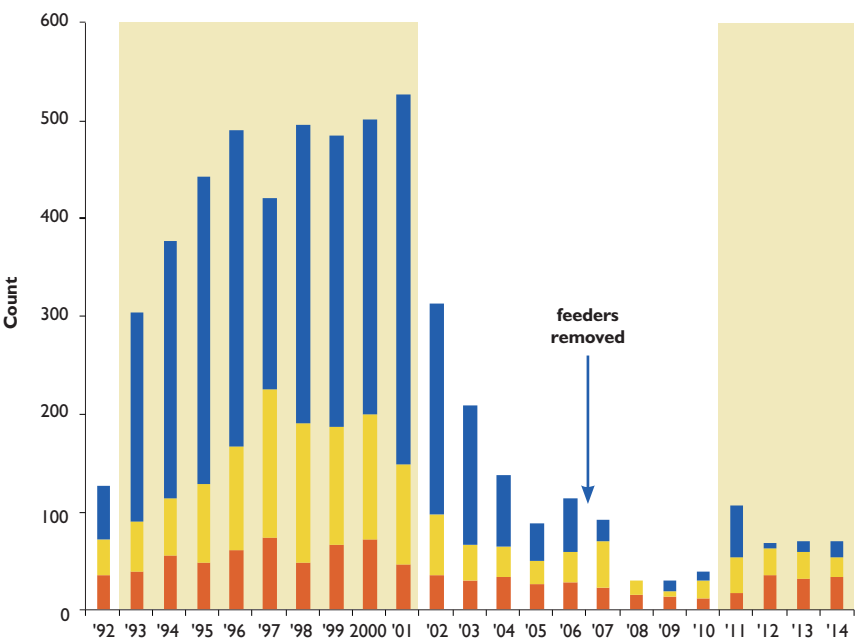


Figure 1
Autumn wild pheasant numbers from 1992 to 2014.

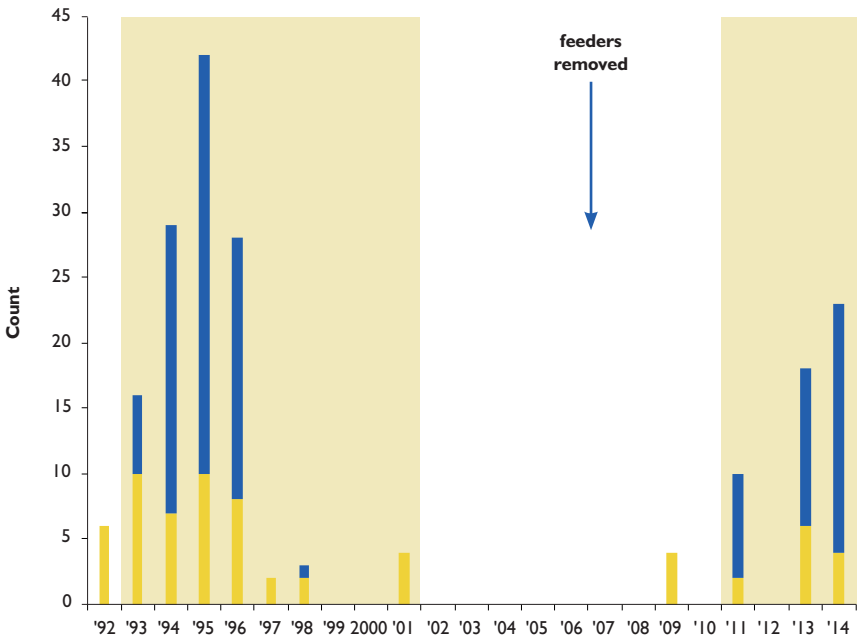


Figure 2
Autumn grey partridge numbers from 1992 to 2014.

Young

Adults

Keepered period

to have established itself on the farm once again during the current period of game management, with 23 birds (four adults and 19 young) being recorded in the autumn.

Like pheasants and hares, overall songbird numbers have not increased over the same period (see Figure 3). Having slipped below the 1992 baseline value for the first time last year, overall songbird numbers are now 16% above that baseline. This compares to a 70% increase over the baseline recorded four years into the previous game management system in the 1990s when the focus was on the management of wild gamebirds. At least in part, the recent response is likely to have been limited by the very wet nesting season in 2012, and by snow cover in two recent winters.

The income that we receive from the shoot days (£50,233 on average per annum) falls well short of the cost of the management needed to support them (£80,383). Having had a period of time in the 1990s when we relied on the management of wild game, followed by a period without shooting, our current experience of a small-scale released bird shoot is enlightening, and not without its challenges. In particular, maintaining the high level of predator control that some species benefit from is difficult to justify where the focus is on reared and released game. We are currently reviewing the shoot at the Allerton Project with a view to providing more cost-effective shooting that benefits wildlife and contributes to the cohesion of the local community.

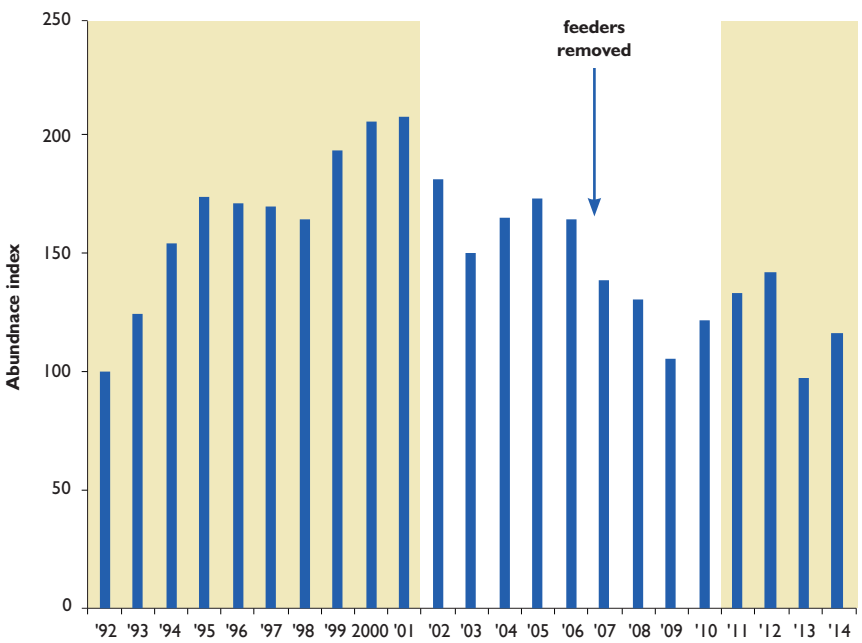


Figure 3
Songbird abundance relative to the start of the project.

The farming year at the Allerton Project

We are continuously reviewing our cropping strategies to help control black-grass. © GWCT

BACKGROUND

The Allerton Project is based around an 333-hectare (800 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. The Project also has an educational and demonstration remit.

KEY FINDINGS

- Soils now recovering from previous years' challenging weather.
- Continuously reviewing cropping strategies helps control our number one weed, black-grass.
- Investment in a biobed will eliminate pesticide run-off from the farmyard.

AlastairLeake
PhilJarvis

The 2014 harvest saw a welcome return to 'normal' yield levels, after two years of depressed performance brought about by unprecedented levels of precipitation. On our heavy soils this presents a particular challenge, and even where we were careful to keep off the land, we created areas of compaction that took time to rectify. Switching to direct seeding with no soil cultivations is certainly helpful, since it reduces the number of tractor journeys across the field and reduces the size of tractor needed for the sowing operation, but when compaction occurs then it needs to be removed promptly to avoid yield loss. We noticed, for instance, that the beans we grew following a shallow surface cultivation fared better than those that were simply direct-seeded. We are also learning how to manage cover crops. These are short-term unharvested crops, which we sow in the autumn in advance of a spring-sown crop to help protect the soil from erosion, take up residual nitrogen from the soil, and help increase soil organic matter when they are destroyed. The perceived wisdom is that these crops help to condition the soil, and the plants take up moisture and help to dry the soil in spring ahead of sowing. In fact, we found they did quite the opposite and created a much wetter and more difficult-to-manage seedbed, particularly sub-surface, compared to the bare stubble, which dried out much more evenly.

We continue to battle with herbicide-resistant black-grass. Back in 2003 we switched from winter to spring beans and began to include some spring oats in our rotation, as it

TABLE 1

Arable gross margins (£/hectare) at the Allerton Project 2009-2014.

	2009	2010	2011	2012	2013	2014 (est)
Winter wheat	496	673	783	255	567	590
Winter oilseed rape	401	799	1082	490	162	414
Spring beans	200	512	507	817	580	646*
Winter oats	387	808	873	676	570	354

(Note – No Single Farm Payment Included)

** winter beans*

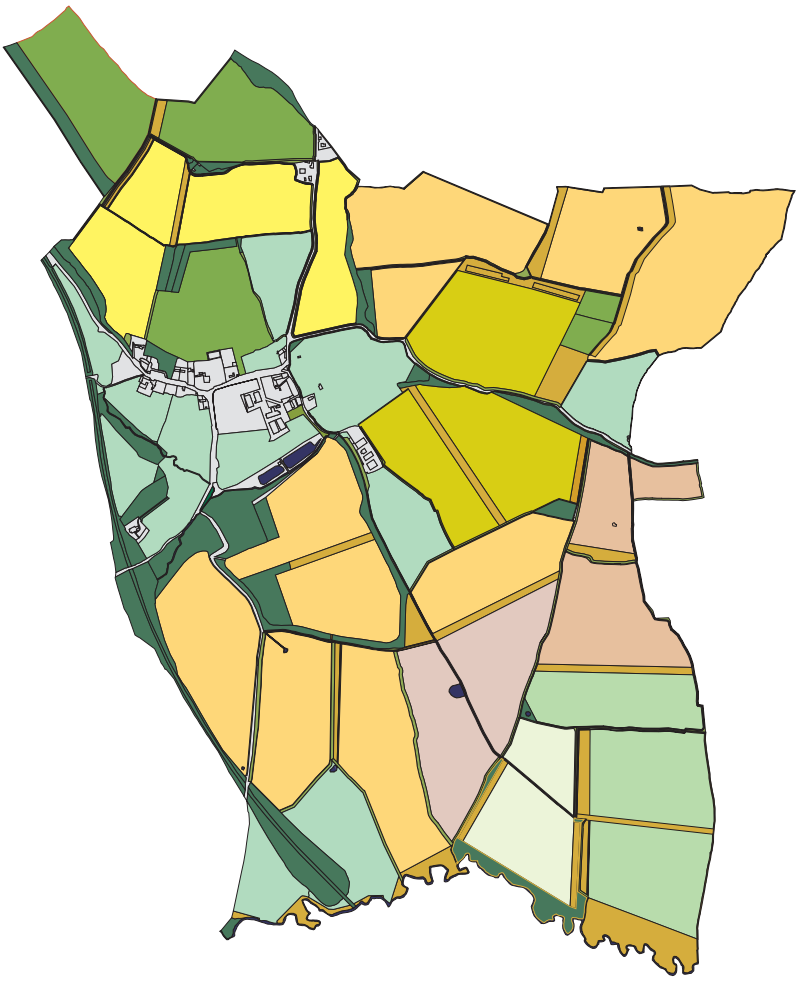


Figure 1

Allerton Project cropping 2013/14

- Winter wheat
- Spring beans
- Winter oilseed rape
- Winter oats
- Spring barley
- Spring oats
- Permanent grass
- Red clover & lucerne
- Stewardship
- Winter beans

is known that a predominance of winter cropping can favour black-grass. This strategy certainly helped initially, but in time the weed has modified its germination window such that the majority of the seeds now are spring-germinating. To counteract this we have returned to winter drilling. This demonstrates the need for farmers to watch weed biology closely and ring the changes to keep one step ahead. Changing drilling dates also means that we have a wider range of herbicides available to us.

The incorporation of short-term grass clover leys will also help, particularly where we direct-seed into the sprayed-off sward when we return to the cropping phase.

Down at the farmyard we have developed a number of green features. We have installed a new self-contained filling area for our sprayer and a biobed to treat dilute

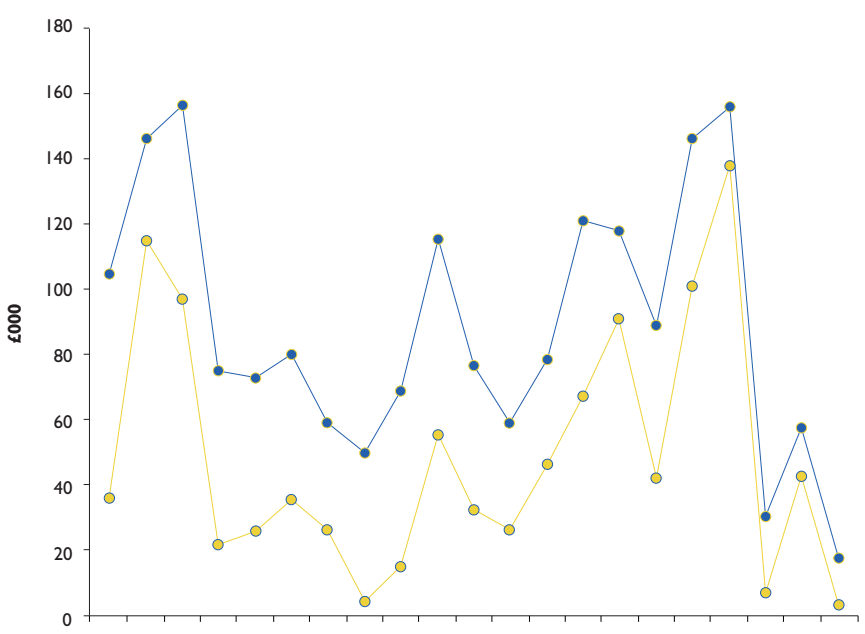
Open Farm Sunday provided an excellent opportunity for over 400 visitors to see the work of the Allerton Project. © GWCT

Investment in a biobed will eliminate pesticide run-off from the farmyard. © GWCT

pesticide washings. Modern spray equipment is designed to minimise the likelihood of spillage. Induction hoppers ensure that containers are opened, dispensed and rinsed within a contained bowl, with everything ending up initially in the spray tank, and then ultimately on the crop. However, the sprayer itself can get contaminated by drift and, if parked outside in the farmyard, rain can easily wash the spray deposits off the machine onto the concrete yard and down the drain to the stream below. Now we can collect these washings and sprinkle them over our sealed biobed. The bed is made up of a mixture of straw, soil and finely chopped woodchip, which provides a highly biologically active substrate for bacteria to break down the spray washings. The treated water is pumped out onto the field, since it is sufficiently clean to no longer pose a threat.

