Review
of 2008

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

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Review of 2008

Issue 40

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

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GAME & WILDLIFE CONSERVATION TRUST 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.

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Game & Wildlife CONSERVATION TRUST

Mallard. (© Laurie Campbell)

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Council

as at 1 January 2009

Chairman's report

Mark Hudson is an organic dairy, beef and arable farmer from North Wales. He is a farm business consultant and past President of the Country Land & Business Association. © Tom Hudson

2008 has been a year of both achievement and challenge. Indeed the whole world is facing challenge on a scale not seen in our lifetime; everything from how we feed our burgeoning population, to climate change and the credit crunch.

Conserving wildlife amidst these challenges is not going to be easy. But no matter how global the issues, at the end of the day it comes back to how things are done on the ground by individuals. It will require real partnership working between land users, owners and managers on the one hand and the government agencies on the other. It will also need the latter to 'work with the grain' of the former. Simple really; if one can pick a conservation 'strategy' that works with the natural preferences and aims of landowners and managers, it is more likely to be adopted. Even better if those land managers have a sense of ownership of the scheme and best if they have been truly involved in its practical design – bottom-up not top-down should be the mantra. And a national conservation strategy that works with the countryside's 5,000 privately employed wildlife managers – gamekeepers – is much more likely to succeed than one that doesn't.

We need to be clear about what constitutes good conservation; especially when we are talking about ecosystems. A recent report published by WWF makes the point that "it is not biodiversity *per se* that underpins ecosystem services, but the abundance of particular species that are critical in maintaining habitat stability…". A significant example from our early work was the demonstration that a big reduction in insect abundance following the introduction of herbicides onto arable crops in the 1950s caused the collapse of grey partridge numbers and other birds too. Building back wildlife abundance is as important as retaining the diversity of species. For some, especially in Britain's highly modified landscapes, we know gamekeeping can contribute to this. This *Review* features our Upland Predation Experiment completed in the summer of 2008. This showed clearly that predation control (carried out for red grouse by gamekeepers) significantly improves the breeding success of upland waders like curlew and golden plover. In fact, the improvement begs the question: how many of these birds would be left in our uplands if grouse moor management ceased? Similarly, the report from the Allerton Project shows how predation control has enhanced the breeding success of a number of farmland and woodland birds.

The challenge we face as a charity is to keep our work relevant and fully funded. I believe that our research continues to test those important areas of wildlife management, game management and their inter-relationship with farming and the wider environment. During 2008 we entered into negotiations over acquiring the research rights at the former CEH salmonid fisheries site at East Stoke in Dorset. This will add to our existing trout fisheries work and give us a broader appeal to all fishermen.

However, our excellent research teams need the support of the rest of our hard working staff in fundraising, administration, finance, IT, membership, marketing, advisory and education as well as our strengthened team in Scotland. To all of these individuals, and especially to our Chief Executive, Teresa Dent, I give my warmest thanks.

The next few years may prove difficult. If ever a charity needed its loyal members, it is now, so my thanks also go to you for your continued support and encouragement.

** WWF Living Planet Report 2008, p4. WWF International, Gland, Switzerland.*

Chief Executive's report

Above: Mike Short showing Agriculture Minister Lord Rooker the details of the mink tracking insert for the GWCT mink raft at the 2008 CLA Game Fair.
© Peter Thompson/GWCT

We changed our name from The Game Conservancy Trust to the Game & Wildlife Conservation Trust in late 2007 so this was the first full year with our new identity. The new name reflects the breadth of work we do (it is a very long time since the only wildlife we researched were game species), and to make the point that game is part of wildlife (virtually all game management benefits the other wildlife that lives alongside game). It is clear that in terms of public perception the name change has worked. In the same way that all political parties want the same outcomes in terms of social equality, adequate health care, good education and financial security, but different political parties advocate different strategies and routes to achieve those aims; the Game & Wildlife Conservation Trust is recognised as wanting the same conservation outcomes in terms of species recovery and a thriving countryside rich in wildlife, but that our strategies are informed and enhanced by our game management heritage and research.

This concept that game management principles can inform national conservation strategies is not new. Indeed our previous research into providing habitat and food sources is already embedded in national conservation strategies, especially though agri-environment schemes. Providing habitat and food are two of the three components of game management, the third being control of predation. This has been more of a Cinderella in terms of national conservation strategies, but work reported in this *Review* at the Allerton Project in Leicestershire and in the uplands at Otterburn begins to reveal just how much this component, in conjunction with the other two, could perhaps contribute to rapid species recovery.

The *Review* also reports on the first year of the Langholm Moor Demonstration Project. This partnership project is assessing whether diversionary feeding can

Mike Swan explains conservation headlands to Lord Rooker at the CLA Game Fair. © Peter Thompson/GWCT

mitigate the impact of hen harriers on red grouse so that the Langholm Moor can be restored as an economically viable driven grouse moor in the presence of hen harriers. The results of this work will feed into Natural England's red grouse/hen harrier reconciliation process which is being facilitated by the Environment Council (a registered charity) and involves all the interested groups from moor owners to Government agencies. This process is looking for the first time at a wide range of options which include diversionary feeding, but also the possibility of re-establishing harriers in areas where there is no conflict with game and local population ceilings on grouse moors. The process has a long way to go but we are pleased to be a part of it, alongside others, and it represents a very real attempt by all those involved to find a solution to this difficult, but genuine, wildlife conflict.

Our accounts show that the latter part of 2008 was not an easy period for fundraising so I am especially grateful to all those people who have continued to be so generous and worked so hard to raise funds for us. Our County Group Committees did a wonderful job. We are grateful to the many companies and organisations which sponsored our work and events, and to numerous individual donors who were so generous in their support. Every gift, great or small, is appreciated – as we say of grey partridges – every one counts!

Langholm Moor Demonstration Project Scientific and Technical Advisory Group meet at Langholm 2008. © Des Thompson/Scottish Natural Heritage

Observing pheasants in our spectacles study (see page 12). © Dave Butler/GWCT

Wildlife disease and epidemiology research

KEY ACHIEVEMENTS

- We continued research into partridge pen design for brood rearing.
- We worked with the Veterinary Laboratories Agency to research links between *Brachyspira* and pheasant disease.
- We worked with Ridgeway biological/Veterinary laboratories Agency on typing Rotavirus infections.
- We completed a trial of fish and protein feeds for pheasants.
- We submitted the final report on the use of bits and specs in pheasant rearing to Defra.

Chris Davis

What a year; with warm, wet weather and a very heavy parasite legacy from 2007, we have had continually to dose our birds on the rearing field, especially the grey partridges, to fend off coccidiosis and gapeworms. This reflects what has been going on elsewhere, with the added problem of hexamitiasis (spironucleus). Game farmers and gamekeepers will need to draw up good health plans to combat these problems in the future.

Grey partridge rearing

In our partridge study, we are trying to understand the best conditions for pairs of grey partridges to lay and rear their own brood within a pen from which they can be released as part of a reintroduction programme. This fits with our partridge reintroduction projects and would allow individual broods to be reared *in situ* and gradually released on site into suitable habitat.

Earlier studies indicated that pens needed to be at least 20' x 10', so this part of the project looked at habitat within the pen and the whether pens should be totally separate or can be attached in a row. Of the 20 pens set up, 13 pairs managed to bring off broods, and the number of chicks hatched ranged from one to 22. The project shows promise and we now know that given the right conditions and space within the pens, pairs of grey partridges will bring off broods successfully. We believe that individual pens give the best results and we hope to continue to fine-tune the environment within the pen in order to find the formula for successful brood rearing.

Brachyspira

Brachyspira is a bacterium that has been increasingly in the news recently as causing problems in poultry flocks especially in layers.

WILDLIFE DISEASE AND EPIDEMIOLOGY RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Gamebird health	*Disease prevention and control in game and wildlife*	*Chris Davis*	*Core funds*	*1998- on-going*
Rearing field	*Provision of the research facility for the grey partridge rearing programme*	*Chris Davis, Matt Ford*	*Core funds*	*2000- on-going*
ABN nutrition study	*Assessing growth and performance of pheasants in relation to addition of protein and fish meal in feed*	*Chris Davis, Matt Ford*	*ABN*	*2008*
PhD: Maternal immunity	*To investigate the extent of any immunity in pheasant chicks acquired from their mothers*	*Matthew Ellis Supervisors: Chris Davis, Dr Emma Cunningham/University of Edinburgh*	*BBSRC/CASE studentship*	*2006-2009*

Key to abbreviations: BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering

In poultry, species such as *B. intermedia* and *B. pilosicoli* are considered to be causes of enteritis the symptoms of which are very similar to those seen in cases of intestinal upsets in pheasants and partridges. However, it is not known to what extent if any *Brachyspira* organisms may play a role in enteritis in pheasants.

The first question asked was does *Brachyspira* actually infect pheasants?

In studies away from Fordingbridge, David Welshman MRCVS of the Veterinary Laboratories Agency (VLA) attempted to culture the *Brachyspira* bacterium from the intestinal contents of release pen pheasants.

David detected *Brachyspira* organisms in the caecum of pheasant poults. Having answered the question of their existence in pheasants the next step is to establish whether there is any link between *Brachyspira* organisms in pheasants and clinical disease.

Rotavirus

Following field reports that rotavirus was causing increasing mortality in young chicks we set up a study with Ridgeway Biologicals Ltd. and Avian Virology at the VLA in order to identify the strains of the virus and see if certain strains were causing the main problems. At the time of writing, only two samples from field outbreaks had been found to contain the virus on scanning electron microscopy. This tends to indicate that either rotavirus was not involved in the syndrome or that the majority of diagnoses are being made on the basis of clinical signs without laboratory confirmation. If strains of rotavirus on particular rearing fields are stable, ie. the one type causes repeat problems, then it may be possible to manufacture a vaccine specific to that rearing field and use it in laying hens in that unit to provide protective antibodies to the young chick via the egg as shown in our earlier studies done in conjunction with Dick Gough at the VLA.

Pheasant rearing diet

Commissioned by ABN, manufacturers of Sportsman Game Feeds, we carried out a feeding trial on whether varying the dietary protein and fish meal content of the feed impacted on the growth performance of pheasants up to seven weeks of age. This study is discussed in more detail on page 10.

Below: our rearing field at Fordingbridge being used for the pheasant feeding trial (see page 12). © Chris Davis/GWCT

Protein levels and type in pheasant feed

We tested different formulations of feed on behalf of ABN, manufacturers of Sportsman Game Feeds.
© Chris Davis/GWCT

During 2008 ABN, manufacturers of Sportsman Game Feeds, commissioned us to carry out a feeding trial on the rearing field at Fordingbridge. The protein content of the feed and whether fishmeal is included are commercially-important issues; both add to the cost, but are perceived to be important in terms of bird performance. Furthermore, some feed manufacturers (those that also make cattle feed) are regulated against using fishmeal in their game feeds. However, the effects that these factors have on performance had not been clearly defined.

This trial investigated the effects of dietary protein level and fishmeal inclusion on the performance of pheasants grown to seven weeks of age. Feeds with either lower or higher protein content were formulated with either no fishmeal or standard levels of fishmeal. We replicated the resulting four feed treatments four times, so we used 16 pens, involving a total of 2,400 pheasants.

The protein levels chosen for the 'high' treatment were typical of those used in the game feed industry (28.5% in the starter and 23.5% in the grower). In the 'low' protein feeds, the starter and grower were formulated to 25.5% and 21.0% protein respectively. The protein levels used reflected differences in the digestible amino acid contents of the feeds, which were reduced by 10% in the low protein feeds.

The fishmeal levels used were either typical levels for commercial game feeds or with no fishmeal inclusion at all.

The effects of protein and fish were almost completely independent of each other. Both protein and fish had a positive effect on growth and this was most significant in the 21-49 day period. This suggests it is important not to reduce the protein levels of the feed too quickly as the bird gets older, and not to introduce whole wheat feeding too early as wheat is low in protein (typically 10-11%).

Both treatments increased feed intake from 28-49 days and fish, but not protein, also significantly increased feed intake from 0-14 days. The effect of fishmeal in young

KEY FINDINGS

- Both higher dietary protein levels and including fishmeal in the feed improved performance in pheasants.
- The best performance at seven weeks of age was achieved by feeding higher levels of protein in conjunction with fishmeal.