We have mounted 128 solar panels on the south-facing roof of the grain store. This will generate electricity to help with our grain-drying costs. We have also found that the grain stores are very good for drying wood chip destined for our biomass boilers. We are currently working on plans to redevelop the old sheep sheds and Dutch barn, which are ready for demolition, and build a new workshop, machinery store and grain storage bays.

Figure 2
Gross profit and farm profit at the Allerton Project 1994-2014.



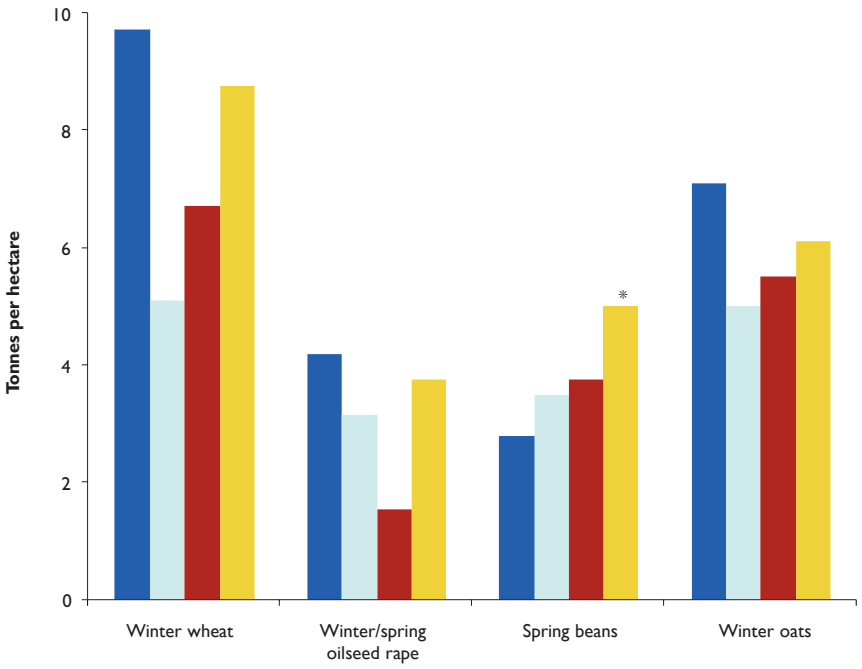


Figure 3
Crop yields at the Allerton Project in 2011-2014.
Spring oilseed rape was sown in 2013
** winter beans*

TABLE 2

Farm conservation costs at the Allerton Project 2014 (£ total)

Higher Level Stewardship costs (including crop income foregone)	-26,160
Higher Level Stewardship income	29,016
Woodland costs	-7,128
Woodland income	3,336
Farm shoot expenses	-7,128
Farm shoot income	7,128
Total profit foregone – conservation	**-936**
Total profit foregone – research and education	**-13,499**
	£14,435

Water-friendly farming project

Buffer strips reduce the movement of sediment and nutrients to water. © Chris Stoate/GWCT

BACKGROUND

Water Friendly Farming is our largest single research project and builds on a series of smaller-scale projects on soil management and field-edge wetlands that have been carried out at Loddington over more than a decade. Wherever possible we consider soil and water together in order to address issues associated with crop performance, flood control and water quality, both to meet statutory obligations such as the Water Framework Directive, and economic objectives for farm businesses.

KEY FINDINGS

- First scientific evidence that new pond creation can compensate for loss of aquatic plant biodiversity at the landscape scale.
- Sewage treatment works are a major source of phosphorus in our agricultural catchments.
- Annual soil loss from arable fields in our catchments is in the order of half a tonne per hectare.
- Hydrological modelling suggests that buffer strips halve the amount of sediment reaching watercourses.

ChrisStoate
JohnSzczur
(with Jeremy Biggs, Adrianna Hawczak, Anita Casey and Penny Williams from the Freshwater Habitats Trust and Colin Brown from University of York)

Research at the Allerton Project and elsewhere has taught us much about how individual management practices such as reduced tillage and constructed wetlands can reduce the impact of agriculture on water quality and ecology. Despite this, little is known about how far we can move towards EU Water Framework Directive targets for water quality and ecology by adopting a combination of such measures at the landscape scale. 'Water Friendly Farming' is our landscape-scale research project, which explores this issue in a practical farming setting, while also adopting a rigorous experimental design. With our main partner, the Freshwater Habitats Trust, we have now gathered three years of baseline data at the base of each of our three study catchments, and across 240 sites within them. About 3,000 hectares of land is included in the study area. Additional data are gathered from the tributaries within each of the three catchments. Together, these represent an exceptionally strong baseline against which to evaluate the effects of current and future management to improve water quality and protect wildlife.

During 2014, we put in place a wide range of measures to reduce the agricultural impact on water in two of the three catchments. The third catchment represents a control in which we do not change the management. These management practices mainly take the form of various interception ponds to capture sediment and associated nutrients in ditches and field drains. We have not introduced new buffer strips as many are already in place under existing Environmental Stewardship agreements in both catchments. Four lengths of stream have been fenced in the Eye Brook catchment to stop or reduce livestock access, and storm water has been diverted from slurry storage at one Eye Brook farm. Soil and nutrient mapping has been carried out and nutrient management advice has been provided to seven Eye Brook farms. We are currently developing our support to farmers for improved soil management. Advice and support for septic tank management has also been provided for 18 individual households, as we know from our previous research that phosphorus reaches water from domestic sources, as well as from farming. In one of the two catchments, 22 new clean water ponds have been created specifically as wildlife habitat.

Our almost continuous monitoring of water quality at the base of each catchment provides a valuable insight into the loss of soil and nutrients from the agricultural land. Because of their impacts on wildlife, and relevance to Water Framework Directive targets, we have focused on sediment and phosphorus. Muddy stream water during and following rainfall is a familiar sight, but our data quantify this movement of soil down the catchment. From previous research we know that soil loss to water from arable land is at least four times that from grassland. We know the proportion of arable land in the study area so can estimate that the soil loss from arable fields is at least half a tonne per hectare per year.

It is not quite that simple, though, as not all soil lost from fields reaches the water courses. Initial hydrological modelling of our data by the University of York suggests

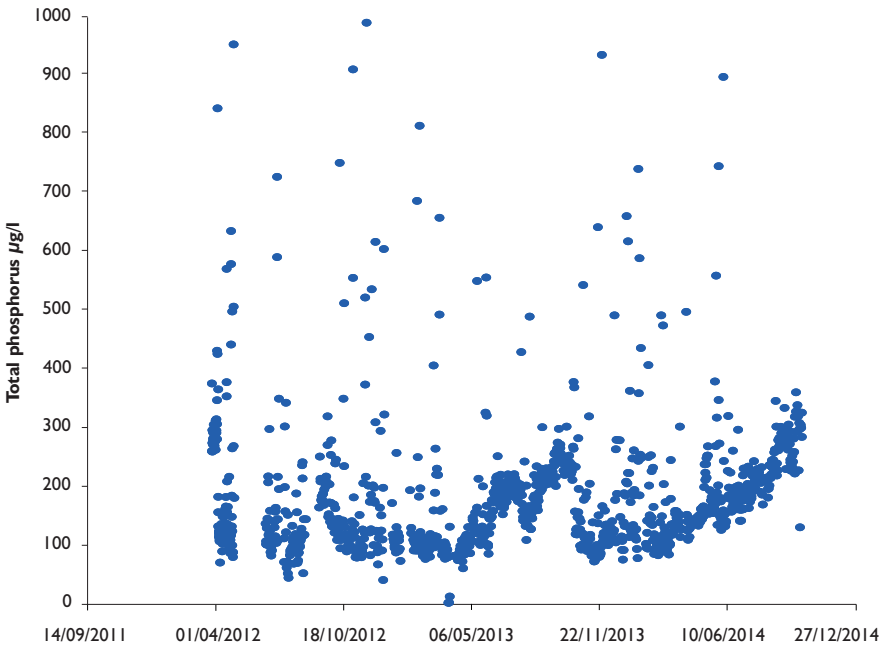


Figure 1
Continuously monitored total phosphorus concentrations in the Eye Brook.

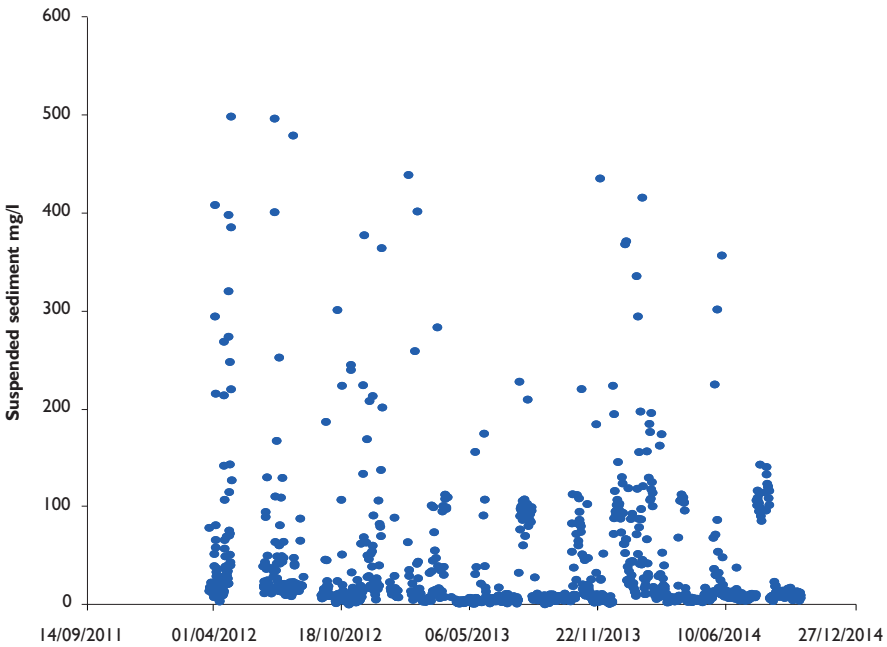
that the existing buffer strips in the project catchments may reduce the movement of sediment from land to water by up to a half. Estimates of soil loss based on base-of-catchment monitoring therefore provide a conservative estimate of the soil lost from the fields themselves. 3-8% of water bodies (ponds, streams and ditches) held clean water that was not significantly affected by human pressure.

Phosphorus concentrations are relatively high during rainfall because phosphorus binds to soil particles and moves with them. However, our base-of-catchment data revealed highest peaks in late summer and early autumn, before runoff from farmland had started. Data collection from tributaries within each of the three catchments confirms that the source of this phosphorus is small rural sewage treatment works, of which there is one in each of the three catchments. Phosphorus concentrations are consistently higher in tributaries with sewage treatment works than in those without them. Total nitrogen concentrations are also high, although there is a slight decline through the study period. Fish communities in the headwater stream are dominated by bullheads in all three catchments, with brown trout being present in the Eye Brook.

In terms of wildlife conservation, there is already evidence of benefits. At the landscape scale, there is some evidence of a decline in aquatic plant species over the

Creation of clean water ponds can restore landscape-scale aquatic biodiversity.
© Chris Stoate/GWCT

Figure 2
Continuously monitored suspended sediment concentrations in the Eye Brook.



four survey years, but this decline is completely offset by an increase in aquatic plants associated with new ponds that have been created specifically for wildlife within the past year. This is the first time that such a landscape-scale benefit to aquatic biodiversity in response to habitat creation has been demonstrated.

Additional data being collected relate to flow, which will be valuable in terms of understanding the implications of our land management on flood control downstream. Improved soil management coupled with interception ponds in headwater catchments could have an important role in attenuating flood peaks and protecting homes and businesses in floodplains from flooding.

We are also monitoring the concentrations of the widely used molluscicide metaldehyde, and important black-grass herbicides, propyzamide and carbetamide. Each of these pesticides regularly exceeds permissible limits for drinking water supply, and, especially in the case of metaldehyde, is difficult to remove from water by water companies. Flow and pesticide datasets will play an important role in guiding our future

Compacted soil is associated with runoff, erosion and poorly performing crops. © Chris Stoate/GWCT

Wildflower mixtures planted around ponds add conservation value by supporting pollinating insects. © Chris Stoate/GWCT

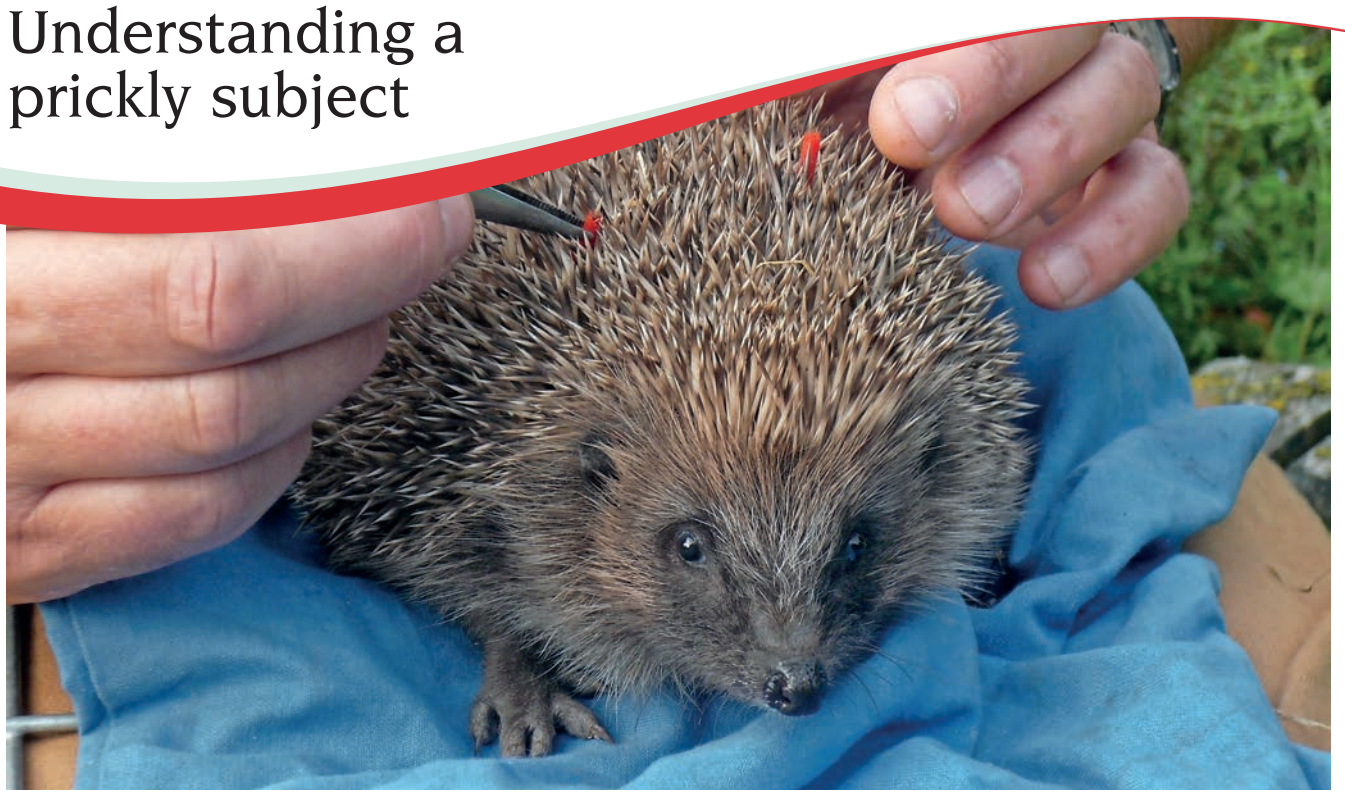
research and informing national policy. We will use these results to guide our work with farmers to reduce drinking water treatment costs and to retain these products for the control of slugs and grass weeds.

We have planted wildflower mixtures around some of the ponds created to reduce the impact of farming on water in order to increase their conservation value. These have failed to establish around very small ponds and ditch sides where high nutrient soils favour competitive, naturally occurring plants such as spear thistle and greater willowherb. Our surveys of pollinators in the first two years reveal that both of these plant species are used by bumblebees, honeybees and other pollinating insects. Sown plant mixtures have established better around larger ponds where the subsoil has been exposed, and the increased plant diversity is associated with a wider range of pollinating insects.

Already, the findings of our research have important implications for policy and practice. Loss of soil from arable land contributes to sedimentation of drainage channels downstream, and consequently to flood risk and to the cost of dredging. But there are implications for farming too. On an annual basis, the loss of soil is towards the lower end of the scale when compared to other catchments across northern Europe, but cannot be sustained in the long term. More importantly, perhaps, it reflects a breakdown in soil function, which has negative consequences for crop performance as well as water quality. In terms of water quality, our results suggest that buffer strips have a role to play, and one that may be threatened by the reduced area that the new Countryside Stewardship scheme is able to reach.

Our results also demonstrate that domestic sources of nutrients need to be addressed alongside those from farming, and the active involvement of water companies is essential to this process.

Understanding a prickly subject



Hedgehogs are easy to catch and mark; but surprisingly, little is known of hedgehog population trends in the wider countryside. © Jo Miles

BACKGROUND

Research on predation issues has been central to GWCT activities for several decades. But predation must be viewed alongside other processes at work in the countryside. Small predators can be prey themselves, and their position in the middle of a food web that's distorted by human activity isn't necessarily a happy one.

KEY FINDINGS

- A perceived decline in hedgehog numbers raises a lot of questions about their status in the countryside.
- As resources allow, we plan to include hedgehogs among the characteristic native species in which we take a close interest.

JonathanReynolds

The hedgehog is one of those animals that seems to belong in the British countryside by ancient right. They are embedded symbolically and sentimentally in our culture, and it is easy to see why they remain popular. In evolutionary terms, the world's spiny hedgehogs have changed little in the last 15 million years. If you think of that as a day, modern man appeared about 10 minutes ago, agriculture less than a minute ago, and the last 100 years occupied the last half-second. Given that the hedgehog 'formula' developed in a world radically different from that of today, it is astonishing that they persist at all. Nevertheless, within living memory hedgehogs have been – and in some parts of Britain remain – a very successful species. For instance, a study in north Norfolk in 2008 found a density there of more than 40 per 100 hectares.

Hedgehogs are a component of the farmed landscape that the GWCT has scarcely considered before, but ecologically they are at the heart of 'hot' countryside issues. The invertebrate creatures that form the bulk of their diet are affected by the intensity of modern agriculture, making an obvious parallel with farmland birds. Agri-environment schemes to mitigate this impact potentially benefit hedgehogs just as they do farmland birds; and indeed hedgehogs have been shown to favour grassy field margins in an otherwise intensive arable landscape. But dead hedgehogs cannot benefit, and there is known to be a strong negative relationship between badger density and hedgehog density; foxes, too, can learn to kill hedgehogs.

Then again, hedgehogs are predators themselves. Predation by hedgehogs on the eggs of ground-nesting wading birds is the reason they are being removed systematically from the Outer Hebrides (where they are not native) and transferred to the mainland. When hedgehogs were more common on the mainland, they were killed on shooting estates as predators of wild gamebird eggs, and thus were routinely recorded in National Gamebag Census data. Both the number of estates recording hedgehog catches and the numbers reported have fallen dramatically since the early 1960s. The Wildlife & Countryside Act 1981 ruled that hedgehogs may not be deliberately trapped, though unless measures are taken to exclude them they can still occur as a by-catch in tunnel traps. Regrettably, we cannot distinguish to what extent the trend in NGC records indicates a declining hedgehog population, lower trapping effort, more focused trapping, unwillingness to record hedgehog captures, or all of these effects.

There is nevertheless a widespread perception that there has been a decline in UK hedgehog numbers in recent decades. As with many other mammal species, there is no routine surveillance system, and no established method to determine distribution or population trends. There have been questionnaire surveys, and systematic recording of road kills. The People's Trust for Endangered Species has mapped hedgehog distribution through questionnaire surveys to householders. This has told us a lot about the national distribution of hedgehogs in gardens, but inevitably it also reflects the distribution of people in Britain.

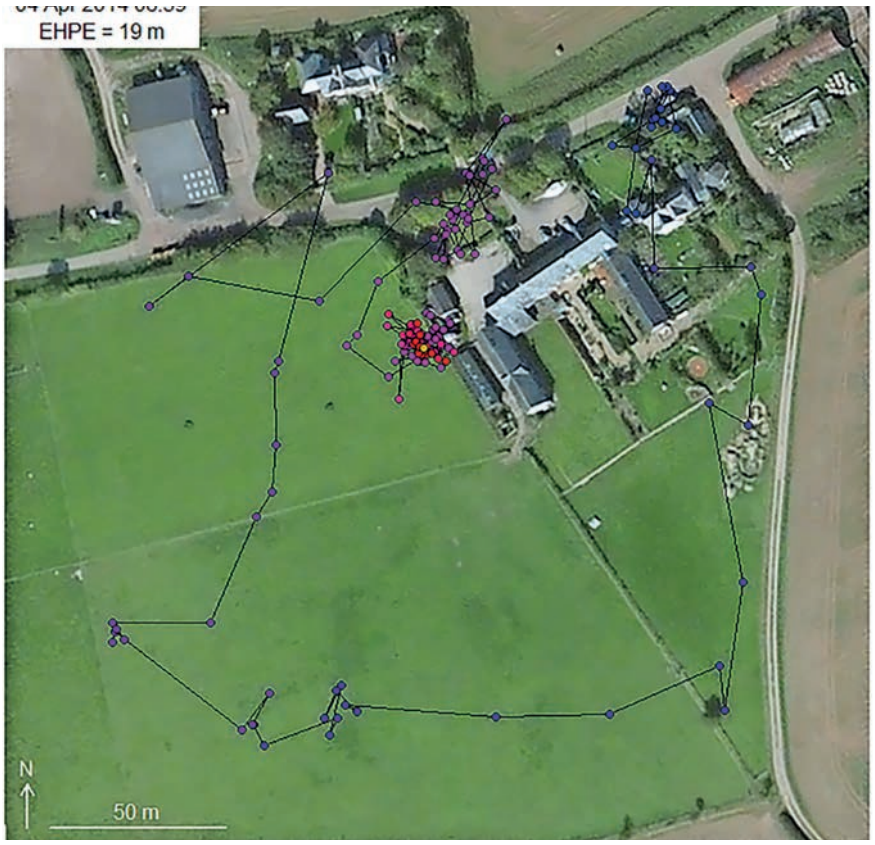


Figure 1

Even in the countryside, villages and cottage gardens are probably safe, productive refuges for hedgehogs. This figure illustrates a single night's movements by an adult male hedgehog during one April night, around houses that stand adjacent to arable farmland in Wiltshire. Locations were determined by a GPS tag every 15 minutes from 18:11 to 06:59. The green fields are horse paddocks; arable fields with spring barley appear a light tan colour around the edges of the figure. Background satellite imagery from Bing Maps.

© 2014 Microsoft Corporation

Trends in the number of hedgehogs killed on roads are complicated by traffic density and speed and by shifts in recorder enthusiasm. In either approach, the 70% of Britain's land area that is agricultural is essentially unsurveyed. The University of Nottingham, in partnership with the Mammal Society, has researched the use of simple ink-and-paper tunnels to detect the presence of hedgehogs by recording their footprints. This provides a cheap tool to help determine hedgehog distribution, and potentially an index of abundance too.

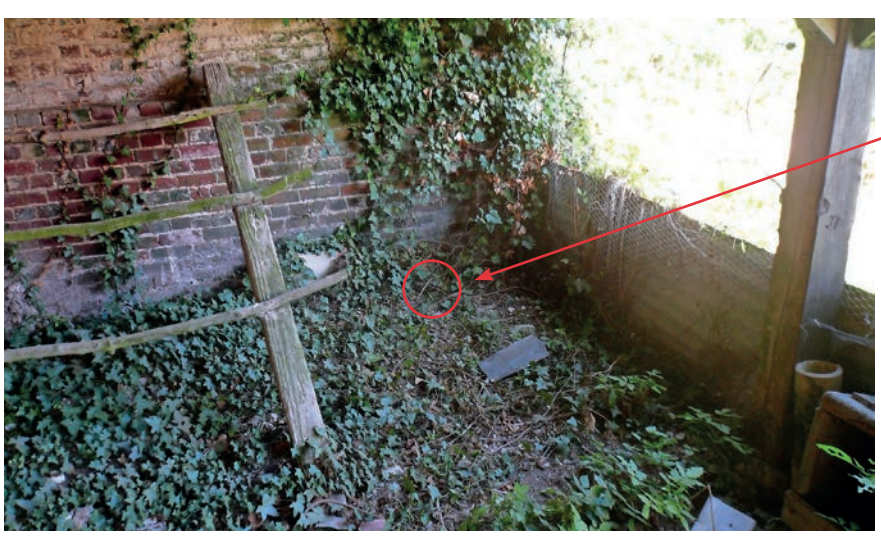
So hedgehogs present themselves as a component of the farmed environment in which the GWCT should take an interest. As opportunity and resources allow, we have made the decision to do that. We believe that we have something to offer, both in further developing the detection methodology (much as we did in the context of mink control), and in establishing what is happening to hedgehogs in the farmland landscape. Is there a decline? And if so, is the cause a shortage of invertebrate food, or predation, or something else? Why do hedgehogs appear to favour gardens, even in the middle of farmland (see Figure 1)? How can we best manage farmland so as to achieve the most satisfactory balance between all our native species?

Ink and paper | Clay mixture

© Mike Short/GWCT

Track-recording is one of the best detection methods for hedgehogs, as it is for mink.

Why do hedgehogs in rural areas use the areas around human settlements so much?