John Round

TABLE 1

Average feed intake and weight gain of pheasants in the feeding trial according to the protein and fish content of the feed

Grams per day	Low protein	High protein	Significance (p=)	No fish	Standard fish	Significance (p=)
Weight gain 21-49 days	10.56	11.29	0.011	10.64	11.21	0.032
Feed intake 0-14 days	7.56	7.74	ns	6.53	8.76	0.011
Feed intake 28-49 days	31.52	32.78	0.050	31.62	32.68	0.085

ns = not statistically significant

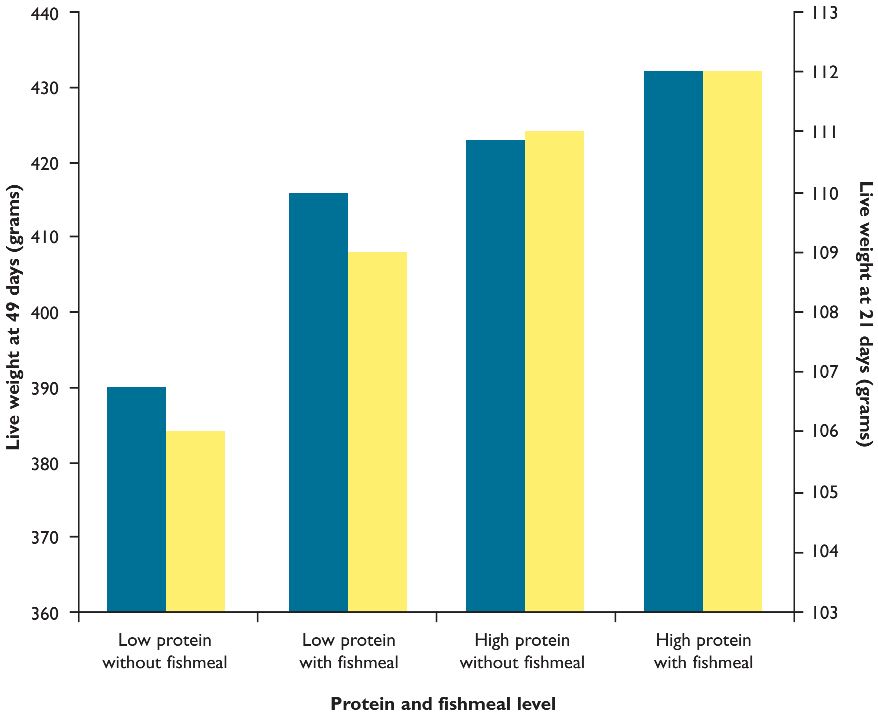


Figure 1

Average live weight gain of pheasants in feed trial at 21 days (right axis) and 49 days (left axis)

49 days

21 days

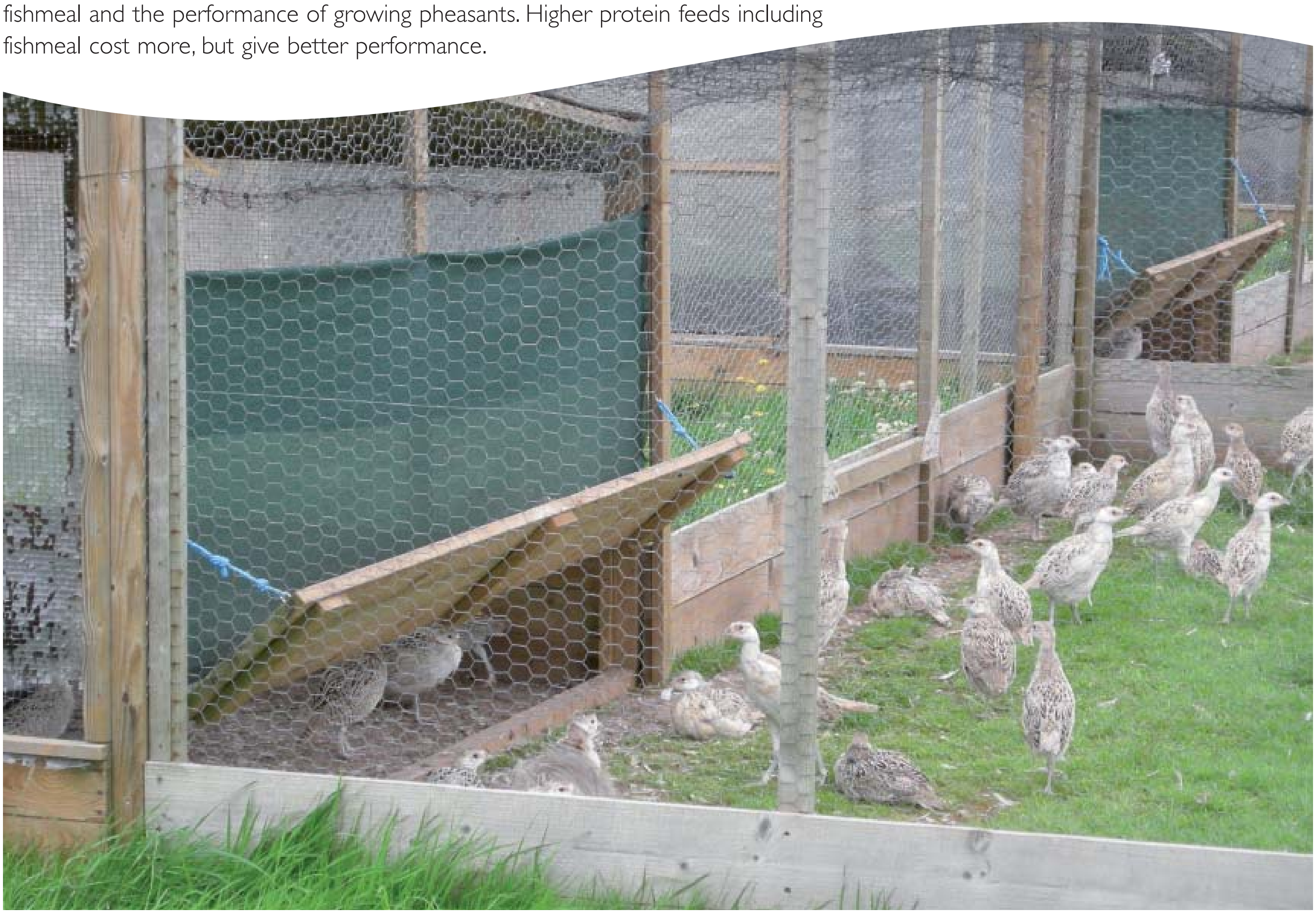
pheasants is perhaps not surprising as pheasants are not naturally vegetarian. Getting birds off to a good start and encouraging food consumption is essential for good long-term performance. The results are shown in Table 1.

In addition, there was a numerical trend ($p=0.135$) for mortality to be reduced (by 3.13% at 49 days) on the high protein feeds. This treatment also gave a small but statistically significant ($p=0.027$) improvement in skin condition at 21 days.

These effects would be very important to both the game farmer and shoot manager. Overall, the best liveweights were obtained on the higher protein feeds with fish and the poorest liveweights were obtained on the lower protein feeds without fish (see Figure 1). The birds that were fed higher protein and fishmeal were more evenly sized and would therefore be easier to rear and manage.

This trial confirms the important link between protein nutrition, the inclusion of fishmeal and the performance of growing pheasants. Higher protein feeds including fishmeal cost more, but give better performance.

Our pheasants did best on a feed with high protein content and added fishmeal. © Chris Davis/GWCT



Effect of spectacles on pheasants

An example of a laying pen used in the study.
© Dave Butler/GWCT

KEY FINDINGS

- Spectacles improved feather condition in hens.
- They reduced incidences of skin damage in hens and cocks.
- They caused damage to the bill and nostrils of hens.
- Spectacles had no effect on the number of eggs collected.
- They had no effect on the body mass index.
- They affected the behaviour of hens.

Dave Butler

Plastic devices known as spectacles (or specs) are often fitted onto the beak of birds to reduce feather pecking, cannibalism and egg eating by pheasants in laying pens (see picture opposite). These mask the bird's forward vision and are attached to the beak by clipping into the nostrils without piercing the septum. Spectacles are fitted to the birds when they are placed in the laying pens (during February/March) and removed just before release into the wild after the laying season (in June/July). As part of a series of studies looking into the welfare effects of anti-feather pecking devices in pheasants (see also *Review of 2007* report on bits, page 10), we examined the effect of spectacles on the physiology and behaviour of pheasants in flock-laying pens on game farms across England.

In 2006 and 2007, we collected data from 15 game farms. On each farm, we randomly allocated a treatment to two pens, where birds either wore spectacles or did not. Management was according to normal practice on each farm and was identical for each treatment apart from the use of spectacles. We assessed the body, feather and skin condition of pheasants in each treatment pen before and after the laying season. We also noted any abnormalities of the bill or nostrils and signs of disease. We recorded data on mortality, feeding and egg production through the laying season. Each week we assessed the behaviour of spectacled and non-spectacled pheasants.

The body mass index (weight divided by tarsus length) of cocks and hens was not affected by the fitting of spectacles. Incidences of skin damage in both cocks and hens were lower in the spectacled pens. The use of spectacles reduced the prevalence of skin damage from 13% to 3% in cocks and from 42% to 23% in hens. Spectacles

Figure 1

The mean feather condition score of hen pheasants in 12 spectacled and non-spectacled laying flocks on game farms across England, 2006 and 2007

Spectacled

Non-spectacled

*ns = not significant; *** = P <0.001*

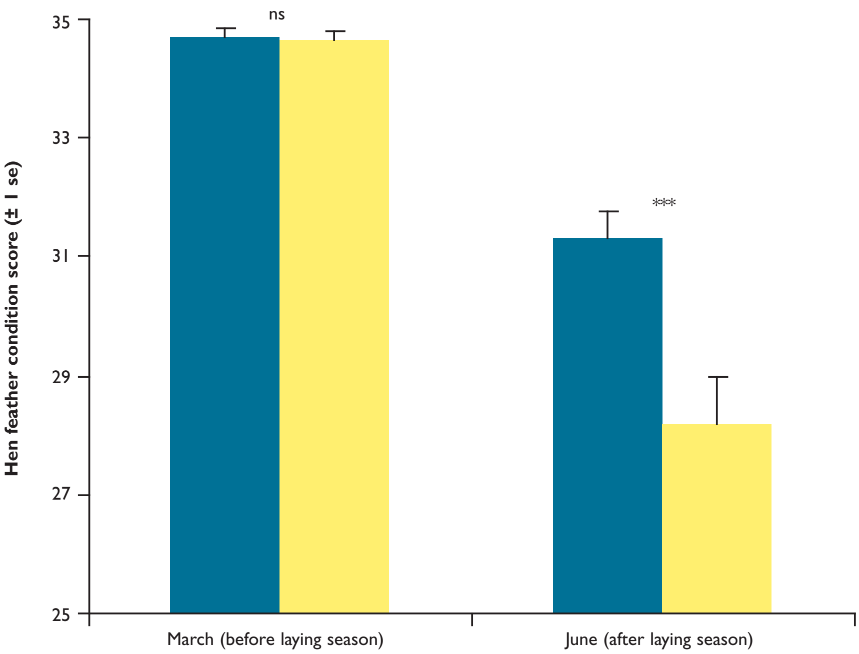


TABLE 1

The mean percentage of spectacled and non-spectacled pheasants with bill or nostril abnormalities in paired pens before (March) and after (June) the laying season on game farms across England, 2006 and 2007

	Cocks						Hens					
Treatment	**March**			**June**			**March**			**June**		
	Number	*Mean*	*se*	*Number*	*Mean*	*se*	*Number*	*Mean*	*se*	*Number*	*Mean*	*se*
Spectacled	10	2.5	2.0	10	9.9	4.8	12	2.4	0.9	12	12.9	4.2
Non-spectacled	10	1.8	1.2	10	4.3	2.4	12	2.3	0.7	12	3.1	1.1
Significance		ns			ns			ns			***	

*ns = not statistically significant, *** = P <0.001*

also reduced feather damage in hens (see Figure 1), but not significantly in cocks (see Figure 2). However, we found that incidences of bill and nostril damage in spectacled hens were over four times higher than whose without spectacles (see Table 1). Incidences of bill damage did not differ between spectacled and non-spectacled cocks. There was little difference in mortality rates between spectacled and non-spectacled pens; this was the case for both cocks and hens. Egg production, egg weights and feed intake were also similar between spectacled and non-spectacled pens.

Although spectacles had no effect on the behaviour of cocks, hens fitted with spectacles behaved differently compared with those without. In particular, spectacles reduced pecking of other birds, perching and foraging, and increased head shaking/ scratching and feeding.

Unlike bits, which prevent birds from grasping feathers, spectacles are designed to reduce feather pecking in pheasants by blocking their forward vision. This study suggests that although spectacles do help prevent birds pecking other birds, the reduction in the birds' field of vision also reduces the ability of hens to feed, and forage. Although spectacled hens foraged less than non-spectacled hens, they were observed feeding from hoppers more. By impairing the ability of hens to direct pecks at individual food items, spectacles may reduce the feeding efficiency of hens and therefore increase the time they must spend feeding to meet their dietary requirements. Despite this effect on feeding behaviour, overall food consumption and body mass index did not differ between spectacled and non-spectacled birds. The provision of perches that are easily accessible by being low to the ground and having a large surface area, such as straw bales, could increase perching by spectacled birds.

Although the results of this study show that spectacles can improve feather and skin condition in pheasants, these benefits may be undone by the damage they can cause to the bill and nostrils of hens. Therefore, consideration should be given to re-designing spectacles to prevent this problem occurring.