© Mike Short/GWCT

River Frome salmon monitoring

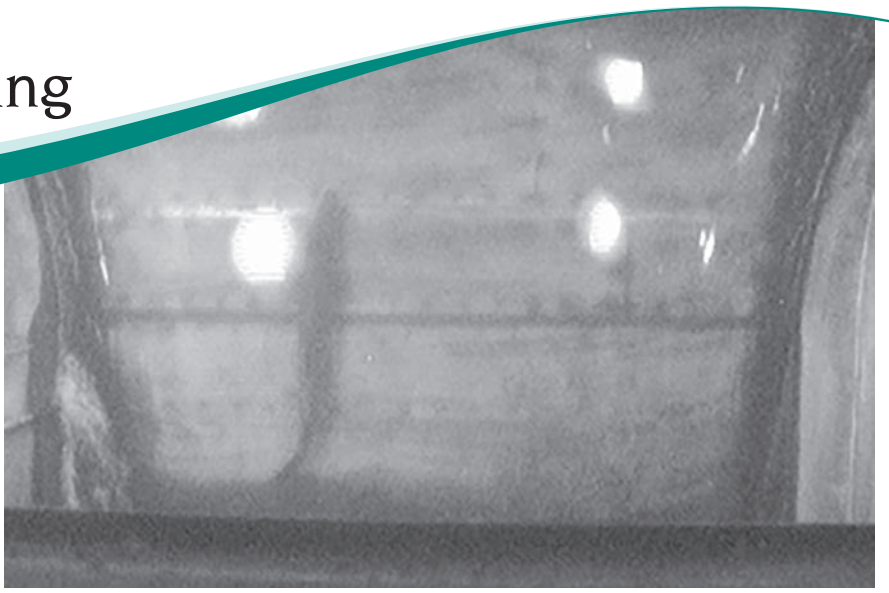


Plate 1

135 cm male salmon ascending the fish counter at East Stoke on River Frome in December 2013.

BACKGROUND

At the Salmon & Trout Research Centre in East Stoke we carry out research on all aspects of salmon and trout life history and have monitored the run of adult salmon on the River Frome since 1973. The installation of full river coverage PIT-tag systems in 2002 facilitated the study of life history traits of salmon and trout at not only population level but also at the level of individuals. The PIT-tag installation also enabled us to quantify the smolt output, and the River Frome is one of only 14 index rivers around the North Atlantic to report on the marine survival of wild salmon populations to the International Council for the Exploration of the Sea (ICES).

KEY FINDINGS

- As a result of the poor 2012 smolt run, 2013 was the first year when the salmon run on the River Frome fell significantly below its Conservation Limit.
- Three new PIT-tag antenna arrays were installed to give coverage of the full river.
- Large multi-sea-winter salmon are still present in the Frome.

RasmusLauridsen

Like many other rivers around the Atlantic, the numbers of salmon returning to spawn in the River Frome crashed in the early 1990s. As this crash was experienced in salmon populations throughout its distribution, it was most likely caused by changes at sea. This event highlighted the importance to our fisheries research group at East Stoke of being able to separately analyse the changes that occur in freshwater and at sea. Only by monitoring both smolt output (freshwater production) and returning adults (marine survival) are we able to separately analyse the two components of the salmon lifecycle (see Figure 1). The number of returning adults has been quantified on the Frome since 1973, but only with the installation of full-river coverage PIT-tag antennae 13 years ago has it been possible to accurately quantify the size of the smolt run. In 2012 we registered the lowest smolt run since the installation of the PIT-tag equipment, so we predicted a small run of one-sea-winter adults (grilse) in 2013 (see Figure 2). This prediction was borne out and 2013 was the first year ever when the numbers of adult salmon returning to the Frome fell significantly below the Conservation Limit set by the Environment Agency (see Table 1). The Frome was not the only river with a poor salmon run in 2013. In fact, 75% (15 of 20) of the rivers in the south-west of England where the number of returning adults are estimated had a smaller adult run than in 2012, with 80% having a run smaller than the average for the nine previous years. The low smolt run on the Frome in 2012 was likely a result of the prolonged drought that we experienced in 2011 and in the early part of 2012. The same weather patterns were experienced by other rivers in the south-west of England and it is therefore not surprising that they suffered similar small adult runs in 2013. However, unlike the Frome, the other rivers in the south-west are monitored only for returning adults and as such

Figure 1

Numbers of adult salmon returning to the River Frome, 1973-2014.

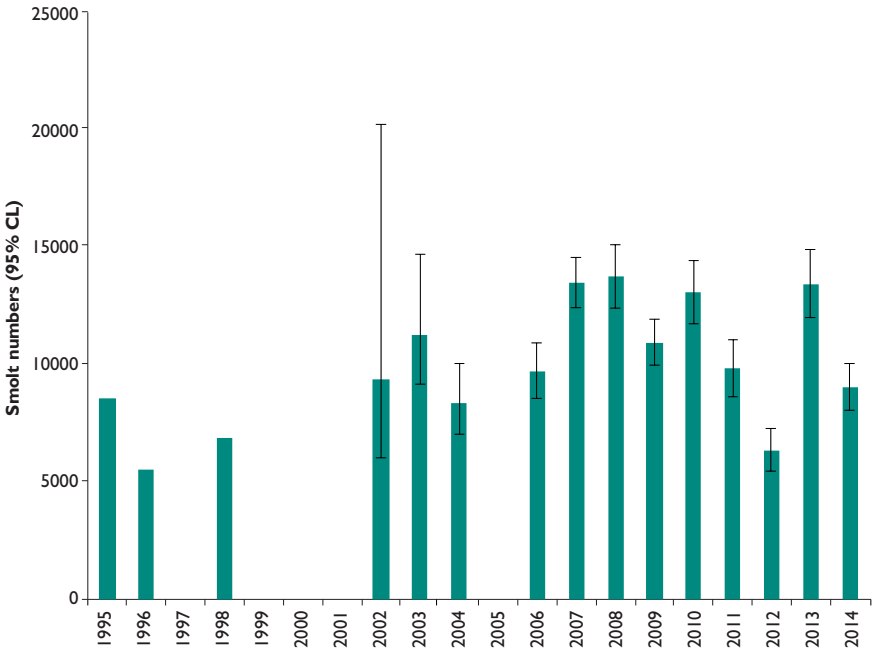


Figure 2
Estimated number of spring smolts, 1995-2014.

the smolt data collected by the GWCT on the Frome is the only dataset with such strong predictive power.

The River Frome was once renowned for its run of very big spring fish. "As an example of the size of fish in those days, my fishing book shows that the first eleven fish I killed on a fly in one season averaged just over 30lbs in weight, which I fancy must be a record for any British river."

This quote is from a letter by Major Radclyffe, a keen angler on the Frome in the early part of the 20th Century, and is testimony to the run of big spring fish that the Frome used to enjoy. We still register fish on the video at the fish counter in excess of a metre in length every year and at the tail end of 2013 a 135-cm cock salmon was captured on video ascending the fish counter, evidence that these large fish still exist (see Plate 1).

In 2014, much staff resource went into the installation of new PIT-tag readers throughout the Frome catchment, including three sites with full river coverage between Dorchester and East Stoke. The installation of these new systems opens new opportunities for us to study within-river movement on a finer scale than hitherto possible, and it will allow us to phase out our old PIT-tag systems that are coming to the end of their life span.

TABLE 1

Percentage of Conservation Limit attained in the River Frome (CL) from 2004 to 2013. Conservation Limit is the minimum spawning stock level below which the stock should not be allowed to fall. Source: CEFAS: Salmon stocks and fisheries in England and Wales, 2013

Year	Percentage of CL attained
2004	124
2005	98
2006	142
2007	111
2008	161
2009	102
2010	179
2011	239
2012	93
2013	**57**

Plate 2
Major Radclyffe with 41lbs Frome salmon, early 20th Century.

Research projects

by the Game & Wildlife Conservation Trust in 2014

LOWLAND GAME RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Pheasant population studies	*Long-term monitoring of breeding pheasant populations on releasing and wild-bird estates*	*Rufus Sage, Maureen Woodburn*	*Core funds*	*1996- on-going*
Game marking scheme	*Study of factors affecting return rates from pheasant release pens*	*Rufus Sage, Maureen Woodburn*	*Core funds*	*2008- on-going*
Arable farming and birds	*Monitoring the response of birds to changes in farmland habitat and management*	*Roger Draycott*	*Sandringham Estate*	*2009- on-going*
Corvids and hedgerow birds	*Does crow and magpie control increase productivity in hedgerow birds?*	*Rufus Sage, Sue Wilson, Tony Powell, Allan Goddard, Emily Robertson*	*Songbird Survival*	*2010-2015*
Rewilding release shoots	*Factors affecting breeding in free-living reared pheasants*	*Rufus Sage, Jack Buckingham*	*Core funds, private funds*	*2010- on-going*
Grey partridge management (see page 36)	*Researching and demonstrating grey partridge management in Scotland*	*Dave Parish, Hugo Straker, Adam Smith, Gemma Davis, Katrina Candy*	*Whitburgh Farms, Mains of Loriston Trust*	*2011-2015*
Scottish Grey Partridge Recovery Project	*Monitoring grey partridge recovery and impacts on associated wildlife*	*Dave Parish, Hugo Straker*	*Core funds*	*2014-2018*
Game crops	*Developing perennial game cover mixes*	*Dave Parish, Hugo Straker*	*Core funds, Kingdom Farming*	*2014-2018*
PhD: Breeding birds in biomass crops	*Breeding success of ground and hedgerow-nesting birds in miscanthus and SRC*	*Henrietta Pringle Supervisors: Rufus Sage, Professor Simon Leather (Harper Adams University)*	*NERC / CASE*	*2011-2014*
PhD: Pheasant behaviour and the rearing system (see page 16)	*Improving behavioural and physiological adaptation of reared pheasants to the wild*	*Mark Whiteside, Jack Buckingham Supervisors: Rufus Sage, Dr Joah Madden (Exeter University)*	*Exeter University, Middleton Estate*	*2012-2015*
PhD: Gapeworm and pheasants (see page 18)	*Gapeworm on shooting estates, spatial and temporal factors affecting infections in pheasants*	*Owen Gethings Supervisors: Rufus Sage, Professor Simon Leather (Harper Adams University)*	*BBSRC / CASE*	*2014-2017*
PhD: Corvids breeding on farmland	*Breeding ecology of corvids, predatory behaviour and the effect of trapping on farmland*	*Lucy Capstick Supervisors: Rufus Sage, Dr Joah Madden (Exeter University)*	*Songbird Survival*	*2014-2017*

WETLAND RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Woodcock monitoring	*Examination of annual variation in breeding woodcock abundance*	*Andrew Hoodless, Chris Heward, Collaboration with BTO*	*Shooting Times Woodcock Club*	*2003- on-going*
Woodcock migration routes (see page 22)	*Use of satellite tags and geolocators to examine woodcock migration strategies*	*Andrew Hoodless, Chris Heward*	*Shooting Times Woodcock Club, Private donors, Woodcock appeal*	*2010-2015*
Woodcock habitat use and behaviour in cold weather	*Radio-tracking of woodcock in arable landscapes in winter*	*Andrew Hoodless, Freya Stacey Alex Fall*	*Core funds*	*2011-2014*
National breeding woodcock population	*Randomised survey to produce country population estimates and assess change since 2003*	*Andrew Hoodless, Chris Heward, Collaboration with BTO*	*Shooting Times Woodcock Club, core funds*	*2013-2015*
Strategies for coping with cold weather in woodcock and snipe	*Examination of regulation of fat reserves and estimation of duration to starvation*	*Andrew Hoodless, Carlos Sanchez, Alex Fall*	*Core funds*	*2014-2016*
Avon Valley waders (see page 20)	*Monitoring lapwing breeding success in relation to the Higher Level stewardship scheme*	*Andrew Hoodless, Freya Stacey*	*Core funds, Natural England*	*2007-2014*
Waders for Real	*Wader recovery project in the Avon Valley*	*Andrew Hoodless, Kaat Brulez*	*EU LIFE+*	*2014-2018*
Lapwings on fallow plots	*Assessment of lapwing breeding success on AES fallow plots*	*Andrew Hoodless, Kaat Brulez, Carlos, Sanchez, Katie Fielding, Collaboration with RSPB*	*Defra, The Manydown Trust*	*2012-2016*
PhD: Landscape-scale effects of game management	*Evaluation of relative importance of landscape and local management influences on species distribution and abundance*	*Jessica Neumann Supervisors: Andrew Hoodless, Dr Graham Holloway (Reading University)*	*Core funds, Private funds, Forestry Commission*	*2010-2015*
PhD: Factors influencing breeding woodcock abundance	*Landscape-scale and fine-scale habitat of breeding woodcock and investigation of drivers of decline*	*Chris Heward Supervisors: Andrew Hoodless, Prof Rob Fuller/BTO, Dr Andrew MacColl (Nottingham University)*	*Private funds, core funds*	*2013-2018*

PARTRIDGE AND BIOMETRICS RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Partridge Count Scheme (see page 26)	*Nationwide monitoring of grey and red-legged partridge abundance and breeding success*	*Neville Kingdon, Nicholas Aebischer, Julie Ewald, Lucy Coals, Charles Cunningham*	*Core funds, GCUSA*	*1933- on-going*
National Gamebag Census (see page 38)	*Monitoring game and predator numbers with annual bag records*	*Nicholas Aebischer, Gillian Gooderham, Chris Wheatley, Lucy Coals, Charles Cunningham*	*Core funds*	*1961- on-going*
Sussex Study (see page 32)	*Long-term monitoring of partridges, weeds, invertebrates, pesticides and land use on the South Downs in Sussex*	*Julie Ewald, Nicholas Aebischer, Steve Moreby, Chris Wheatley, Dr Dick Potts (consultant)*	*Core funds*	*1968- on-going*