A pheasant fitted with spectacles.
© Dave Butler/GWCT

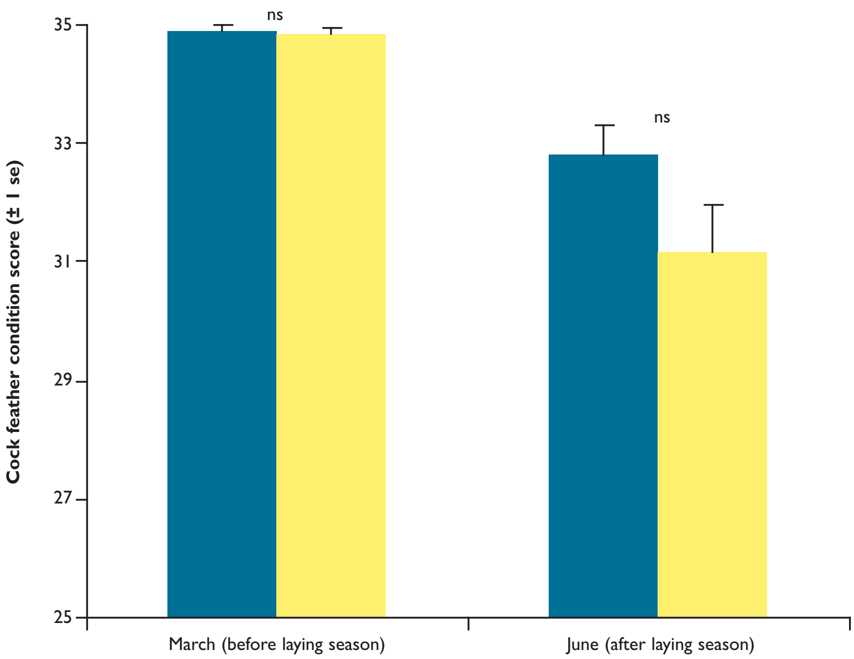


Figure 2

The mean feather condition score of cock pheasants in 12 spectacled and non-spectacled laying flocks on game farms across England, 2006 and 2007

Spectacled

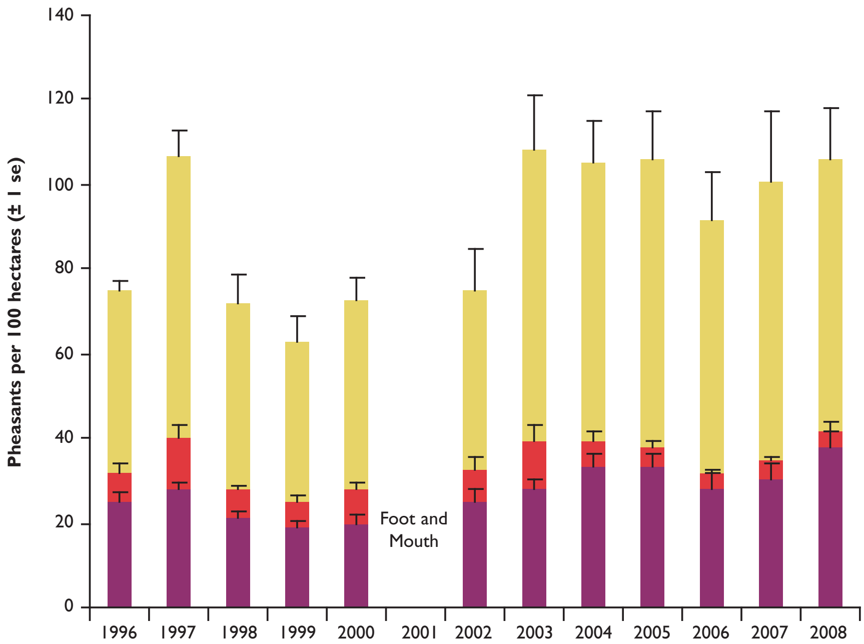
Non-spectacled

*ns = not significant; *** = P <0.001*

Summary of lowland game research

Figure 1

Breeding densities of wild pheasants in East Anglia from 1996 to 2008. Site number varies between years from six to 24



KEY ACHIEVEMENTS

- A new radio-tagging study aims to document fate and dispersal in released red-legged partridges.
- Monitoring in East Anglia shows the long-term trend in wild pheasant populations on wild shoots.
- A major new radio-tagging study of woodcock behaviour has begun.
- We can use imprinted pheasant chicks to study feeding behaviour and diet in other wild farmland birds.
- Studies of biomass crops shows variable use of miscanthus crops by birds compared with SRC.

Rufus Sage

Tracy Greenall's PhD project at Lees Court Estate finished in 2008. The study looked at biodiversity and wild bird productivity on a reared pheasant shoot (see *Review of 2006*) and at social attitudes to shooting among game managers, shoot owners and customers of commercial shoots. Tracy's PhD submission was examined during the year.

We began a new programme looking at the fate and dispersal of released red-legged partridges. We radio-tagged around 60 birds at each of two sites this year and plan to do two more in each of the next two years.

Spring counts of wild pheasants on our long-term monitoring sites in East Anglia in 2008 were very similar to 2007 (see Figure 1). This was encouraging as the summer of 2007 was poor for wild chick production (See *Review of 2007*, pages 12-13). Unfortunately, summer 2008 was also poor, with prolonged wet and cool conditions.

Our current work on the effect of releasing is nearing completion, but we are currently collecting data on plants and insects in and around disused pheasant release pen sites in woodlands. We are interested to know whether woodland soils and flora recover when a pen is removed. This is an important consideration when shoots are thinking about moving pens. We published a paper in the *Journal of Applied Ecology* on how game-managed woods are often better for some woodland birds than other similar non-game woods.

Our work on biomass crops and biodiversity on farmland continues. We collaborated on biodiversity studies in short-rotation coppice (SRC) and miscanthus with Rothamsted Research. An article on page 18 describes our work on birds in miscanthus.

We have been radio-tagging woodcock this winter to compare the behaviour and habitat use of resident and migrant birds. This work forms part of new study on woodcock migration funded by the Countryside Alliance Foundation.

Gwen Hitchcock completed the second year of her Imperial College PhD on human-imprinted gamebird chicks at the Seefeld Estate in Austria. Gwen has been imprinting newly-hatched pheasant chicks so that they regard her as their mother. We think imprinted chicks feed as wild ones do so we can use them to study chick behaviour in the wild, for example their feeding patterns and diet.

During the first year of her PhD, Josie Orledge (Exeter University) undertook a large experiment on the rearing field examining how dietary carotenoids and vitamin E in pheasant chick diets influence growth and subsequent fitness in adults.

LOWLAND GAME RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Pheasant population studies (see page 16)	*Long-term monitoring of breeding pheasant populations on releasing and wild bird estates*	*Rufus Sage, Maureen Woodburn, Roger Draycott*	*Core funds*	*1996- on-going*
Wildlife in energy crops	*Social, economic and environmental implications of increasing land-use under energy crops*	*Rufus Sage, Rothamsted Research, Mark Cunningham*	*RELU*	*2006-2009*
Birds in miscanthus (see page 18)	*Study of birds in winter and summer miscanthus plantations*	*Rufus Sage, Mark Cunningham*	*Defra*	*2006-2008*
Monitoring of East Lothian LBAP	*Monitoring the effects of LBAP measures on bird populations in East Lothian*	*Dave Parish, Hugo Straker*	*Core funds*	*2003- on-going*
Grey squirrels and woodland birds	*Does grey squirrel control increase productivity in woodland birds?*	*Rufus Sage, Andrew Hoodless*	*European Squirrel Initiative*	*2007-2010*
Woodcock monitoring	*Examination of annual variation in breeding woodcock abundance*	*Andrew Hoodless*	*Shooting Times Woodcock Club*	*2003- on-going*
Testing the effects of unharvested crops on song-bird populations	*Large-scale field experiment investigating the impact of winter feeding on songbird populations*	*Dave Parish, with RSPB Scotland*	*SGRPID*	*2004-2009*
Monitoring SGRPID's agri-environment schemes	*Comparing biodiversity on in- and out-scheme farms across Scotland*	*Dave Parish, various collaborators*	*SGRPID*	*2004-2009*
The management of grass-lands for wildlife and game	*Monitoring the impact of introduced game crops in grassland areas of south west Scotland*	*Dave Parish, collaboration with SAC*	*SAC, SGRPID*	*2008-2010*
Wild game cropping	*Productivity in wild game in East Anglia compared with cropping patterns*	*Roger Draycott, Matt Cooke*	*Cobbold Trust, Chadacre Trust*	*2008-2009*
Released red-legged partridges	*Fate and dispersal in released red-legged partridges*	*Rufus Sage, Andrew Hoodless,*	*Core funds*	*2008-2010*
Game marking scheme (see page 20)	*Study of factors affecting return rates of pheasant release pens*	*Rufus Sage, Maureen Woodburn, Andrew Hoodless, Roger Draycott*	*Core funds*	*2008- on-going*
Impacts of releasing	*Recovery of ground flora in pheasant release pens*	*Rufus Sage, Andrew Hoodless*	*Core funds*	*2007-2009*
Avon Valley waders	*Breeding waders in the Avon Valley*	*Andrew Hoodless*	*Core funds*	*2007-2010*
DPhil: Oxfordshire partridges	*To quantify the fate of released grey partridges in Oxfordshire*	*Elina Rantanen Supervisors: Francis Buner, Prof David McDonald & Dr Phil Riordan/ WildCru, Oxford University*	*Private individual donor, Core funds, Various charitable trusts*	*2006-2009*
PhD: Imprinting gamebird chicks	*Human imprinting gamebird chicks to release and recover as a tool for sampling chick-food invertebrates in crops*	*Gwendolen Hitchcock Supervisors: Rufus Sage, Dr Simon Leather/Imperial College, London*	*BBSRC/CASE studentship*	*2006-2009*
PhD: Trade-offs during pheasant growth and development	*Examination of the effects of carotenoid supplementation and parasite infection in early life on adult phenotype*	*Josephine Orledge Supervisors: Andrew Hoodless, Dr Nick Royle/University of Exeter*	*NERC/CASE studentship*	*2007-2010*
PhD: The management of grasslands for wildlife and game	*Autecological studies of granivorous birds in intensive agricultural grasslands of south west Scotland*	*Graeme Cook Supervisors: Dave Parish, Dr Davy McCracken/SAC, Prof Neil Metcalfe/ University of Glasgow, Dr Jane MacKintosh/SNH*	*Core funds, SNH, SAC*	*2006-2009*
PhD: Lees Court Estate Project	*Quantifying the biodiversity and the economics of a quality, released bird shoot following management for game with other comparison sites*	*Tracy Greenall Supervisors: Rufus Sage, Prof Nigel Leader-Williams/University of Kent*	*John Swire Charitable Trust, Lees Court Estate, Holland & Holland*	*2000-2007*
DPhil: Origins of over-winter woodcock	*The use of stable isotopes to study woodcock migration and winter movements*	*Adele Powell Supervisors: Andrew Hoodless, Dr Andrew Gosler/Edward Grey Institute/University of Oxford*	*The Countryside Alliance Foundation*	*2008-2011*

Key to abbreviations: BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering; Defra = Department for the Environment, Food & Rural Affairs; NERC = Natural Environment Research Council; RELU = Rural Economy and Land Use; SAC = Scottish Agricultural Colleges; SGRPID = Scottish Government Rural Payments and Inspections Directorate; SNH = Scottish Natural Heritage.

Pheasant nest predation

A radio-tagged hen pheasant, recently predated.
© Roger Draycott/GWCT

KEY FINDINGS

- 43% of pheasant nests we studied were predated.
- Foxes and corvids accounted for the majority of nest predation.
- Intensive predation control can reduce by a third predation rates on pheasant nests.

Roger Draycott

Pheasants, like all gamebirds, are vulnerable to predation during nesting. Reducing levels of nest predation is fundamental to maintaining or increasing stocks of wild-bred pheasants. Predators and their impacts on birds have always been controversial subjects. Recently, some conservation organisations have begun to tackle the issue of high nest predation rates in ground-nesting birds; something that game managers have been doing for many years. However, nest predation rates, identifying predators and the factors that influence predation are difficult to study in the field as kills are rarely witnessed. We have often used radio-telemetry as a research tool in projects investigating particular aspects of the biology or ecology of pheasants and always record detailed data on nests of radio-tagged pheasants. To gain a better insight into the factors influencing nest predation in pheasants, we reviewed data from approximately 900 radio-tagged hens collected over a 15-year period on six different shooting estates in southern England, eastern England and Austria.

During our field studies, we checked nests three times a week to ensure that nest outcome data were as precise as possible and, when a nest was predated, the remains of birds and nests were examined carefully to identify the predator. Common predators including foxes, badgers and corvids could often be identified from characteristic field signs. For example foxes often chew transmitters and bury carcasses whereas badgers trample vegetation around nests, and corvids leave characteristic peck marks in eggs.