Partridge over-winter losses	*Identifying reasons for high over-winter losses of grey partridges in the UK*	*Nicholas Aebischer, Francis Buner, Lucy Coals, Charles Cunningham*	*Core funds, GCUSA*	*2007-2014*
Wildlife monitoring at Rotherfield Park (see page 28)	*Monitoring of land use, game and songbirds for the Rotherfield Demonstration Project*	*Francis Buner, Malcolm Brockless, Peter Thompson, Roger Draycott, Julie Ewald*	*Core funds*	*2010-2017*
BDS Shooting Accuracy Project	*Analysis of data from the BDS Shooting Accuracy and Deer Recovery Research Project*	*Nicholas Aebischer, Chris Wheatley*	*British Deer Society*	*2012-2014*
Winter hopper feeding	*Assessing hopper use by gamebirds and other wildlife through camera trapping*	*Carlos Sánchez, Francis Buner, Nicholas Aebischer, Max Krioutchkov*	*Fundación Caja Madrid*	*2012-2014*
Capacity building in Himachal Pradesh, India	*Bird ringing, monitoring and Galliform re-introduction capacity building for Himachal Pradesh Wildlife Department*	*Francis Buner, Lucy Coals, Charles Cunningham*	*Forest and Wildlife Department of Himachal Pradesh*	*2013- on-going*
Cereal invertebrates and pesticides	*An update of pesticide use in the Sussex Study*	*Julie Ewald, Chris Wheatley, Lucy Coals Charles Cunningham, Neville Kingdon*	*Natural England*	*2014-2014*

UPLANDS RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Grouse Count Scheme	*Annual grouse and parasitic worm counts in relation to moorland management indices and biodiversity*	*David Baines, David Newborn, Mike Richardson, Kathy Fletcher, Phil Warren, David Howarth, Graeme Neish*	*Core funds, Gunnerside Estate*	*1980- on-going*
Long-term monitoring of breeding ecology of waders in the Pennine uplands	*Annual measures of wader density, lapwing productivity, recruitment and survival*	*David Baines, Zoe Deal, Melissa Dawson*	*Core funds*	*1985- on-going*
Black grouse monitoring	*Annual lek counts and brood counts*	*Philip Warren, Frances Atterton, David Baines, David Newborn*	*Core funds*	*1989- on-going*
Capercaillie brood ecology	*Surveys of capercaillie and their broods in Scottish forests*	*Kathy Fletcher, David Baines, David Howarth, Graeme Neish, Mike Richardson, Phil Warren*	*SNH, Forest Enterprise Scotland*	*1991- on-going*
Timing of breeding in red grouse	*Long-term assessment of changes in laying dates in relation to climate change*	*David Howarth, Kathy Fletcher, Graeme Neish*	*The Samuels Trust, Core funds*	*1995- on-going*
Black grouse range expansion	*Black grouse range restoration in Yorkshire Dales by translocating surplus wild males*	*Philip Warren, Frances Atterton*	*Biffa, private funder, Yorkshire Water, Nidderdale AONB*	*1996-2015*
Strongylosis research	*Development of strongylosis control techniques in red grouse, best practice and resistance testing*	*David Newborn, David Baines Mike Richardson*	*Core funds*	*2006- on-going*
Monitoring Langholm Moor Demonstration Project (see page 46)	*Research data for moorland restoration to achieve economically viable driven grouse shooting and sustainable numbers of hen harriers*	*Sonja Ludwig, David Baines, Merlin Becker*	*Core funds, Buccleugh Estates, SNH, Natural England, RSPB,*	*2008-2018*
Tick impacts on grouse chicks	*Development of tick control techniques through trialling acaricide -impregnated neck collars*	*David Baines, David Newborn, Mike Richardson*	*Private donor*	*2011-2014*
Black grouse in southern Scotland	*Analysis of habitat and predator variables associated with declines in abundance of lekking males*	*Philip Warren, Frances Atterton, David Baines, Patrick White*	*SNH, Southern Uplands Partnership*	*2013-2014*
Alternative grouse diseases	*Cryptosporidiosis in red grouse: study of spread of disease, prevalence and impacts on grouse survival and fecundity*	*David Baines, Mike Richardson David Newborn*	*Core funds*	*2013-2016*
Capercaillie and disturbance	*Desk study that considers whether within-forest distribution and breeding success of capercaillie varies in relation to the proximity and intensity of track use for recreational purposes*	*Kathy Fletcher*	*Cairngorms National Park Authority*	*2014*
The effects of heather burning and peat depth on densities and productivity of red grouse	*Analysis of long-term grouse monitoring data in relation to burning indices and peat depth measurements across core sites in northern England and Scotland*	*David Baines, Gail Robertson*	*Core funds*	*2014-2015*
Capercaillie genetics	*How accurately can non-invasive genetic techniques be used to estimate population size?*	*Kathy Fletcher, David Baines, Graeme Neish*	*Royal Zoological Society Scotland*	*2014-2015*
Black grouse national Survey	*Co-ordination and analysis of data from lek counts in England and Scotland*	*Philip Warren, Frances Atterton*	*SNH, Moorland Association, Forestry Commission Scotland, RSPB Yorkshire Dales National Park*	*2014-2015*
Captive-bred black grouse and range extension	*Desk study that considers whether captive-bred birds can be used to augment naturally expanding populations at the edge of the current range*	*Philip Warren*	*World Pheasant Association*	*2014-2015*
The Berwyn, Migneint and Radnor Hills Moorland Recovery Project	*Monitoring the effects of and advising on methods to help restore grouse and other wildlife*	*David Baines, Merlin Becker, Cath Hughes, Paul Stephens*	*Welsh Government's Nature Fund*	*2014-2015*
Black grouse in Wales	*Analysis of interaction of habitat and predator management in determining increases in black grouse at Ruabon Moor*	*David Baines, Merlin Becker*	*Natural Resources Wales*	*2014-2015*
Capercaillie, martens and generalist predators	*Development work for anticipated trial that experimentally considers the role of martens and other generalist predators in determining capercaillie breeding success*	*Kathy Fletcher, Graeme Neish*	*SNH, Forestry Commission Scotland, Cairngorms National Park Authority*	*2014-2016*
How best to count mountain hares	*Test of a variety of count methods used to determine local densities of mountain hares*	*Scott Newey (JHI), Kathy Fletcher, Anna McWilliams*	*SNH, James Hutton Institute*	*2014-2016*
PhD: Impacts of buzzards on red grouse	*Dietary studies of breeding buzzards and foraging patterns in relation to grouse survival.*	*Richard Francksen Supervisors: David Baines, Professor Mark Whittingham (Newcastle University)*	*Langholm Moor Demonstration Project*	*2012-2015*

FARMLAND RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Sainfoin	*To investigate the potential of sainfoin as a resource for wildlife*	*Barbara Smith, Tom Birkett, Tom Elliot*	*Core funds*	*2011- on-going*
River Avon invertebrates	*Long-term monitoring of River Avon aquatic invertebrates*	*Tom Birkett*	*Core funds*	*2011- on-going*
People and pollinators in India	*To improve understanding of native Indian pollinators, their ecology and best-practice management*	*Barbara Smith*	*Darwin Initiative*	*2012-2015*
QuESSA	*Quantification of Ecological Services for Sustainable Agriculture*	*John Holland, Barbara Smith, Tom Birkett, Steve Moreby, Laura James, David Stevenson, Liam Crowley, Tom Elliott*	*EU FP7*	*2013-2017*
HGCA Encyclopaedia	*Encyclopaedia of pests and natural enemies in field crops*	*John Holland, Barbara Smith, Steve Ellis (ADAS), Rosemary Collier (Warwick University)*	*HGCA*	*2013-2014*
PhD Ecology of small mammals on farmland	*Habitat use, distribution and population genetics of small mammals on farmland in eastern Scotland*	*Amanda Wilson Supervisors: Dave Parish, Professor Hubbard (University of St Andrews), Dr Begg (Hutton Institute)*	*BBSCR/CASE*	*2011-2014*
PhD: Farmland birds and agri-environment schemes (see page 48)	*The breeding success of farmland birds and the impact of agri-environment scheme habitats*	*Niamh McHugh Supervisors: John Holland, Mick Crawley (Imperial College, London)*	*BBSRC/CASE studentship and Natural England*	*2012-2015*
PhD: Bumblebees and agri-environment schemes	*How effective are agri-environment schemes in boosting bumblebee populations?*	*Tom Wood Supervisors: John Holland, Professor Dave Goulson (University of Sussex)*	*NERC/CASE studentship*	*2013-2016*

ALLERTON PROJECT RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Monitoring wildlife at Loddington	*Annual monitoring of game species, songbirds, invertebrates, plants and habitat*	*Chris Stoate, John Szczur, Alastair Leake, Steve Moreby, Barbara Smith*	*Allerton Project funds*	*1992- on-going*
Effect of game management at Loddington (see page 54)	*Effect of changing shoot management on nesting success and breeding numbers of songbirds.*	*Chris Stoate, Alastair Leake, John Szczur*	*Allerton Project funds*	*2001- on-going*
Pesticides in water	*Assessing pesticide concentrations in water and the mitigation potential of constructed wetlands*	*Chris Stoate, John Szczur, Colin Brown (York University), Chris Sinclair (FERA)*	*Chemicals Regulation Directorate*	*2012-2014*
School Farm catchment	*Practical demonstration of ecosystem services*	*Chris Stoate, John Szczur*	*Allerton Project, EA, Anglian Water, Agrii SoilQuest*	*2012- on-going*
Innovate UK microwave-assisted catalytic treatment of agricultural wastewater	*Development of technology for the removal of pesticides and other pollutants from agricultural waste water*	*Chris Stoate, Loughborough and Leicester de Montfort universities, and other partners*	*Technology Strategy Board*	*2012-2015*
Water Friendly Farming (see page 60)	*A landscape-scale demonstration of resource protection integration with farming in the upper Welland*	*Chris Stoate, John Szczur, Jeremy Briggs, Penny Williams, Adrianna Hawczak, Anita Casey (Freshwater Habitats, Trust), Colin Brown (York University)*	*EA, Syngenta, Chemicals Regulation Directorate, Anglian Water*	*2012-2015*
Remote sensing data applications	*An investigation into the potential uses of remote sensing and ground-sourced spatial data for catchment management*	*Chris Stoate, Nicola Hinton, Antony Antony Williamson (EA), Crispin Hambidge (Geomatics)*	*EA*	*2013-2015*
Sustainable Intensification Platform Project 1	*Farm-scale assessment of soil properties in relation to crop establishment and cover crops, and sheep performance in relation to sward minerals*	*Chris Stoate, Nicola Hinton, Phil Jarvis, Alastair Leake, Jim Egan, Ron Stobart (NIAB), Nigel Kendall (Nottingham University)*	*Defra*	*2014-2017*
Sustainable Intensification Platform Project 2	*Landscape-scale assessment of potential for collaborative interventions to meet sustainable intensification objectives*	*Chris Stoate, Exeter and Nottingham Universities, and other partners*	*Defra*	*2014-2017*
Soil monitoring	*Annual survey of soil properties*	*Chris Stoate, Nicola Hinton, Alastair Leake, Phil Jarvis*	*Allerton Project*	*2014- on-going*
PhD: Soil compaction and biology	*The relationship between arable soil compaction, earthworms and microbial activity*	*Falah Hamad Supervisors: Chris Stoate, Dr David Harper (Leicester University)*	*Leicester University*	*2014-2017*
PhD: Environmental learning careers of farmers	*An investigation into how farmers learn about effective environmental management through their active participation in agri-environment schemes*	*Susanne Jarratt Supervisors: Chris Stoate, Dr Carol Morris (University of Nottingham)*	*ESRC/NERC studentship*	*2009-2014*

PREDATION RESEARCH IN 2014

Projecttitle	Description	Staff	Fundingsource	Date
Fox control methods	*Experimental field comparison of fox capture devices*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2002- on-going*
Tunnel traps	*Experimental field comparison of tunnel traps and methods of use*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2008- on-going*
Grey squirrel trapping strategy	*Exploratory research on optimal trapping strategy for grey squirrel control*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2013-2015*
PhD: Pest control strategy	*Use of Bayesian modelling to improve control strategy for vertebrate pests*	*Tom Porteus Supervisors: Jonathan Reynolds, Prof Murdoch McAllister/University of British Columbia, Vancouver*	*Core funds, University of British Columbia*	*2006-2014*

FISHERIES RESEARCH IN 2014

ProjectTitle	ProjectDescription	Staff	Fundingsource	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 – On-going*
Monnow habitat improvement project	*Large-scale conservation project and scientific monitoring of 30 km of river habitat on the River Monnow in Herefordshire*	*Dylan Roberts, Sian Griffiths Cardiff University, Janine Burnham*	*Defra, Rural Enterprise Scheme, Monnow Improvement Partnership, Kess EU*	*2003 – On-going*
Salmon life-history strategies in freshwater	*Understanding population declines in salmon*	*Anton Ibbotson, Rasmus Lauridsen (from August), William Beaumont, Luke Scott, Dylan Roberts*	*Core funds, EA, CEFAS, Anthony Daniell, Winton Capital*	*2009 – On-going*
Salmon smolt screw trap assessment	*Calculating the effects of rotary screw traps on salmon smolts*	*Anton Ibbotson, Rasmus Lauridsen (from August), William Beaumont, Luke Scott, Dylan Roberts*	*CEFAS, core funds*	*2009 – On-going*
Water temperatures and salmonids	*Micro-habitat use by salmonids in relation to temperature*	*Dylan Roberts, Paul Kemp (Southampton University)*	*Southampton University, Centre for Ecology & Hydrology, core funds*	*2009-2014*
Avon Demonstration Test Catchment Project (DTC)	*Demonstrating the impacts of catchment management to reduce diffuse agricultural run-off pollution on fish populations*	*Dylan Roberts, Luke Scott*	*Defra*	*2010-2014*
Juvenile salmon and hydro	*The effects of a hydropower installation on salmon smolts*	*Anton Ibbotson, Rasmus Lauridsen (from August), William Beaumont, Graeme Storey (EA)*	*EA, core funds, S&TA, Lulworth Estate*	*2012-2015*
MorFish	*Alignment of data collection on the Rivers Frome, Oir and Scorff, Technical development of PIT equipment on these rivers*	*Dylan Roberts, Jean-Marc Roussel and Didier Azam (INRA), William Beaumont, Rasmus Lauridsen, Anton Ibbotson, Stephen Gregory*	*Core funds, INRA, EU Interreg Channel programme*	*2012-2015*
MorFish	*An international collaboration to model historical fish populations using state-of-the-art Bayesian theory*	*Stephen Gregory, Anton Ibbotson, Jean-Marc Roussel, Etienne Rivot, Marie Nevoux*	*Core funds, INRA, EU Interreg Channel Programme*	*2012-2015*
Sea trout smolt survival	*Monitoring sea trout smolts through the Frome estuary and Poole harbour and their return to the river*	*Rasmus Lauridsen, William Beaumont, Luke Scott*	*Sir Chips Keswick, Anthony Daniell, Winton Capital, Clay Brendish Foundation*	*2014-2015*
Grayling ecology	*Long-term study of the ecology of River Wylye grayling*	*Anton Ibbotson, Stephen Gregory (from April 2015), Luke Scott*	*NRW, Core Funds, Grayling Research Trust, Piscatorial Society.*	*2009 – Ongoing*
PhD: Beavers and salmonids	*Impacts of beaver dams on salmonids*	*Robert Needham Supervisors: Dylan Roberts, Paul Kemp (Southampton University)*	*Core funds, Southampton University, Scottish National Heritage, S&TA*	*2014-2017*
PhD: Atlantic salmon, climate change and human exploitation	*Assessing the sustainability of Atlantic salmon across the southern part of their European range in the light of climate change and human exploitation*	*Charles Ikediashi Supervisors: Jamie Stevens (Exeter University), Dylan Bright (WCRT), Anton Ibbotson*	*Core funds, Exeter University, AST, S&TA, WRT*	*2011-2014*