We were able to analyse in detail data from 450 nests. We found that 34% of pheasant clutches hatched successfully, 43% of nests were lost because of predators, a further 10% were abandoned completely and 5% were destroyed by farming operations. The remaining nests failed owing to other causes including flooding. 43% of nests were in woodland, 30% in arable fields, 13% in field margins, 7% in set-aside, 6% in grassland and 1% in other habitat types.

Figure 1

Causes of predation of nests of radio-tagged pheasants

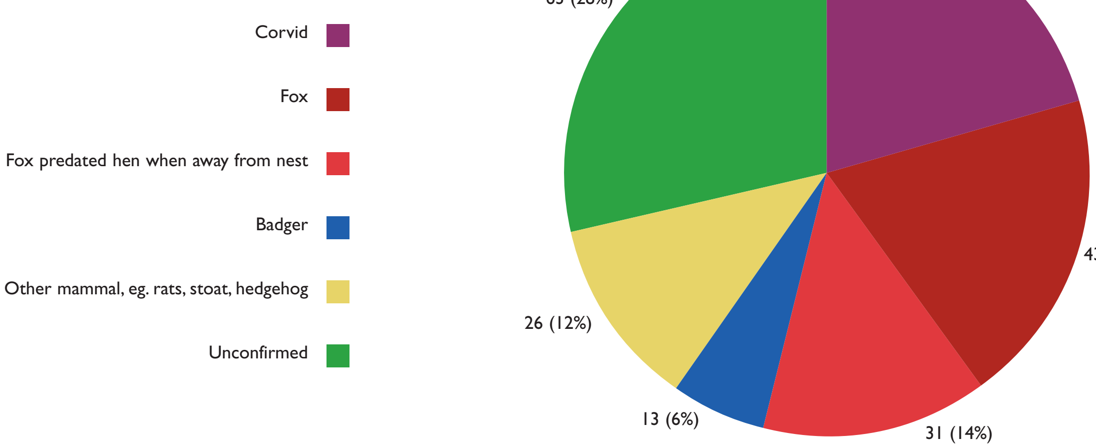


TABLE 1

Average nest predation rates of radio-tagged pheasants during incubation on six study sites in southern England, eastern England and Austria

Factor	Level	No of nests	Overall nest predation rate (%)
Habitat type	Woodland	159	51
	Arable crop	119	45
	Field margin	44	48
	Grassland	23	40
	Set-aside	22	52
Predation control	**High**	**122**	**37**
	Low	**255**	**58**
Age	First year	293	47
	Two+ years	51	47
Date	April	87	56
	May	167	43
	June	85	53
	July-August	38	38

Note: figures exclude nests which were predated in the laying stage. Significant factors in bold.

Of the nests that were predated, foxes and corvids (mainly carrion crows) were the most important nest predators. Foxes accounted for 33% and corvids 20% of predated nests (see Figure 1). The estimates of fox and corvid predation are conservative as the nest predator could not be confirmed in a third of cases where the entire nest contents had been removed; something that foxes and corvids are known to do.

We conducted an analysis to determine the influence of a range of factors on nest predation rates. These included habitat, the age of the hen, laying date, the level of predation control on the estate and the density of hen pheasants. Habitat type, laying date, hen age and hen density did not influence nest predation. However, nests on estates with intensive predation control in the nesting season were a third less likely to be predated than nests on sites with low-intensity predation control (see Table 1).

Many gamekeepers are busy on the rearing field in the spring and summer, so predation control at this time can be a secondary duty. This research shows that a targeted and efficient predation control programme can significantly improve the nesting success of wild pheasants. It is likely that other birds may benefit from this predation control too. Several recent studies of declining farmland birds, including lapwing, yellowhammer, skylark and corn bunting, found that predation was the most important cause of nest failure.

Checking a pheasant nest.
© Roger Draycott/GWCT

Birds in miscanthus grass grown for biomass

Cut miscanthus and new shoots in early spring.
© Rufus Sage/GWCT

We have shown that commercial willow short-rotation coppice (SRC) can be good for some birds. Certain species can be displaced, for example grey partridges and yellow wagtails, otherwise a variety of farmland, scrub and wood-edge birds can be found in the crop in spring, often at quite high densities – sometimes comparable with scrub or traditional coppice habitats. We think that the birds are attracted by the structure of the crop and may benefit from the high invertebrate abundance found in the willow coppice canopy when rearing broods.

Little work has been done on biodiversity in miscanthus grass (*Miscanthus x giganteus*), which has quickly become the most commonly-planted biomass crop in the UK. Recent estimates suggest that there may now be about 6,000 hectares in England (figures available from Defra's Energy Crop Scheme) and, although there are varying projections for future acreage, it could become a major crop.

In 2006, we were asked by Rothamsted Research to join a research programme (www.relu-biomass.org.uk) that aims to explore the social, economic and environmental effect of widespread biomass cropping in the UK, including biodiversity. The project overall will report during 2009; however, we did the bird surveys and our findings are described here.

We counted birds monthly at 15 recently-planted commercial miscanthus sites in winter and summer from 2006 to 2008. The sites were mostly in the south west, had been established well and were well managed. We compared these with adjacent fields of grass or cereals and, in summer only, with a group of SRC fields that had been

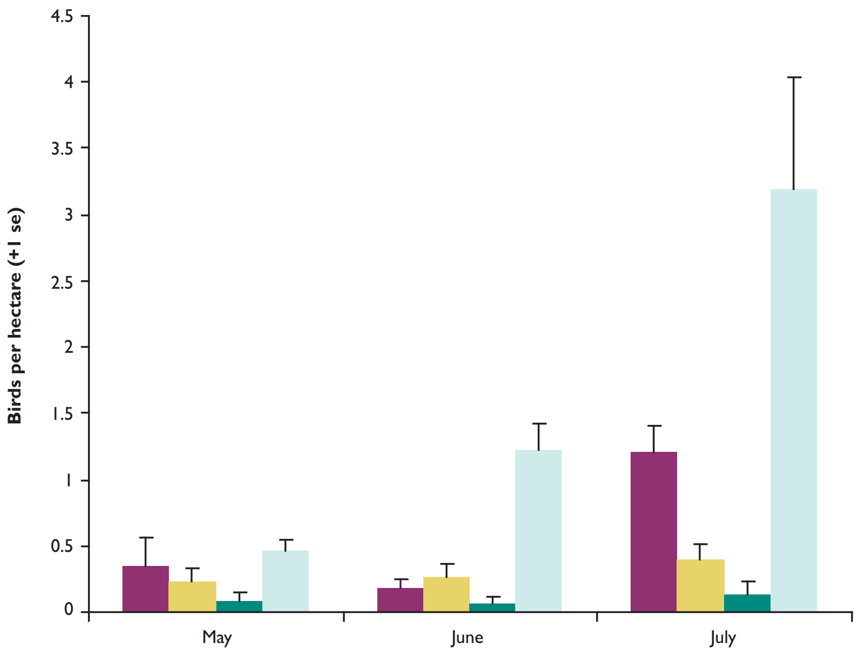
KEY FINDINGS

- We have developed a new survey method for birds in dense tall-growing miscanthus fields.
- Miscanthus does attract some birds but fewer than short-rotation coppice.

Rufus Sage
Mark Cunningham

Figure 1

Mean number of birds per hectare (excluding corvids) recorded during May, June and July in 16 miscanthus fields, compared with adjacent control plots



Although SRC is not harvested every year, data for SRC are from recently cut plots only.

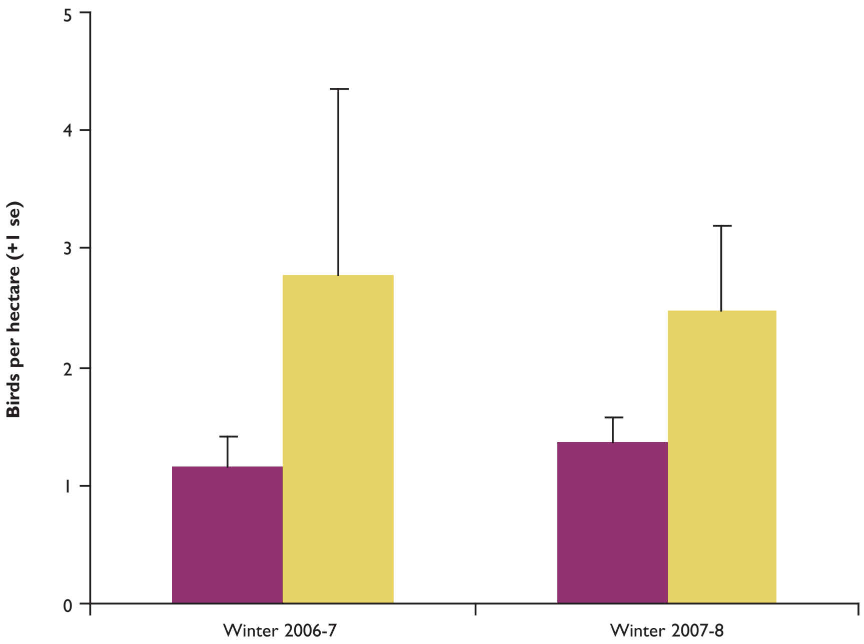


Figure 2

Mean number of birds in miscanthus plots compared with grassland and arable fields

Miscanthus

Grassland and arable fields

There tended to be fewer birds in the miscanthus plots compared with the primarily grassland fields that the miscanthus plots in the south west region had replaced. However, the difference was not significant because of high variance in control plots.

Above: Mark Cunningham (foreground) of the GWCT lets Guy Anderson of the RSPB try out our deer seat used for surveying birds in miscanthus crops from late May onwards. © Rufus Sage/GWCT

cut the previous winter. In May and June following harvest, the height of the miscanthus was low enough to allow birds to be surveyed by systematically walking along transects through the crop (as in the control plots). However, in the winter and in late summer, its height and density (more than two metres) demanded a novel technique involving two surveyors, one watching from a high vantage point (usually a deer seat) while the other walked through the crop flushing birds.

We found that encounters with territorial male birds in miscanthus in May and June were low compared with the cut SRC, but similar to the (much larger) cereal control fields (see Figure 1). In July, encounters with post-breeding individuals, primarily blackbirds and reed buntings, were greater in miscanthus compared with the controls, but still lower than in the recently cut SRC. In winter, we encountered birds in miscanthus plots at similar or slightly lower densities to those in the controls (see Figure 2). Thrushes (mainly blackbirds) were most common, whereas woodcock and snipe were attracted to open patches in this otherwise dense crop (see Figure 3). In both summer and winter there tended to be slightly more species in miscanthus fields compared with the controls.

This last finding suggests that bird numbers in miscanthus (and SRC) could be improved by changing plantation design (eg. including a ride) and managing it differently. However, when planted under Defra's energy crop grant scheme, these biomass crops are currently largely excluded from Environmental Stewardship (ES). We think there is scope for well-researched plantation design and management protocols to be included in ES that could improve the crop's value to wildlife.

ACKNOWLEDGEMENTS

This work was funded by the Research Councils via the Rural Economy and Land Use (RELU) programme and by Defra. The RELU-Biomass programme is led by Rothamsted Research. We are very grateful to the growers of miscanthus in the south west for allowing us to undertake this work on their land.

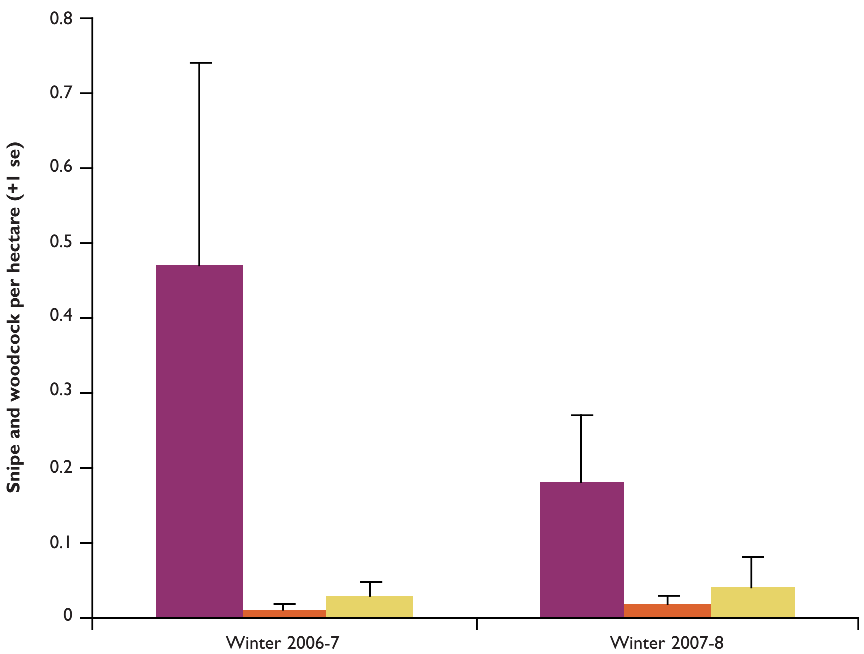


Figure 3

Mean number of snipe and woodcock using open and dense miscanthus and adjacent controls

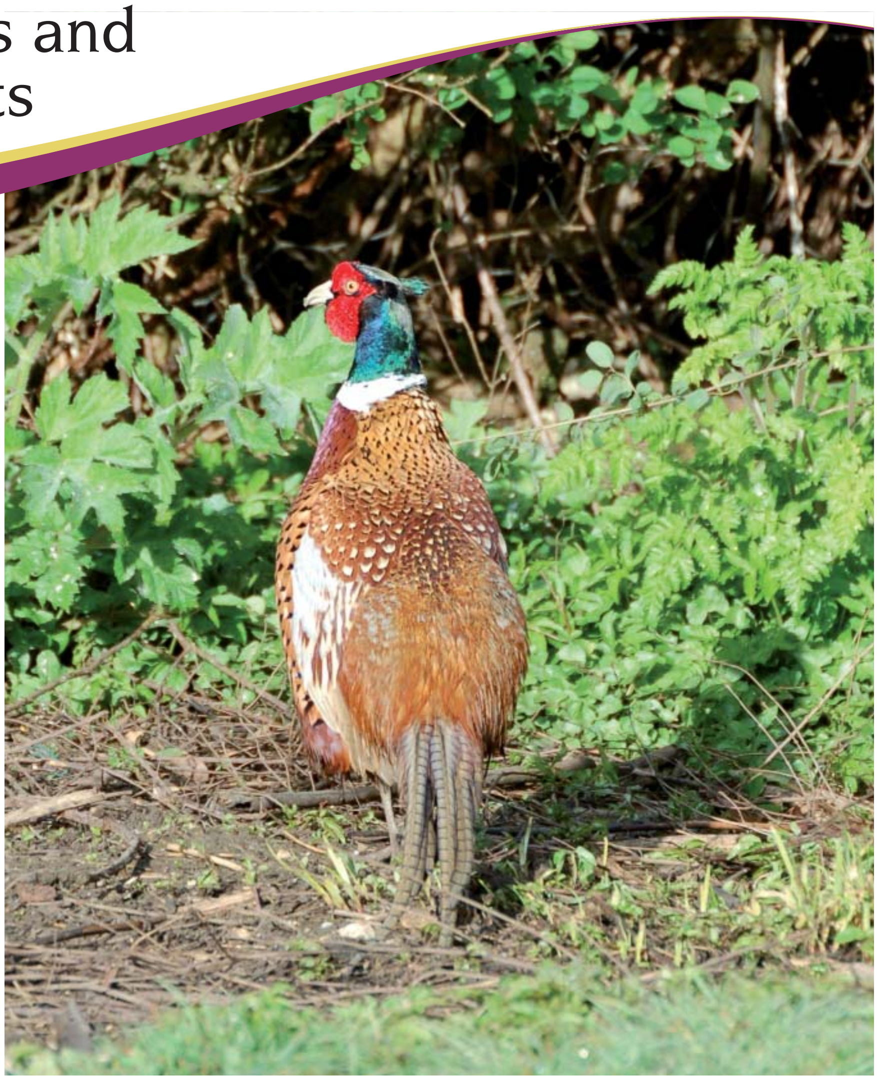
Miscanthus (open)

Miscanthus (dense)

Other crop

There were significantly more (P>0.05) snipe and woodcock using patchy miscanthus plots compared with closed dense miscanthus plots or the controls.

Shooting returns and reared pheasants



© Peter Thompson/GWCT

PLEASE GET INVOLVED

We anticipate that if we can involve initially around 100 and eventually perhaps several hundred estates in this study we would be able to investigate how some or all of the following specific factors tend to influence return rates of released pheasants across many sites:

- Source of birds and strain
- Rearing field practice
- Date of release
- Poult age at release
- Predator control
- Pen medication
- Pen size and stocking density
- Pen construction
- Habitat

To get an accurate estimate of a return rate for a pen, we think participating estates will need to tag all the birds for smaller releases, say between 100 and 200, and as pens get larger, a decreasing proportion. So, for pens with in excess of around 2,000 birds, 500 would be sufficient. Participating estates would be provided with a tagging pack including a tagging training guide.

There is time to get involved in this study this summer. Contact Maureen Woodburn mwoodburn@gct.org.uk if you would like to hear more and to receive a tagging pack.

In the late 1960s, we ran a national game marking scheme involving several hundred estates where pheasants were released. The scheme provided an insight into overall trends in return rates and how releasing factors such as the date and age of birds at release might affect these returns (see Table 1). This work contributed to the development of the current pheasant releasing system. Long-term members can refer to an article by Bray in the *Review of 1970*.

We would like to start a new game marking scheme, which we hope will enable us to look again at the current releasing system for pheasants and if necessary to refine it. We plan to collect some simple data from a large number of pheasant shoots. Firstly, we need an accurate return rate for one or more pens on each estate participating in this study and we would get this by wing-tagging a proportion of birds released into that pen.

To test whether different releasing strategies and management account for variation in return rates between sites, we would then need to collect information about the release specific to the individual pens from which we also measured the return rate. We can then pool data from our large sample of sites and look for relationships between return rates and whatever releasing factors we collect data for.

All estates would therefore be asked for information about their rearing-field methods, releasing strategy, and about management work/effort, for example disease management, feeding strategy and predator control in relation to the study pen(s). A project officer would visit each pen on each participating estate to make assessments that require a standardised approach, for example in relation to habitat. All information will be kept confidential in a secure database.

To get accurate shooting return rates, participating estates would also need to look systematically for tagged birds on shoot days to provide an accurate estimate of the return for the pen. We realise that to tag and then look for tags on shoot days is extra work but, in return, each estate will receive a report which provides a picture of the return from the participating pen in the context of the regional and national average. We will also provide participating estates with wings tags and a tagging gun if required.

TABLE 1
(EXTRACTED FROM THE REVIEW OF 1970)

National game marking survey data from 1969

Release period	Number of sites	Total birds released	Number shot	Return rate (%)
June 16-30	50	9,347	3,064	32.7
July 1-15	174	34,962	11,382	32.5
July 16-31	212	32,554	10,222	31.4
Aug 1-15	142	24,332	7,032	28.9
Aug 16-31	80	10,803	3,078	28.8
Sept 1-15	23	2,569	640	24.9
Total	**681**	**114,567**		

The apparent decline of the return rate with release date may be a consequence of releasing mostly older birds in August and September. Many sites did not use release pens at all in those days and the older birds were more inclined to disperse far from release sites. We might expect a very different relationship today. Preliminary data from Clare Turner's work on release pens (see Review of 2005*) suggested that return rates may increase with later released birds.*

In the past, the earlier pheasants were released the higher the return rate. © Peter Thompson/GWCT

Summary of partridge and biometrics research

KEY ACHIEVEMENTS

- The Sussex study area sees its highest chick survival rate since we started monitoring 41 years ago.
- Despite bad weather, our demonstration in Hertfordshire is proving its worth for grey partridge management.
- The National Gamebag Census continues to inform our knowledge of quarry species.

Nicholas Aebischer

Above: a grey partridge area in Sussex.
© Peter Thompson/GWCT

Unfortunately 2008 was not a good year for grey partridges. We still need people to join our Partridge Count Scheme, which has seen fewer participants send in returns this year. Having said that, those who are counting provide us with valuable data, and these are summarised in our article on the Partridge Count Scheme on page 24.

It is not all doom and gloom for grey partridges, however. On our long-term Sussex study area, where we have been monitoring grey partridges since 1968, management undertaken on the Duke of Norfolk's estate specifically for this species has resulted in the highest chick survival rate we have ever seen there and on this area autumn densities are nearly back to those at the start of the study. An article describing this major achievement starts on page 26.

Our demonstration project in Hertfordshire is also doing well. 2008 was the seventh year of the project. Despite testing weather during the breeding season, grey partridge pairs were five times as numerous in 2008 on the demonstration area as when the project began, and autumn numbers were nine times as high. Meanwhile on the reference area, numbers were less than a third of those on the demonstration area. As intended, this project is showing clearly what can be done to help grey partridges – all we need now is for our members to replicate the ideas wherever possible on their land and that way we have a real chance of achieving a comeback for this great British gamebird. More detail on the 2008 results appears in an article on page 28.

Within our biometrics research, Julie Ewald has been looking at management prescriptions on the North Wessex Downs Area of Outstanding Natural Beauty. Often funds for wildlife management on arable land are targeted at species of conservation concern, with declining farmland birds getting priority. But the conservation of other arable flora and fauna is also important. Julie has produced a map of the area highlighting where management priorities may conflict with promoting

PARTRIDGE AND BIOMETRICS RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Partridge count scheme (see page 24)	*Nationwide monitoring of grey and red-legged partridge abundance and breeding success*	*Neville Kingdon, Nicholas Aebischer, Julie Ewald, Dave Parish*	*Core funds*	*1933- on-going*
National Gamebag Census (see page 34)	*Monitoring game and predator numbers with annual bag records*	*Nicholas Aebischer, Gillian Gooderham, Peter Davey*	*Core funds*	*1961- on-going*
Sussex study (see page 26)	*Long-term monitoring of partridges, weeds, invertebrates, pesticides and land use on 62 square kilometres of the South Downs in Sussex*	*Julie Ewald, Nicholas Aebischer, Steve Moreby, 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*	*Core funds*	*2007-2009*
Mammal population trends	*Analysis of mammalian cull data from the National Gamebag Census under the Tracking Mammals Partnership*	*Nicholas Aebischer, Jonathan Reynolds Gillian Gooderham, Peter Davey*	*JNCC*	*2003-2009*
Scottish mountain hare survey	*Postal survey of distribution and culling of mountain hares in Scotland*	*Julie Ewald, Vikki Kinrade, Adam Smith*	*SNH*	*2007-2008*
Arable strategy (see page 31)	*Mapping and arable strategy for the North Wessex Downs AONB*	*Julie Ewald*	*NWD AONB*	*2007-2008*

Key to abbreviations:
JNCC = Joint Nature Conservation Committee; NWD AONB = North Wessex Downs Area of Outstanding Natural Beauty; SNH = Scottish Natural Heritage.

a diverse arable environment. Her article explaining how this has been done begins on page 31.

Our National Gamebag Census, which began in 1961, continues to contribute to our understanding of quarry species, both game and predators. Over 150 new participants joined in 2008, and many have kindly provided large quantities of fascinating historical records. In this review, Peter Davey reports on what the Census tells us about changes in numbers of mink, foxes, stoats and weasels (see page 34).

Below: much of our biometrics research involves grey partridges. © Peter Thompson/GWCT

Partridge Count Scheme

Counting grey partridges is most successfully done using binoculars and a vehicle, which acts as a hide. *© Peter Thompson/GWCT*

KEY FINDINGS

- Bad weather meant that breeding success in 2008 was as poor as in 2007.
- On average, spring densities fell by 14% between 2007 and 2008.
- Autumn densities dropped overall by only 8% between years, better than expected thanks to a 22% increase in Northern England.

Neville Kingdon
Julie Ewald

Our Partridge Count Scheme (PCS) collates information on the annual abundance and breeding success of grey partridges provided by volunteer contributors to the scheme, and has held data since the 1930s. The scheme is one of the cornerstones of our research. The PCS also serves as a means of supplying practical support and advice to farmers and landowners, both through information given directly to its contributors and through talks and demonstrations provided by our advisory and research staff at meetings of the Regional Grey Partridge Groups, all of which help to fulfil our role as lead partner for the UK grey partridge Biodiversity Action Plan.

Expectations were not high for the 2008 spring grey partridge counts after poor chick survival in the summer of 2007 throughout the country. It did not help that counts were delayed owing to a cold start in many places – keeping birds within cover and delaying pairing. As a result, the number of estates that returned counts declined from 978 to 877, a drop of 10% (see Table 1a), as did the number of grey partridges counted. Compared with the 2007 figures, when Northern England and Scotland increased their grey partridge stocks, in 2008 declines in spring pair density occurred throughout England, Scotland and Wales. Excluding Wales, Northern and Eastern England were the regions with the biggest falls (of approximately 16% on last year's figures). Both the Southern and Midland regions showed the smallest decline – around 6% each. However, the Southern region remains the area of England with the lowest average grey partridge density among contributing sites.

Following a disappointing spring came another poor summer. Although summer temperatures were around the long-term average, higher than average summer rainfall (with the exception of north west Scotland and south east England), combined with lower than average hours of sunshine, produced poor conditions for grey partridge chick production. There were some remarkable exceptions, where good management resulted in high autumn densities of grey partridges (see Sussex article on page 26).

August 2008 was wet, delaying harvest and making autumn counts difficult. Harvesting and planting took place within a very short weather window and many participants could count only small areas of ground compared with normal. They often counted much later than usual, making the separation of old and young in many coveys difficult. A measure of this delay was that it was only on 24 November that we had received a total of 500 counts, a month later than usual. The number of autumn counts returned was 10% lower than the number returned in 2007, reflecting the difficulties in counting (see Table 1b). The average young-to-old ratio overall was similar to last year, with Northern and Eastern England figures higher than in 2007. The higher young-to-old ratio in Northern England fed into higher autumn densities in 2008 compared with 2007 – one of the few positive signs from what was not a good year for partridges. Overall, the average grey partridge autumn density declined by 8%.