Key to abbreviations: ADAS = Agricultural Development & Advisory Service; AST = Atlantic Salmon Trust; BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering; CEFAS = Centre for Environment, Fisheries & Aquaculture Science; CEH = Centre for Ecology and Hydrology; Defra = Department for Environment, Food and Rural Affairs; EA = Environment Agency; ESRC = Economic & Social Research Council; EU = European Union; HGCA = Home Grown Cereals Authority; INRA = French National Institute for Agricultural Research; JNCC = Joint Nature Conservation Committee; NE = Natural England; NERC = Natural Environment Research Council; NFU = National Farmers' Union; RSPB = Royal Society for the Protection of Birds; S&TA = Salmon & Trout Association; SNH = Scottish Natural Heritage; WCRT = Westcountry Rivers Trust.

Scientific publications

by staff of the Game & Wildlife Conservation Trust in 2014

Aebischer, NJ (2014) Mediterranean Gulls in Alderney. *British Birds*, 107: 487-488.

Aebischer, NJ, Wheatley, CJ & Rose, HR (2014) Factors associated with shooting accuracy and wounding rate of four managed wild deer species in the UK, based on anonymous field records from deer stalkers. *PLoS ONE*, 9 e109698: 1-12.

Alonso, ME & Sánchez-García, C (2014) Breve recuerdo sobre la biología y ecología de las especies de perdiz en España: perdiz roja, perdiz pardilla y perdiz moruna. In: *Seminario Nacional de Perdices 1, León 2011. Libro de Resúmenes*: 6-15. Universidad de León, León.

Awan, MN & Buner, F (2014) Conservation of the Western Tragopan *Tragopan melanocephalus* around Salkhala Game Reserve, Azad Kashmir, Pakistan. *Birding ASIA*, 21: 107-111.

Baines, D, Fletcher, K, Howarth, D, Newborn, D & Richardson, M (2014) Grouse moor management: effects on other upland birds in the UK (abstract). In: Buchanan, G., Thompson, D., Chamberlain, D. & Pearce-Higgins, J. (eds) *Ecology and Conservation of Birds in Upland and Alpine Habitats:* 1. British Ornithologists' Union, Peterborough. http://www.bou.org.uk/bouproc-net/uplands/baines-et-al.pdf.

Baines, D, Newborn, D & Richardson, M (2014) Spread of *Cryptosporidium baileyi* in red grouse *(Lagopus lagopus scoticus). Veterinary Record*, 175: 149 (doi: 10.1136/vr.102275).

Butler, DA & Davis, C (2014) The effects of plastic spectacles on the condition and behaviour of pheasants. *Veterinary Record*, 174: 198 (doi: 10.1136/vr.102059).

Callegari, SE, Bonham, E, Hoodless, AN, Sage, RB & Holloway, GJ (2014) Impact of game bird release on the Adonis blue butterfly *Polyommatus bellargus* (Lepidoptera: Lycaenidae) on chalk grassland. *European Journal of Wildlife Research*, 60: 781-787.

Elston, DA, Spezia, L, Baines, D & Redpath, SM (2014) Working with stakeholders to reduce conflict – modelling the impact of varying hen harrier *Circus cyaneus* densities on red grouse *Lagopus lagopus* populations. *Journal of Applied Ecology*, 51: 1236-1245.

Fletcher, K, Newborn, D & Baines, D (2014) Game management in the UK uplands: a review of the effects of management on other wildlife and ecosystem services. In: Buchanan, G., Thompson, D., Chamberlain, D. & Pearce-Higgins, J. (eds) *Ecology and Conservation of Birds in Upland and Alpine Habitats:* 1-4. British Ornithologists' Union, Peterborough http://www.bou.org.uk/bouproc-net/uplands/fletcher-et-al.pdf.

Gregory, SD, Ancrenaz, M, Brook, BW, Goossens, B, Alfred, R, Ambu, LN & Fordham, DA (2014) Forecasts of habitat suitability improve habitat corridor efficacy in rapidly changing environments. *Diversity and Distributions*, 20: 1044-1057.

Harris, DB, Gregory, SD, Brook, BW, Ritchie, EG, Croft, DB, Coulson, G & Fordham, DA (2014) The influence of non-climate predictors at local and landscape resolutions depends on the autecology of the species. *Austral Ecology,* 39: 710-721.

Harris, JBC., Putra, DD, Gregory, SD, Brook, BW, Prawiradilaga, DM, Sodhi, NS, Wei, D & Fordham, DA (2014) Rapid deforestation threatens mid-elevational endemic birds but climate change is most important at higher elevations. *Diversity and Distributions,* 20: 773-785.

Holland, JM, Gerowitt, B, Bianchi, F, Kêdziora, A, Lupi, D, van Helden, M, Moonen, C & van Rijn, P (eds) (2014) Landscape Management for Functional Biodiversity. *International Organisation for Biological Control/West Palaearctic Regional Section Bulletin,* 100: 1-158.

Holland, JM, Jeanneret, P, Herzog, F, Moonen, A-C, Rossing, W, van der Werf, W, Kiss, J, van Helden, M, Paracchini, ML, Cresswell, J, Pointereau, P, Heijne, B, Veromann, E, Antichi, D, Entling, M & Balázs, B (2014) The QuESSA Project: Quantification of Ecological Services for Sustainable Agriculture. *Landscape Management for Functional Biodiversity. International Organisation for Biological Control/West Palaearctic Regional Section Bulletin*, 100: 55-58.

Holland, JM & Smith, BM (2014) Natural Enemies. In: Boys, E. (ed.) *Encyclopaedia of Pests and Natural Enemies in Field Crops:* 170-198. Agriculture and Horticulture Development Board. Home Grown Cereals Authority Publications, Kenilworth, Warwickshire.

Holland, JM, Storkey, J, Lutman, PJW., Birkett, TC, Simper, JN & Aebischer, NJ (2014) Utilisation of agri-environment scheme habitats to enhance invertebrate ecosystem service providers. *Agriculture, Ecosystems and Environment,* 183: 103-109.

Lauridsen, RB, Edwards, FK, Cross, WF, Woodward, G, Hildrew, AG & Jones, JI (2014) Consequences of inferring diet from feeding guilds when estimating and interpreting consumer-resource stoichiometry. *Freshwater Biology*, 59: 1497-1508.

Moss, R, Leckie, F, Biggins, A, Poole, T, Baines, D & Kortland, K (2014) Impacts of human disturbance on capercaillie *Tetrao urogallus* distribution and demography in Scottish woodland. *Wildlife Biology*, 20: 1-18.

Ockenden, MC, Deasy, C, Quinton, JN, Surridge, B & Stoate, C (2014) Keeping agricultural soil out of rivers: evidence of sediment and nutrient accumulation within field wetlands in the UK. *Journal of Environmental Management,* 135: 54-62.

Pérez, JA & Sánchez-García, C (eds) (2014) *Seminario Nacional de Perdices 1, León 2011. Libro de Resúmenes*. Universidad de León, León.

Riley, WD, Ibbotson, AT, Maxwell, DL, Davison, PI, Beaumont, WRC. & Ives, MJ (2014) Development of schooling behaviour during the downstream migration of Atlantic salmon *Salmo salar* smolts in a chalk stream. *Journal of Fish Biology*, 85: 1042-1059.

Sánchez-García, C (2014) Otra perdiz roja de granja es posible. In: Pérez, J.A. & Sánchez-García, C. (eds) *Seminario Nacional de Perdices 1, León 2011. Libro de Resúmenes:* 25-36. Universidad de León, León.

Santana, J, Reino, L, Stoate, C, Borralho, R, Carvalho, CR, Schindler, S, Moreira, F, Bugalho, MN, Ribeiro, PF, Santos, JL, Vaz, A, Morgado, R, Porto, M & Beja, P (2014) Mixed effects of long-term conservation investment in Natura 2000 farmland. *Conservation Letters*, 7: 467-477.

Sotherton, NW, Aebischer, NJ & Ewald, JA (2014) Research into action: grey partridge conservation as a case study. *Journal of Applied Ecology,* 51: 1-5.

Stoate, C (2014) Wildlife has its uses. Managing farmland for ecosystem services. *British Wildlife,* 25: 154-160.

Stoate, C (2014) Delivering integrated farm management in practice: understanding ecosystem services. In: McCracken, K. (ed.) *Agriculture and the Environment X. Delivering Multiple Benefits from our Land: Sustainable Development in Practice:* 46-52. Scotland's Rural College and Scottish Environment Protection Agency, Edinburgh and Stirling.

Storkey, J, Holland, JM, Henderson, IG, Lutman, PJW, Orson, J, Baverstock, J & Pell, JK (2014) Balancing food production and biodiversity conservation in arable landscapes: lessons from the Farm4Bio experiment. *Outlooks on Pest Management*, 25: 252-256.

Warren, P & Baines, D (2014) Changes in the abundance and distribution of upland breeding birds in the Berwyn Special Protection Area, North Wales 1983-2002. *Birds in Wales,* 11: 32-42.

White, PJC, Stoate, C, Szczur, J & Norris, KJ (2014) Predator reduction with habitat management can improve songbird nest success. *Journal of Wildlife Management,* 78: 402-412.

Wilson, A (2014) *Landscape Genetics of Highly Disturbed Arable Systems: Insights Gained from Investigating a Small Mammal Species.* Unpublished Ph.D. thesis. University of St Andrews, St Andrews.

Winder, L, Alexander, CJ, Woolley, C, Perry, JN & Holland, JM (2014) Cereal aphid colony turnover and persistence in winter wheat. *PLoS ONE,* 9 e106822: 1-14.

Financial report
for 2014

KEY POINTS

- Overall funds increased by £230,438.
- There was a surplus of £57,627 on unrestricted funds.
- Income was £7.46 million, an increase of 5% from 2013.
- Expenditure on research exceeded £3.8 million

The summary report and financial statement for the year ended 31 December 2014, set out below and on pages 76 to 77, 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, GWCT Events Limited (formerly Game Conservancy Events Limited) and Game and Wildlife Scottish Demonstration Farm.

They do not comprise the full statutory Trustees' report and accounts, which were approved by the Trustees on 16 April 2015 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.

The Trust received a record amount of income in 2014 and, combined with the gains on its investments, this allowed it both to spend around £4.5 million on its charitable objects and to continue to rebuild its reserves in accordance with its plan. The increase in income compared with 2013 amounted to about 5%, reflecting both the continuing generosity of our supporters and our continuing success in accessing public sector funding from both UK and EU sources. Once again expenditure was carefully controlled, resulting in a surplus on the unrestricted General Fund of £57,627 before investment gains.

The unrestricted investments and Underwood endowment produced total returns of 3.9% which is considerably better than their manager's investment policy which remains to exceed the return on cash. The ARET endowment achieved a total return of 3.2%, which is slightly below its blended benchmark of 4.3%.

The Trustees continue to keep the Trust's financial performance under close review and to take appropriate measures to protect the Trust against the inevitable uncertainty in fundraising in the current climate. They continue to be satisfied that the Trust's overall financial position is sound. The Trust's reserves policy is that unrestricted cash and investments should exceed £1.5 million and must not fall below £1 million. At the end of 2014 the Trust's reserves (according to this definition) were around £1.3 million.

Plans for future periods

The Trust's five-year business plan was prepared in March 2012. The key aims are:

1. To focus on three areas of work: species recovery, game and wildlife management and wildlife-friendly farming.
2. To strengthen our ability to deliver the results and implications of that science to our three audience groups: the public, policy makers and practitioners.
3. To maintain the financial security of the Trust.
4. To improve the profile of the Trust as an organisation relevant to a broader range of stakeholders.

These continue to direct our work; our research and policy initiatives aim to deliver effective wildlife conservation alongside economic land use and in the light of the new challenges of food security and climate change. Our focus on practical conservation in a working countryside makes our work even more relevant as these challenges unfold.

I Coghill
Chairman of the Trustees

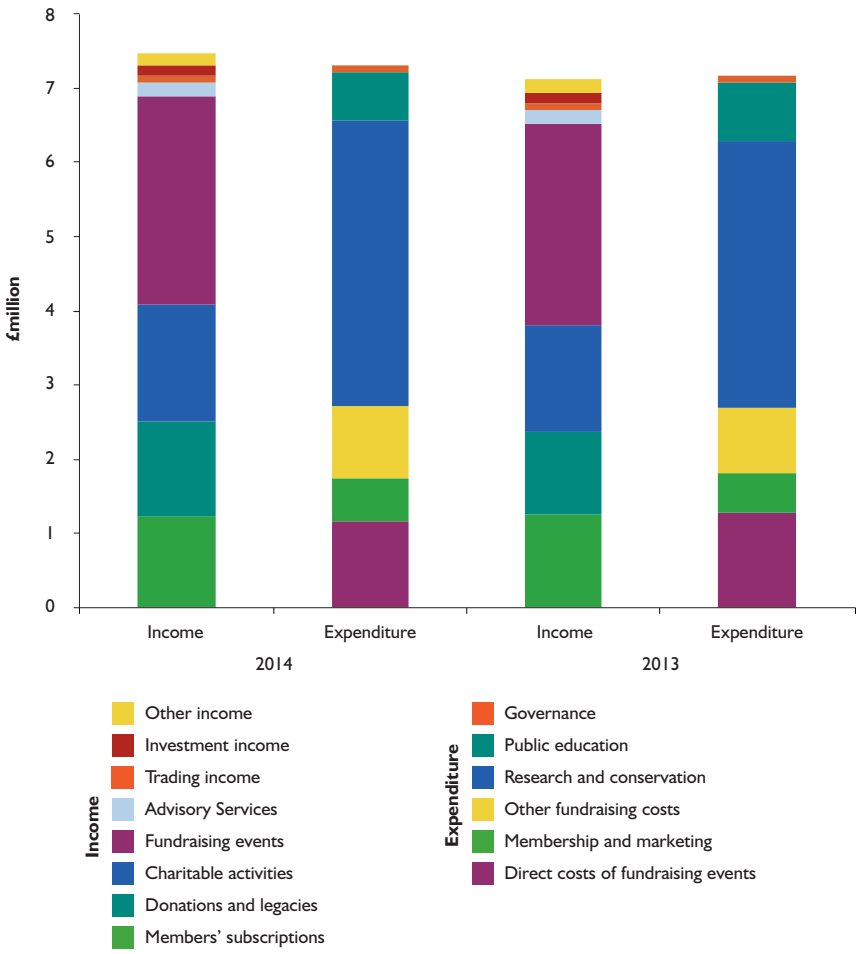


Figure 1

Total incoming and outgoing resources in 2014 (and 2013) 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 2014 which is set out on pages 76 and 77.

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 misstatements or inconsistencies with the summary financial statement. The other information comprises only the Review of Financial Performance.

We conducted our work in accordance with Bulletin 2008/3 issued by the Auditing Practices Board. Our report on the Trust's full annual financial statements describes the basis of our opinion on those financial statements.

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 2014 and complies with the applicable requirements of Section 427 of the Companies Act 2006 and the regulations made thereunder.

FLETCHER & PARTNERS
Chartered Accountants and Statutory Auditors
Salisbury, 30 April 2015

Consolidated

Statement of financial activities

	General Fund £	Designated Funds £	Restricted Funds £	Endowed Funds £	**Total 2014 £**	Total 2013 £
INCOME AND EXPENDITURE						
INCOMING RESOURCES						
Incoming resources from generated funds						
Voluntary income						
Members' subscriptions	1,228,600	–	9,560		**1,238,160**	1,248,680
Donations and legacies	361,305	–	923,941	–	**1,285,246**	1,103,088
	1,589,905	–	933,501	–	**2,523,406**	2,351,768
Activities for generating funds						
Fundraising events	2,806,522	–		–	**2,806,522**	2,715,545
Advisory Service	172,436	–	–	–	**172,436**	183,199
Trading income	88,673	–	–	–	**88,673**	83,494
Investment income	10,512	–	109,683	13,925	**134,120**	132,931
Incoming resources from						
Charitable activities	275,778	–	1,298,105	–	**1,573,883**	1,438,157
Other incoming resources	102,927	–	63,048	–	**165,975**	185,371
TOTAL INCOMING RESOURCES	5,046,753	–	2,404,337	13,925	**7,465,015**	7,090,465
RESOURCES EXPENDED						
Costs of generating funds						
Direct costs of fundraising events	1,162,079	–	–	–	**1,162,079**	1,228,530
Membership and marketing	563,342		–	–	**563,342**	568,058
Other fundraising costs	975,497	–	–	–	**975,497**	887,105
	2,700,918	–	–	–	**2,700,918**	2,683,693
Charitable activities						
Research and conservation – Lowlands	944,747	–	533,292	–	**1,478,039**	1,486,998
Research and conservation – Uplands	341,698	–	287,537	–	**629,235**	644,542
Research and conservation – Demonstration	154,635	–	973,533	4,150	**1,132,318**	976,088
Research and conservation – Fisheries	303,941	–	298,708	–	**602,649**	468,956
	1,745,021	–	2,093,070	4,150	**3,842,241**	3,576,584
Public education	470,536	–	128,287	50,000	**648,823**	784,263
	2,215,557	–	2,221,357	54,150	**4,491,064**	4,360,847
Governance costs	72,651	–	–	8,039	**80,690**	93,224
TOTAL RESOURCES EXPENDED	4,989,126	–	2,221,357	62,189	**7,272,672**	7,137,764
NET INCOMING/(OUTGOING) RESOURCES BEFORE TRANSFERS	57,627	–	182,980	(48,264)	**192,343**	(47,299)
Transfers between funds	-	–	–	–	–	–
NET INCOMING/(OUTGOING) RESOURCES	57,627	–	182,980	(48,264)	**192,343**	(47,299)
OTHER RECOGNISED GAINS AND LOSSES						
Realised gains/(losses) on investments	2,707	–	-	5,019	**7,726**	43,073
Unrealised gains/(losses) on investments	14,026	–	613	15,730	**30,369**	490,951
NET MOVEMENT IN FUNDS	74,360	–	183,593	(27,515)	**230,438**	486,725
BALANCES AT 1 JANUARY 2014	2,196,910	136,492	327,284	5,853,655	**8,514,341**	8,027,616
BALANCES AT 31 DECEMBER 2014	£2,271,270	£136,492	£510,877	£5,826,140	**£8,744,779**	£8,514,341

Consolidated

Balance sheet

as at 31 December 2014

	2014		2013	
	£	£	£	£
FIXED ASSETS				
Tangible assets		3,196,907		3,264,672
Investments		4,193,852		4,337,851
		7,390,759		7,602,523
CURRENT ASSETS				
Stock	387,449		178,122	
Debtors	913,600		878,667	
Cash at bank and in hand	1,207,345		1,087,952	
	2,508,394		2,144,741	
CREDITORS:				
Amounts falling due within one year	655,603		892,747	
NET CURRENT ASSETS		1,852,791		1,251,994
TOTAL ASSETS LESS CURRENT LIABILITIES		9,243,550		8,854,517
CREDITORS:				
Amounts falling due after more than one year		498,771		340,176
NET ASSETS		£8,744,779		£8,514,341
Representing:				
CAPITAL FUNDS				
Endowment funds		5,826,140		5,853,655
INCOME FUNDS				
Restricted funds		510,877		327,284
Unrestricted funds:				
Designated funds	136,492		136,492	
Revaluation reserve	323,848		356,051	
General fund	1,904,053		1,795,895	
Non-charitable trading fund	43,369		44,964	
		2,407,762		2,333,402
TOTAL FUNDS		£8,744,779		£8,514,341

Approved by the Trustees on 16 April 2015 and signed on their behalf

I COGHILL

Chairman of the Trustees

Staff

of the Game & Wildlife Conservation Trust
in 2014

CHIEF EXECUTIVE	Teresa Dent BSc, FRAgS
Personal Assistant	Lindsay Watson BSc, MSc (until August), Sue McKechnie (from August)
Head of Finance	James McDonald ACMA, GCMA
Finance Assistant – Limited	Lin Dance
Accounts Assistant (p/t)	Suzanne Hall
Head of Administration & Personnel (p/t)	Ian Collins MCIPD, BA (until March), Jayne Cheney Assoc CIPD (from April)
Administration & Personnel Assistant (p/t)	Jayne Cheney Assoc CIPD (until March), Melani Cartwright (March – August), Lindsay Watson BSc, MSc (from August)
Head Groundsman (p/t)	Craig Morris
Headquarters Cleaner (p/t)	Rosemary Davis
Headquarters Janitor (p/t)	Chris Johnson
Head of Information Technology	James Long BSc
DIRECTOR OF COMMUNICATION & PUBLIC AFFAIRS	Tom Oliver MA, Dip.LA, FRSA (until January)
DIRECTOR OF RESEARCH	Nick Sotherton BSc, PhD
Personal Assistant (p/t)	Lynn Field
Head of Database	Corinne Duggins Lic ès Lettres
Head of Fisheries	Dylan Roberts BSc
Project Administrator – MorFish & Quessa	Paul Stephens BApp.Sc
Public Sector Fundraiser	Paul Stephens (from July)
Head of Salmon & Trout Research Centre	Anton Ibbotson BSc, PhD (until July)
Fisheries Scientist	Rasmus Lauridsen BSc, MSc, PhD (until July)
Head of Fisheries – Research	Rasmus Lauridsen BSc, MSc, PhD (from August)
Senior Fisheries Scientist	Bill Beaumont MIFM
MorFish Project Scientist	Stephen Gregory BSc, MPhil, PhD
Research Assistant	Luke Scott
PhD Student (University of Bournemouth) – pike removal and weed cutting	Sui Phang BSc, MSc
PhD Student (University of Exeter) – salmon genetics	Charles Ikediashi BSc
PhD Student (University of Southampton) – Impacts of Beavers on Salmonids	Robert Needham BSc
MRes Student (University of Cardiff) – brown trout and bullheads	Janine Burnham BSc
Head of Lowland Gamebird Research	Rufus Sage BSc, MSc, PhD
Ecologist – Pheasants, Wildlife (p/t)	Maureen Woodburn BSc, MSc, PhD
Bird Surveyors	Sue Wilson BA (April-July), Tony Powell (April-July), Allan Goddard (April-July)
PhD Student (Imperial College, London) – birds and miscanthus	Henrietta Pringle BSc
PhD student (University of Exeter) – pheasant behaviour	Mark Whiteside MSc
PhD student (Harper Adams University) – Syngamus in pheasants	Owen Gethings MSc
PhD Student (Exeter University) – corvids and songbirds	Lucy Capstick MSc
MSc Student (Exeter University) pheasants and reptiles	George Berthon
MSc student (Bournemouth University) pheasant release pens	Andy Hall
Placement Student (University of Reading)	Jack Buckingham (until September)
Placement Student (University of Durham)	Emily Robertson (August – January)
Senior Scientist – Scottish Lowland Research	David Parish BSc, PhD
PhD Student (University of Glasgow) – yellowhammer ecology	Dawn Thomson BSc
PhD Student (University of St Andrews and John Hutton Institute) – small mammal ecology on farmland	Amanda Wilson BSc
MSc Student (Newcastle University) - songbird breeding success	Sophie Carr BSc
MSc Student (Imperial University) - songbird breeding success	Rachel Shepherd BSc
MSc Student (Newcastle University) - raptor breeding biology	Richard O'Brien BSc
Head of Wetland Research	Andrew Hoodless BSc, PhD
Research Assistants	Kaat Brulez MSc, PhD (from April), Carlos Sanchez Garcia Abad PhD, BVSc (from April)
Research Assistant/PhD Student (p/t University of Nottingham) – breeding ecology of woodcock	Chris Heward BSc
PhD Student (University of Reading) – game landscapes	Jessica Neumann BSc
MSc Student (University of Reading) – lapwings on fallow plots	Katie Fielding BSc
MSc Student (University of Leeds) – lapwings in Peak District	Shanna Rice BSc
Placement Student (University of Birmingham)	Alex Fall (until June)
Placement Student (University of Cardiff)	Freya Stacey (until August)
Placement Student (University of Leeds)	Joel Brittain (from October)
Placement Student (University of Leeds)	Leah Kelly (from October)
Head of Predation Control Studies	Jonathan Reynolds BSc, PhD
Senior Field Ecologist	Mike Short HND
Research Assistant	Tom Porteus BSc, MSc
Head of Farmland Ecology	John Holland BSc, MSc, PhD
Senior Ecologist	Barbara Smith BSc, PhD
Senior Entomologist	Steve Moreby BSc, MPhil
Entomologist	Sue Southway BA seconded Plantlife (until December)
Ecologist	Tom Birkett BSc, PgC (until April)
Research Assistants	Matthew Brown BSc (from April), Kevin McGee BSc, MSc (April – August), Melanie Stone BA, MSc (April – August)
PhD Student (Imperial College London) – stewardship and farmland birds	Niamh McHugh BSc, MSc
PhD Student (University of Sussex) – stewardship on wild bees	Tom Wood BSc, MSc
MSc Student (Harper-Adams University) - bumblebees in the New Forest	Claire Bowers BSc
Placement Student (University of Bath)	Liam Crowley (until September)
Placement Student (University of Reading)	Tom Elliott (until September)
Placement Student (University of Sheffield)	David Stevenson (from September)
Placement Student (University of Bath)	Laura James (from September)
Director of Upland Research	David Baines BSc, PhD
Office Manager, Uplands	Julia Hopkins
Senior Scientist	Phil Warren BSc, PhD
Project Assistant – Black Grouse	Frances Atterton BSc, MSc (until May)