TABLE 1

Grey partridge counts

a. Densities of grey partridges pairs in spring 2007-2008, from contributors to our Partridge Count Scheme

	Number of sites		*Spring pair density (pairs per km² (100ha))*		
Region	*2007*	**2008**	*2007*	**2008**	**Comparison**
South	*165*	145	*1.7*	1.6	-5.9%
Eastern	*265*	225	*5.8*	4.9	-15.5%
Midlands	*170*	159	*3.4*	3.1	-8.8%
Wales	*3*	3	*1.3*	0.9	-30.8%
Northern	*210*	201	*5.5*	4.6	-16.4%
Scotland	*165*	144	*3.8*	3.5	-7.9%
Overall	*978*	**877**	*4.3*	**3.7**	**-14.0%**

b. Densities and young-to-old ratios for grey partridges in autumn 2007-2008, from contributors to our Partridge Count Scheme

	Number of sites		*Young-to-old ratio*		*Autumn density (birds per km² (100ha))*		
Region	*2007*	**2008**	*2007*	**2008**	*2007*	**2008**	**Comparison**
South	*114*	117	*1.8*	1.5	*6.2*	6.5	4.8%
Eastern	*194*	171	*1.7*	2.0	*27.4*	23.8	-13.1%
Midlands	*137*	115	*1.6*	1.4	*15.1*	9.3	-38.4%
Wales	*3*	1	*1.8*	-	*6.2*	0	-100.0%
Northern	*175*	156	*1.8*	2.0	*24.4*	29.7	+21.7%
Scotland	*136*	120	*1.9*	1.6	*14.0*	10.1	-27.9%
Overall	*759*	**680**	*1.8*	**1.8**	*18.7*	**17.2**	**-8.0%**

The number of sites includes all those who returned information, including zero counts. The young-to-old ratio is calculated from estates where at least one adult grey partridge was counted. The autumn density was calculated from estates that reported the area counted.

If you have grey partridges on your ground, regardless of where you are in the country or how many you have, we urge you to join our scheme and let us provide you with information that can benefit your birds.

Please join the scheme, by visiting our website (www.gct.org.uk/partridge) or contacting Neville Kingdon (nkingdon@gct.org.uk; 01425 651066).

A covey of grey partridges using a field margin.
© Peter Thompson/GWCT

Grey partridges on the Sussex Downs

The Sussex study area, where grey partridges are now making a recovery. © Dick Potts

KEY FINDINGS

- Management for grey partridges on part of the Sussex study area has resulted in the highest chick survival we have yet observed and autumn densities near those at the start of the study.
- The management prescription included in-field measures such as beetle banks and low-input conservation headlands; the least favourite ELS/HLS options.
- We urge land managers on farmland throughout the country to use those ELS/HLS options most suited to increasing grey partridge numbers.

Dick Potts
Julie Ewald
Nicholas Aebischer

Some farmers believe that the extinction of the grey partridge on the Sussex Downs is inevitable. However, successful breeding on the Duke of Norfolk's estate near Arundel suggests this need not be the case.

The basics of wild grey partridge management have been known for a generation. We have known the importance of controlling nest predators, providing nesting cover, having sufficient insect food for the chicks and appropriate rates of shooting. More recently, we have come to believe that we need to provide more food for adult birds and more protection from birds of prey. Following experiences in France, we advocated the use of grain hoppers for adults from autumn to summer and, from research in France, Sussex and Norfolk, including the work of Mark Watson (see *Review of 2003*, pages 64-67), we also think we need to create umbrella-like cover (eg. kale or thorns) as protection from harriers, buzzards and sparrowhawks, as well as bare areas for roosting (to avoid foxes).

Providing habitat such as beetle banks, hedges and conservation headlands is expensive, but fortunately costs can be recovered either through the Entry Level Stewardship or, preferably, Higher Level Stewardship operated by Natural England. However, the landowner still needs to pay for the essential gamekeeper.

This is a formidable list of recommendations but, since the 2003/04 cropping season, one part of the Sussex study area, Norfolk Estate, has taken up the challenge with spectacular results (see Figure 1). Autumn densities of grey partridges on the area with new management have gone from 1.2 birds per 100 hectares in 2003 to 64.0 in

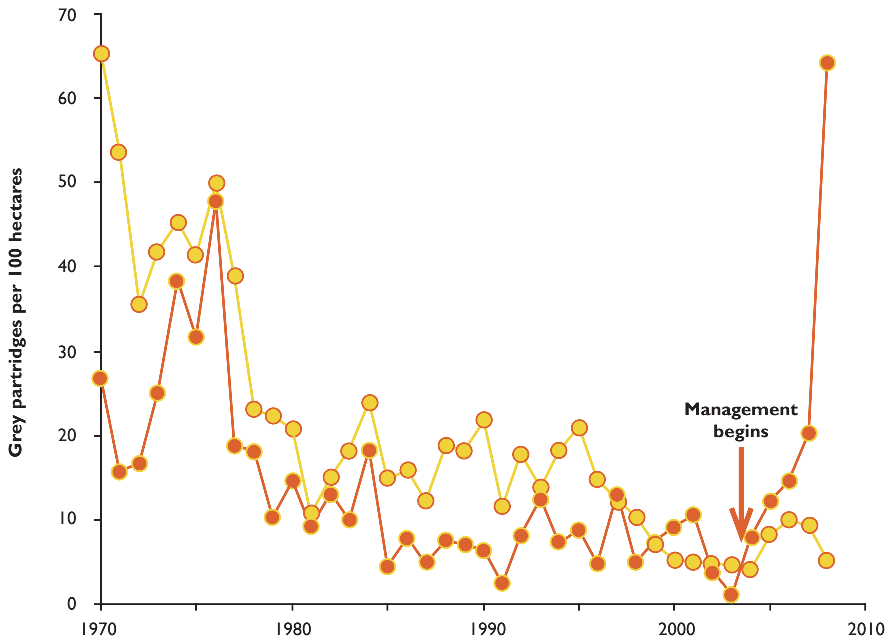
Figure 1

September densities of grey partridges on the Sussex Downs study area

Grey partridge management area

Rest of Sussex study area

The red line indicates the situation in the 1,000-hectare area that began to be managed in 2003/04, the yellow is the remaining 2,200 hectares.



Local farmer, Christopher Passmore, Steve Moreby (with D-vac) and Julie Ewald sampling for insects on the Sussex study area. © Dick Potts

2008, whereas on the remaining area the densities were 4.6 per 100 hectares in 2003 and 5.2 in 2008.

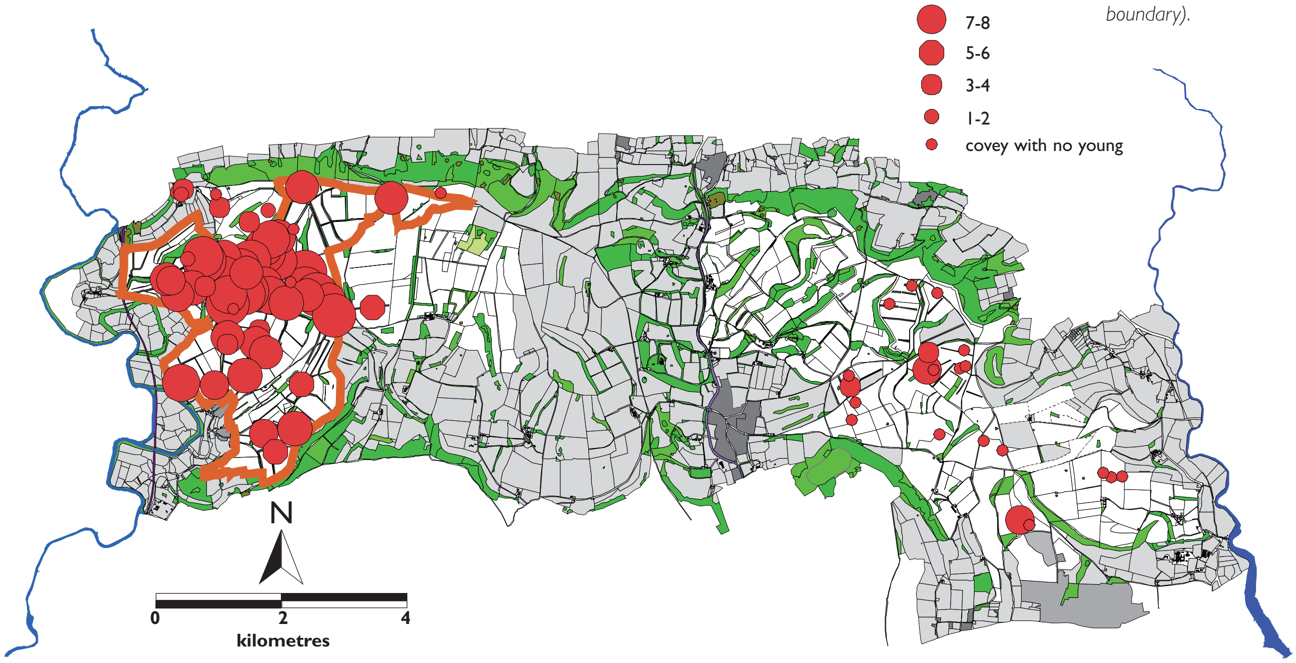
In 2008, partridge breeding success on the managed area was the highest we have known with a young-to-old ratio of 4.5. It was 0.4 on the rest of the Sussex study area. Large grey partridge broods were found on the managed area, but not elsewhere (see Figure 2).

Low-input conservation headlands are key ingredients to this new management as they provide the invertebrate food for chicks in the summer months.

It is a sad fact that the precursors of conservation headlands were in place 40 years ago on the study area, but conservation headlands remain one of the least popular management options available in stewardship; fewer than 5% of farmers or landowners in Entry Level Stewardship have put them in.

Figure 2

Grey partridge coveys counted on the Sussex study area in autumn 2008



Note the higher breeding success on the managed area (within the orange boundary).

Grey partridge recovery at Royston

© Peter Thompson/GWCT

KEY FINDINGS

- Despite a bad 2007 breeding season, in 2008 there were 15.8 grey partridge pairs per 100 hectares on the demonstration area, five times as many as when the project started.
- Summer 2008 was also poor, but autumn numbers were still nine times higher than at the start of the project.
- Grey partridge density on the reference area was less than a third of that on the demonstration area in spring, and less than a quarter of that in the autumn area in spring and autumn.

Nicholas Aebischer
Malcolm Brockless
Julie Ewald

The Grey Partridge Recovery Project at Royston began in 2002. As lead partner for the grey partridge under the UK government's Biodiversity Action Plan, we set up the project to demonstrate the feasibility of restoring numbers of wild grey partridges on farmland. It has shown convincingly that it is possible to restore numbers to over 15 pairs per 100 hectares (250 acres) within a modern farming environment.

The demonstration (keepered) area is in northern Hertfordshire, south-west of Royston, on 1,000 hectares (2,500 acres) of mainly arable land on chalk. It is surrounded by a reference area (not keepered) of similar size and topography. Based on the landscape, farming and management, we predicted in 2001 that we should be able to achieve a spring density of 18.6 grey partridge pairs per 100 hectares.

TABLE 1

Annual percentages of arable land as set-aside at Royston since the start of the project, and equivalent percentages for England from Defra statistics

Set-aside type							
Demonstration area	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rotational	6.2	**12.4**	**7.9**	**7.6**	**6.9**	**2.6**	**0.5**
Non-rotational	1.9	7.1	4.3	4.9	1.8	2.2	2.4
Total	8.1	19.5	12.2	12.5	8.7	4.8	2.9
Reference area	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rotational	1.3	**1.8**	**3.2**	**3.2**	**3.7**	**1.6**	**0**
Non-rotational	2.3	2.2	2.8	2.5	2.3	1.9	2.0
Total	3.6	4.0	6.0	5.7	6.0	3.5	2.0
England (Defra statistics)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rotational	- - - - - - not available - - - - - -				**4.0**	**3.5**	**0.5**
Non-rotational	- - - - - - not available - - - - - -				4.0	3.7	1.9
Total	11.3	13.2	10.3	9.2	8.0	7.2	2.4

Management includes habitat creation, year-round predation control targeted at foxes, stoats, rats, crows and magpies, and supplementary feeding of wheat in hoppers from autumn to spring (at least two hoppers per grey partridge pair). We count the partridges in March (spring pair counts) and just after harvest (autumn counts). The sex of all grey partridge adults is recorded, as is the number of young birds present in each covey in the autumn.