Research Assistants	Michael Richardson BSc,
Research Ecologist	Gail Roberston BSc, MSc, PhD (from November)
Research Ecologist Langholm	Sonja Ludwig MSc, PhD
Research Assistant	Merlin Becker BSc (January – March)
Placement Student (University of Bath)	Emily Trevail (from August)
PhD student (University of Newcastle) – buzzards and grouse	Richard Francksen BSc
Placement Student (University of Leeds)	Zoe Deal (until July)
Placement Student (University of Cardiff)	Harriett Fuller (from August)
MSc Student (University of Reading) - red grouse nesting success and chick survival	Kathryn Fingland
MSc Student (Newcastle University) - raptor foraging activity	Sarah Emerson
Senior Scientist – North of England Grouse Research	David Newborn HND
Senior Scientist – Scottish Upland Research	Kathy Fletcher BSc, MSc, PhD
Research Assistant – Scottish Upland Research (p/t)	David Howarth
Research Assistants – Scottish Upland Research	Graeme Neish (until August), Anna McWilliam (November – December)
Placement Student (Bangor University)	Sion Thomas (until July)
Placement Student (University of Birmingham)	Amy Withers (from September)
Head of Advisory	Roger Draycott[1] HND, MSc, PhD
Co-ordinator Advisory Services (p/t)	Lynda Ferguson
Field Officer – Farmland Ecology	Peter Thompson DipCM, MRPPA (Agric)
Head of Education	Mike Swan BSc, PhD[2]
Regional Advisor	Austin Weldon BSc, MSc (from June)
Game Manager – Rotherfield	Malcolm Brockless
DIRECTOR OF POLICY & THE ALLERTON PROJECT	Alastair Leake BSc (Hons), MBPR (Agric), PhD, FRAgS, MIAgM, CEnv
Secretary (p/t)	Katy Machin, Sarah Large (from January)
Head of Research for the Allerton Project	Chris Stoate BA, PhD
Ecologist	John Szczur BSc
Senior Research Assistant	Nicola Hinton BSc, PhD
Game Manager	James Watchorn
Head of Education and Development	Jim Egan
PhD Student (University of Nottingham) – farmers' environmental learning	Susanne Jarratt BSc
MSc Student (University of Nottingham) – field margin soil biology	Stephen Jones BSc
MSc Student (University of Southampton) mapping ecosystem services	Richard Stone BSc
MSc student (University of Derby) – catchment hydrology	Michael Dorr BSc
MSc student (University of Cranfield) – soil properties	Tichaona Sanangura BSc
MSc student (University of York) – catchment water quality	Alejandra Barrios Rivera BSc
MSc student (University of Nottingham) – Catchment ecology	Tom Keighley BSc
Research Assistant	Sofi Lloyd (until September)
Policy Officer UK	Sofi Lloyd (from September)
Farm Manager	Philip Jarvis MSc
Farm Assistants	Michael Berg, Ben Jarvis
DEPUTY DIRECTOR OF RESEARCH	Nicholas Aebischer Lic ès Sc Math, PhD
Secretary, Librarian & National Gamebag Census Co-ordinator	Gillian Gooderham
Senior Conservation Scientist	Francis Buner Dipl Biol, PhD
SCCS Cambridge intern (Wildlife Department HP, India)	Sat Pal Dhiman (March – April)
Post-Doctoral Researcher (University of León)	Carlos Sánchez García-Abad, PhD, BVSc (until March)
Head of Geographical Information Systems	Julie Ewald BS, MS, PhD
Partridge Count Scheme Co-ordinator	Neville Kingdon BSc
Biometrics/GIS Assistants	Chris Wheatley BSc (until September), Ryan Burrell BSc (from November)
Placement Student (University of Bath)	Lucy Coals (until September)
Placement Student (University of Bath)	Charles Cunningham (until September)
Placement Student IT (University of Surrey)	Christopher Price (until August)
Placement Student (University of the West of England)	Georgina Tucker (from September)
Placement Student University of Southampton)	Sophie Watts (from September)
DIRECTOR OF FUNDRAISING	Edward Hay
Shoot Sweepstake Fundraiser (p/t)	Kathryn Solari (until October)
National Events Co-ordinator (p/t)	Mel Dellow (until May)
London Events Manager	Lucinda Pearson
London Events Assistant	Tortie Hoare
Events Assistant	Phoebe Cumming (until December)
Northern Regional Fundraiser (p/t)	Sophie Dingwall
Southern Regional Fundraiser	Max Kendry
Eastern Regional Fundraiser	Lizzie Herring
Regional Organisers (p/t)	Gay Wilmot-Smith BSc, Charlotte Meeson BSc, David Thurgood, Sarah Matson
Regional Organiser (p/t)	Caroline Gray (January – November)
National Development Manager	Jennifer Thomas (from September)
DIRECTOR OF MEMBERSHIP, MARKETING & COMMUNICATIONS	Andrew Gilruth BSc
Head of Media	Morag Walker MIPR
PR Assistant (p/t)	Daniel O'Mahony
Head of Publications	Louise Shervington
Database Assistant (p/t)	Beverley Mansbridge
Shop Assistant (p/t)	Melani Cartwright (August – December)
Membership Assistant (p/t)	Angela Hodge
National Recruitment Manager	Andy Harvey
Digital Fundraising & Marketing Officer	Rob Beeson
Direct Mail Fundraising & Marketing Officer	James Swyer
Website Editor	Oliver Dean
Events Manager (p/t)	Adrienne Tollman (from May)
DIRECTOR SCOTLAND	Adam Smith BSc, MSc, DPhil
Scottish HQ Administrator (p/t)	Irene Johnston BA
Policy Officer Scotland	Gemma Hopkinson MA
Senior Scottish Advisor & Scottish Game Fair Chairman	Hugo Straker NDA[3]
Head of PR & Education – Scotland (p/t)	Katrina Candy HND

[1] Roger Draycott is also Regional Advisor for the East; [2] Mike Swan is also Regional Advisor for the South of England; [3] Hugo Straker is also Regional Advisor for Scotland and Ireland.

External committees with GWCT representation

1. BASC Gamekeeping and Gameshooting	Mike Swan
2. BBC Scottish Rural And Agricultural Advisory Committee	Adam Smith/ Katrina Candy
3. BCPC Science and Environment Group	Alastair Leake
4. Bird Expert Group of the England Biodiversity Strategy	Nicholas Aebischer
5. CFE Hampshire Co-ordinator	Peter Thompson
6. CFE Steering Committee (Natural England-led)	Alastair Leake
7. CFE National Delivery Group	Peter Thompson
8. Capercaillie BAP Group	David Baines/Adam Smith/Kathy Fletcher
9. Capercaillie Research Group	David Baines
10. Code of Good Shooting Practice	Mike Swan
11. Cold Weather Wildfowl Suspensions	Mike Swan/Adam Smith
12. Conservation Grade	Peter Thompson
13. Cornish Red Squirrel Project	Nick Sotherton
14. Council of the World Pheasant Association	Nick Sotherton
15. Deer Initiative	Austin Weldon
16. Deer Management Qualifications	Austin Weldon
17. Defra Upland Stakeholder Forum & Burning sub-groups	Adam Smith/David Newborn/Teresa Dent
18. Defra Hen Harrier Action Plan Group	Adam Smith/Teresa Dent
19. English Black Grouse BAP Group	Phil Warren/David Baines
20. Farmland Biodiversity 'Toolkit' Partnership	Peter Thompson
21. Fellow of the National Centre for Statistical Excellence	Nicholas Aebischer
22. Freshwater Fisheries CEO Meetings	Nick Sotherton
23. Futurescapes Project: North Wales Moorlands	David Baines
24. Gamekeepers Welfare Trust	Mike Swan
25. Hampshire Ornithological Society	Peter Thompson
26. Hares Best Practice Group	Mike Swan
27. Heather Trust Board	Adam Smith
28. Honorary Scientific Advisory Panel of the S&TA	Nick Sotherton
29. IUCN/SSC European Sustainable Use Specialist Group	Nicholas Aebischer/ Julie Ewald
IUCN/SCCS Galliformes Specialist Group	Francis Buner
30. IUCN/SSC Grouse Specialist Group	David Baines
IUCN/SCCS Re-introduction Specialist Group	Francis Buner
31. Joint Hampshire Bird Group	Peter Thompson
32. Lead Ammunition Group – Primary Evidence and Risk Assessment Working Group	Alastair Leake
33. LEAF Policy and Communications Advisory Committee	Alastair Leake
34. Marlborough Downs NIA Board	Teresa Dent
35. Marlborough Downs NIA Species Delivery Group	Peter Thompson
36. MESME Steering Group	Alastair Leake
37. Moorland Gamekeepers Association	David Newborn
38. Natural England – Main Board	Teresa Dent
39. Natural England National Arable Systems Option	Peter Thompson
40. Natural England National CAP Species Workstream Review	Peter Thompson
41. NGO Committee	Mike Swan
42. Norfolk CFE Local Liaison Group	Roger Draycott
43. North Wessex Farmland Bird Advisor Steering Committee	Peter Thompson
44. Perthshire Black Grouse Group	Kathy Fletcher
45. Operation Turtle Dove, Suffolk and Essex Steering Committee	Roger Draycott
46. Pesticides Forum Indicators Group of the Chemicals Regulation Directorate	Julie Ewald
47. Purdey Awards	Mike Swan
48. Rivers and Lochs Institute Advisory Group	Adam Smith
49. Scientific Advisory Committee of the Office National de la Chasse et de la Faune Sauvage	Nicholas Aebischer
50. Scotland's Moorland Forum and sub-groups	Adam Smith
51. Scotland's Rural College Council	Adam Smith
52. Scottish Black Grouse BAP Group	Phil Warren/ David Baines
53. Scottish Game Industry Snare Training Group	Hugo Straker
54. Scottish Biodiversity Strategy Executive and two sub-groups	Andrew Salvesen/Adam Smith/Gemma Hopkinson
55. Scottish Government CAP Greening Stakeholder Group	Gemma Hopkinson
56. Scottish Parliament Rural Policy Cross Party Working Group	Gemma Hopkinson
57. Scottish Government CAP Reform Stakeholder Group	Gemma Hopkinson
58. Scottish Land & Estates Moorland Working Group	Adam Smith
59. Scottish Moorland Groups (four regional groups)	Adam Smith/Hugo Straker
60. Scottish PAW Executive, Raptor and Science sub-groups	Adam Smith
61. Scottish Upland Coordination Group (Technical Advisors)	Adam Smith/ Gemma Hopkinson
62. SNH Deer Management Round Table	Gemma Hopkinson
63. SNH Moorland Sustainability Review	Adam Smith
64. SNH National Species Reintroduction Forum	Adam Smith
65. SNH Scientific Advisory Committee Expert Panel	Nicholas Aebischer
66. South Downs Farmland Bird Initiative	Julie Ewald
67. South West Farmland Bird Advisor Steering Committee	Peter Thompson
68. Strathspey Black Grouse Group	Kathy Fletcher
69. Squirrel Forum	Mike Swan
70. Suffolk FWAG Advisory Committee	Roger Draycott
71. Tayside Biodiversity Partnership Farmland Ecosystem Group	David Parish
72. Technical Asessment Group (Scotland)	Hugo Straker/Mike Short/ Jonathan Reynolds
73. The ACP Environmental Panel	Alastair Leake
74. The ACP/COT Bystanders Risk Assessment Working Group	Alastair Leake
75. The Agri-Environment Stakeholder Group	Alastair Leake
76. The Bracken Control Group	Alastair Leake
77. The CAAV Agriculture and Environment Group	Alastair Leake
78. The Green Food Project	Alastair Leake
79. The UK Pesticides Forum	Alastair Leake
80. The UK Soil Management Initiative Executive Committee	Alastair Leake
81. Understanding Predation Project Steering Group	Adam Smith
82. Upland Hydrology Group	David Newborn
83. UK Avian Population Estimates Panel (JNCC-led)	Nicholas Aebischer
84. UK Birds of Conservation Concern Panel (RSPB-led)	Nicholas Aebischer
85. Welsh Bird Conservation Forum	David Baines
86. Wildlife Estates Scotland Expert Panel	Adam Smith
87. Winning Ways for Wildlife (Hampshire group)	Peter Thompson
88. World Pheasant Association Scientific Advisory Committee	David Baines

Key to abbreviations: ACP = Advisory Committee on Pesticides; BAP = Biodiversity Action Plan; BASC = British Association for Shooting and Conservation; BCPC = British Crop Production Council; CAAV = Central Association of Agricultural Valuers; CAP = Common Agricultural Policy; CFE = Campaign for the Farmed Environment; COT = Committee on Toxicity; FWAG = Farming & Wildlife Advisory Groups; IUCN = International Union for Conservation of Nature, JNCC = Joint Nature Conservation Committee; LEAF = Linking Environment And Farming; MESME =Making Environmental Stewardship More Effective; NGO = National Gamekeepers' Organisation; NIA = National Improvement Area; PAW = Partnership for Action Against Wildlife Crime; RSPB = Royal Society for the Protection of Birds; S&TA= Salmon & Trout Assosication SSC = Species Survival Commission; SNH = Scottish Natural Heritage.

Game & wildlife management

Good productivity is essential for all shoots; whether from the rearing field or achieving maximum productivity from wild stock

Get the best advice now

The GWCT's advisory team are the most experienced consultants in their field, able to provide advice and training across all aspects of game management, from wild bird production and farm conservation management to the effective and sustainable management of released game

Renowned for our science-based game and wildlife management advice that guarantees the best possible outcome from your shoot, we will work closely with your farm manager, gamekeeper and existing advisors to identify ways of making your game and shoot management more effective by providing tried and tested advice backed by science

Call us today 01425 651013

www.gwct.org.uk/advisory
advisory@gwct.org.uk

www.gwct.org.uk/advisory

Game & Wildlife
CONSERVATION TRUST
Advisory Service