A big agricultural change that took place in the UK in 2007 was the reduction of the set-aside requirement to zero for 2007/08. Set-aside has been a valuable tool for habitat creation at Royston, so we measured the percentages of arable area at our study site that were in set-aside in June of each year, and compared this with equivalent values for England compiled from Defra statistics (see Table 1). Nationally, set-aside peaked in 2003 and declined thereafter. At Royston, the difference in percentage set-aside between demonstration and reference areas lay mainly with rotational set-aside, where levels were close to double or higher on the demonstration area than on the reference area throughout the study period. Whereas the amounts of both types of set-aside fell after the switch from set-aside payments to arable area payments, rotational set-aside bore the brunt of the zero quota in 2008, being reduced to only 0.5% on the demonstration area and disappearing completely on the reference area. The percentage of non-rotational set-aside, by contrast, remained relatively constant after 2006. In habitat terms, it is set-aside as winter cover that has suffered most, falling by 82% on the demonstration area and 93% on the reference area between 2007 and 2008.

The density of grey partridge pairs in spring 2008 was 15.8 per 100 hectares on the demonstration area, down 14% relative to the 18.4 of spring 2007 (see Table 2 overleaf). On the reference area, the 2008 spring count was 4.7 pairs per 100 hectares. The 2008 breeding season began with a cold dry April followed by a fine dry start to May. This was spoilt by a 10-day wet period from the end of May into the first week of June totalling 104 mm (four inches) of rain. Subsequently, July was the coldest it had been for eight years, with 11 days of rain (65 mm), and August was the wettest for 100 years (110 mm of rain). The main harvest was delayed by two weeks, and the

The grey partridge management at Royston includes habitat creation. © Peter Thompson/GWCT

TABLE 2

Grey partridge counts on the recovery project at Royston, 2001-2008

a. Spring pairs per 100 hectares

Area	2002	2003	2004	2005	2006	2007	2008	Predicted
Demonstration	2.9	**5.1**	**8.0**	**11.2**	**13.0**	**18.4**	**15.8**	**18.6**
Reference	1.3	2.1	1.4	2.1	2.8	4.2	4.7	3.7

b. Autumn birds per 100 hectares

Area	2001	2002	2003	2004	2005	2006	2007	2008
Demonstration	7.6	**28.8**	**39.2**	**53.4**	**60.8**	**87.8**	**83.8**	**70.0**
Reference	8.1	6.4	18.3	11.8	18.6	25.9	17.9	15.0

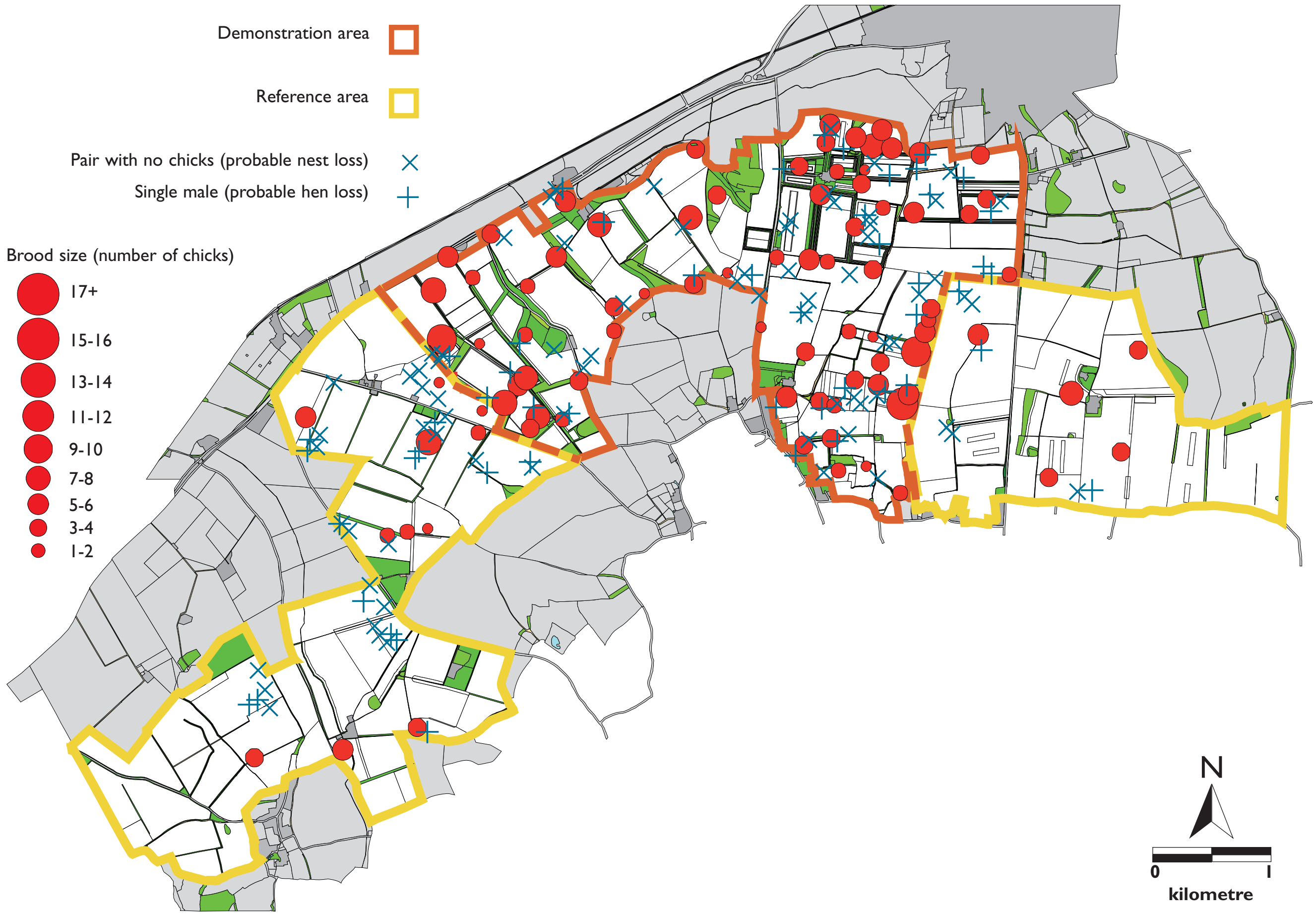
Bold *denotes years/area managed for grey partridges.*

partridge stubble counts were similarly late. Grey partridge productivity in 2008 was as poor as 2007, with an identical young-to-old ratio of 1.5 on the demonstration area, and a disastrous 0.8 on the reference area. The overall densities of grey partridges in the autumn were 70.0 birds per 100 hectares on the demonstration area and 15.0 on the reference area, a 16% drop from 2007 (see Table 2). It is not possible to separate out the effects of the weather from those of the loss of set-aside on either the drop in spring densities or the poor productivity, but it is likely that one exacerbated the other.

Alex Butler, one of our advisory team, organised visits to the demonstration area in 2008 for members of our county committees, the Country Land & Business Association and the Hertfordshire and Middlesex Wildlife Trust. More visits are planned for 2009 and Alex would be pleased to organise others on request. We are most grateful to all the farmers on the study area for their co-operation in the many aspects of this project.

Figure 1

Distribution of grey partridge coveys at Royston in autumn 2008, showing barren pairs, single males and brood sizes



Targeting arable flora and fauna

Corn cockle. © Peter Thompson/GWCT

In early 2008 we were commissioned, along with Black Sheep Countryside Management, by the North Wessex Downs Area of Outstanding Natural Beauty (AONB) to produce an Arable Strategy that included a target map to highlight areas of high potential for farmland birds, mammals and arable flora (see Table 1) within the AONB. This was to help AONB staff promote management practices that enhance and extend areas of high arable biodiversity and identify where other management priorities might be in conflict with promoting a diverse arable environment, for instance expanding chalk downland through arable reversion

Agri-environment funds are often prioritised and allocated using a targeted approach, usually based on recorded sightings of wildlife of conservation concern, with those of declining farmland bird species given particular importance. One drawback to this approach is that the distribution of other fauna and flora is not considered. Another is that using the known local distribution of flora and fauna to construct these target maps means that land where no surveys have been undertaken or where the required biodiversity information is not easily available may be excluded.

Our approach used information about the location of arable plants and mammals, in addition to farmland birds, to overcome these drawbacks and identify arable land with the highest density of arable plants, mammals and farmland birds in the AONB. We also identified areas with few records but with similar elevation, aspect and soil types and included these as places where the physical conditions made it likely that the arable plants, birds and mammals we were interested in could be found. Further refinement to the map included only selecting land that historically had been either arable or open land, using English Heritage's Historical Landscape Character (HLC) areas. The result was a target area that covered a third of the North Wessex Downs.

KEY FINDINGS

- We produced an Arable Strategy target map highlighting areas of high potential for farmland birds, mammals and arable flora in the North Wessex Downs AONB.
- The target map identified areas of the AONB where further survey work on arable flora and fauna is needed.
- We used the target map to show where there were conflicts with the AONB's Chalk Grassland Strategy map – these covered 40% of the area of the Chalk Grassland Strategy map.

Julie Ewald
Simon Smart

TABLE 1

Species used in the construction of this target

Arable plants

Broad-leaved spurge, corn buttercup, corn chamomile, corn cleavers, corn marigold, corn parsley, corn spurrey, corncockle, cornfield knotgrass, cornflower, cut-leaved dead-nettle, dense-flowered fumitory, dwarf spurge, few-flowered fumitory, field gromwell, field madder, field woundwort, grey field-speedwell, henbit dead-nettle, knotted hedge-parsley, mousetail, narrow-fruited cornsalad, prickly poppy, red hemp-nettle, rough poppy, round-leaved fluellen, sharp-leaved fluellen, shepherd's needle, slender tare, small toadflax, spreading hedge-parsley, Venus' looking-glass, wild candytuft and yellow vetchling.

Records were provided by the Thames Valley Environmental Record Centre, Wiltshire and Swindon Biological Records Centre, Hampshire Biodiversity Information Centre, Northmoor Trust, Plantlife and Simon Smart. The dates of recording were from 1954 to 2006, with the majority (70%+) collected since 1995; we only used records whose location was plotted to the nearest 100 metres.

Farmland birds

Corn bunting, grey partridge, lapwing, stone-curlew, tree sparrow, turtle dove and yellow wagtail.

Records were provided by through the Bird Conservation Targeting Project with the aid of Natural England and the Royal Society for the Protection of Birds. The dates of recording were from 2000 to 2006, with data on individual species location supplied to the nearest kilometre.

Farmland mammals

Brown hare and harvest mice.

Records were provided by the Thames Valley Environmental Record Centre, Wiltshire and Swindon Biological Records Centre and Hampshire Biodiversity Information Centre. The dates of recording were from 1968 to 2006, with the majority (50%+) collected since 1980; we only used records whose location was plotted to the nearest 100 metres

The corn cockle (previous page) and the tree sparrow (below) were two of many species used to construct our target. © Peter Thompson/GWCT

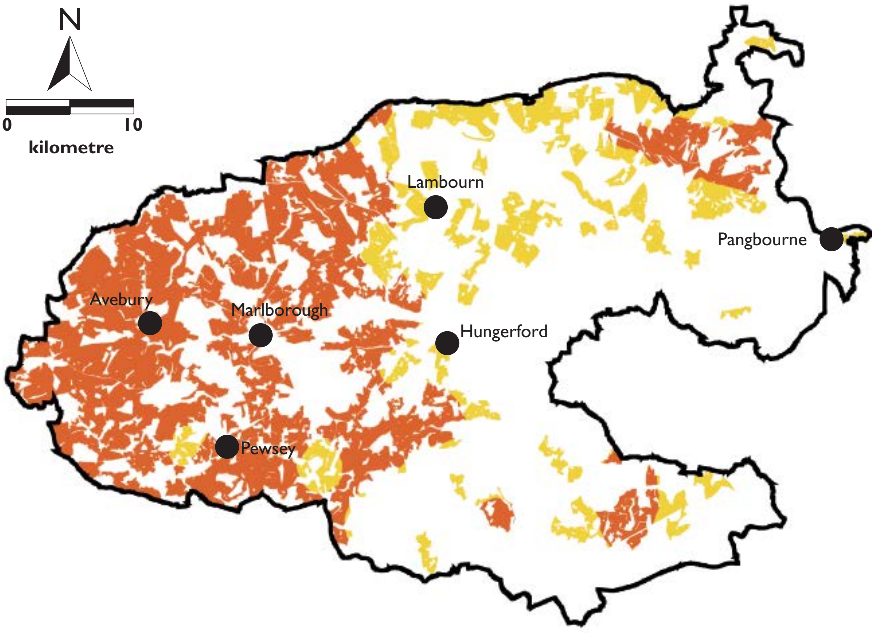


Figure 1

Using our Arable Strategy target map to identify areas where further survey work is needed

- Areas with known records of arable plants, farmland birds and farmland mammals
- Area likely to hold high numbers of arable flora and fauna based on habitat characteristics (further survey work required)

We examined two applications of our target map. The first was to identify areas where further survey work for arable flora and fauna is needed by selecting farmland where there were few records of the arable flora and fauna, but which had similar conditions to areas with high densities of these species (see Figure 1). The other application was to identify areas with conflicting management priorities, for example the promotion of chalk downland through reversion to grassland rather than the promotion of extensive arable farming. We compared our target area with the AONB's Chalk Grassland Strategy, compiled by the Wilts and Swindon Biological Records Centre, which identifies potential areas for targeted expansion of chalk grassland to link existing chalk grassland sites (see Figure 2). Just over 40% of the area selected by the Chalk Grassland Strategy was within our target area for arable biodiversity, identifying conflicts between the two strategies. We feel that where these two models overlap, the biodiverse arable area – particularly with regard to rare arable flora – should be maintained or enhanced, avoiding reversion to grass. If the priority is to revert to grassland, a thorough survey for arable biodiversity should be undertaken to ensure that arable species will not be lost. It should be possible to maintain a diversity of habitats that includes species-rich semi-natural grassland alongside extensively-managed arable farmland. The method we devised is applicable throughout the country, allowing for targeting that is more representative of arable flora and fauna in general than some of the current approaches.

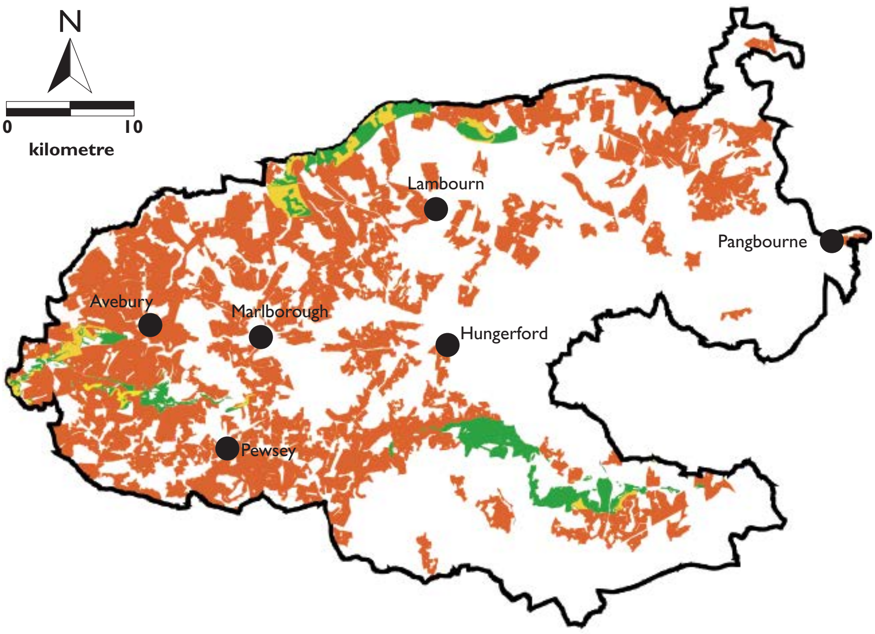


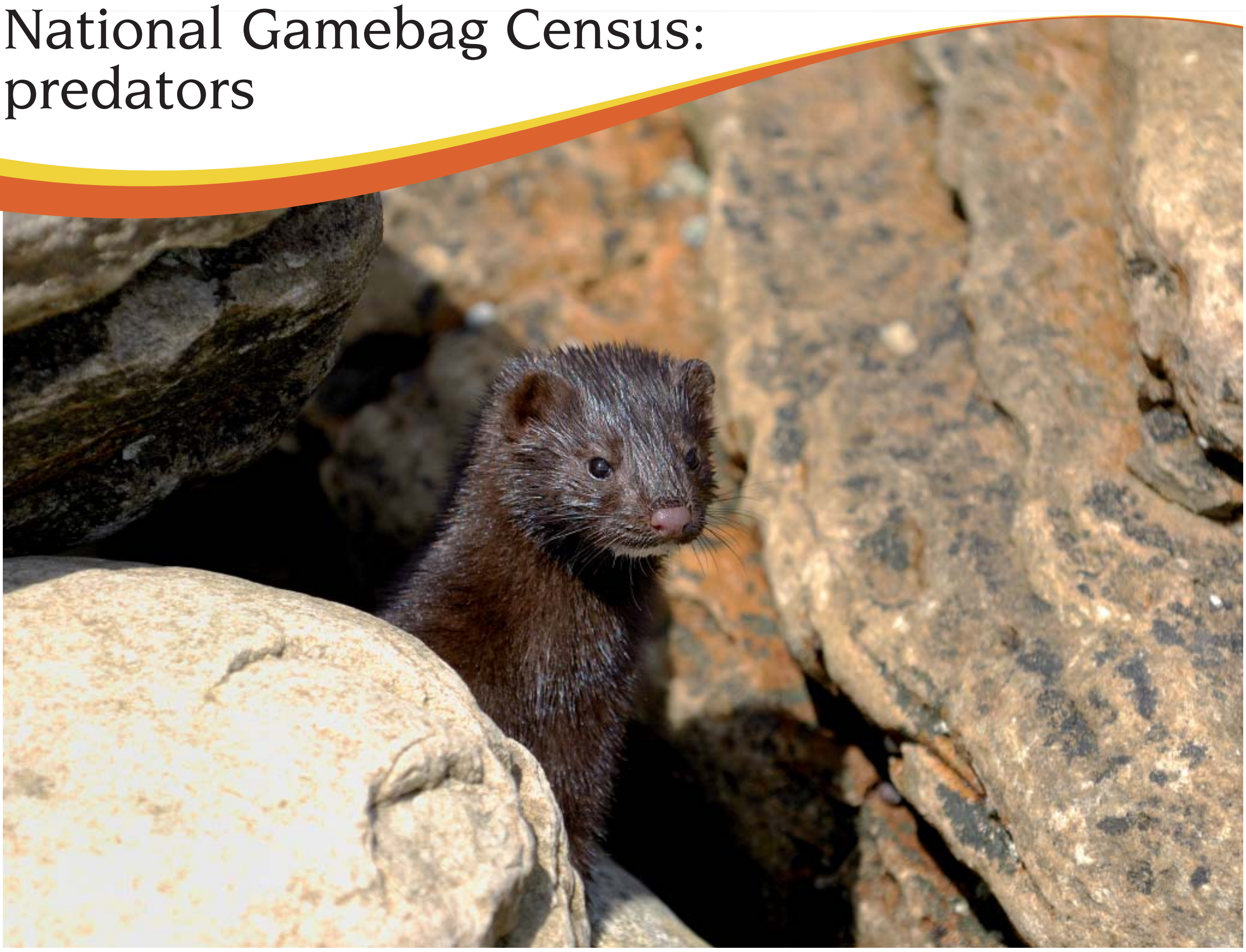
Figure 2

Our Arable Strategy target map overlaid onto Chalk Grassland Strategy map

- Arable Strategy map
- Overlap area
- Chalk Grassland Strategy target map

The yellow areas are those where the management priorities of extensive arable management are in conflict with the priority of arable reversion to grassland.

National Gamebag Census: predators



Although originally released in the south, mink are now found in Scotland. © Laurie Campbell

Through our National Gamebag Census (NGC), we monitor the bag sizes not only of game, but also of a wide range of pest and predator species. These data are of interest because the span of time they cover, extending back up to 200 years for some species, is considerably greater than that of any other UK bird or mammal monitoring scheme or national scheme. The NGC therefore provides a unique insight into historical trends of game and pest species, including species that are difficult to observe, such as American mink, stoat and weasel. We review here the UK trends for American mink, fox, stoat and weasel, all monitored since the NGC began in 1961, by selecting records from at least 75 sites on average each year for American mink, and at least 250 sites on average each year for fox, stoat and weasel.

We collect bag records by mailing questionnaires to some 650 NGC contributors at the end of each season. Participation in the NGC is voluntary, and we are most grateful to all the owners and keepers who send in their returns each year. For each species, data analysis is based on sites that have returned bag records for two or more years. The analysis summarises year-to-year changes within estates relative to the start year.

KEY FINDINGS

- Mink bags increased across the UK between 1962 and 2007.
- Fox bags increased steeply between 1961 and 1994, and have shown a gradual increase since.
- Stoat bags have fluctuated with rise and falls in rabbit populations.
- Weasel bags have fallen overall since 1961, although there has been a significant increase since 1986.

Peter Davey
Nicholas Aebischer

Mink (see Figure 1)

American mink have spread from animals escaping from fur farms since the late 1920s, and as mink farming increased in the post-war years, breeding in the wild began in England with the first instance of wild-bred young in Devon in 1956. By the early 1960s, wild breeding was discovered in Hampshire and south-west Wales, then spread further afield including to Scotland. At present, the animal is firmly established across much of Britain. There has been a significant 372% overall increase in bags across the UK between 1962 and 2007 (the increase was of 965% between 1962 and 1976), but a significant decrease of 56% has occurred in the phase 1976 to 2007 across the UK. It is possible, though not certain, that the recent decline could be associated with the recovery of otter numbers over the same period, with the net effect of decreasing mink territory.

Fox (see Figure 2)

Foxes are widespread and numerous across the UK, although they are largely absent

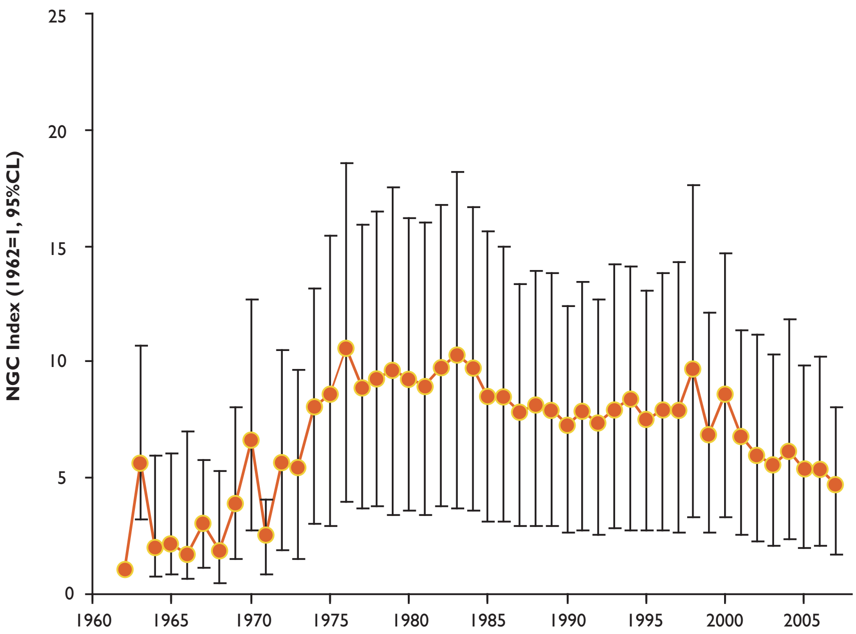


Figure 1

Changes in number of mink culled per square kilometre in the UK, 1962-2007

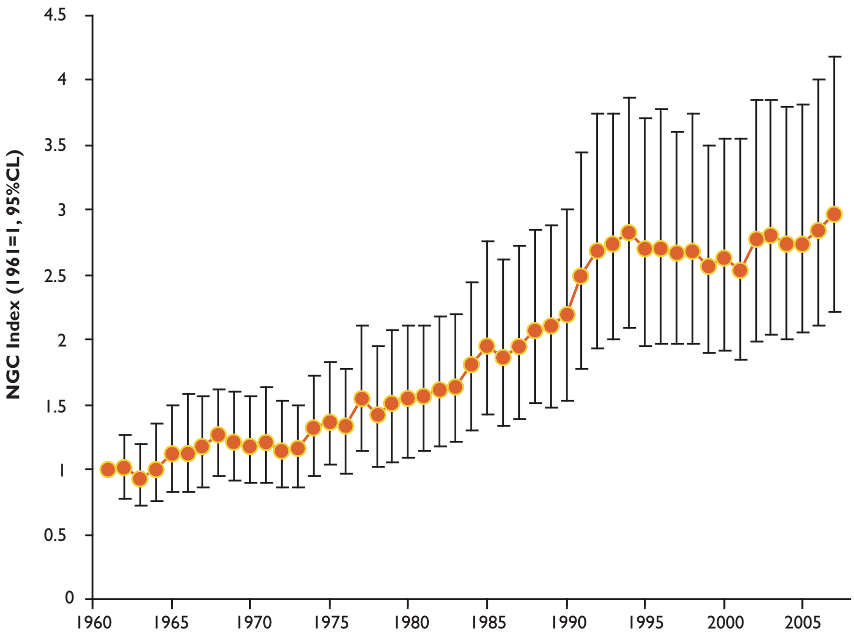


Figure 2

Changes in number of foxes culled per square kilometre in the UK, 1961-2007

Fox bags continue to increase.
© Peter Thompson/GWCT

The stoat is relatively plentiful across Britain.
© Laurie Campbell

from grouse moors. A significant 182% increase in bags across the UK is clear between 1961 and 1994, slowing down to one of only 8% from 1995 to 2007. The continued increase is possibly because of increasing fox numbers in suburban districts spreading into rural areas. There have, however, been changes in fox culling methods over this period, specifically the use of halogen lamp plus rifle from the early 1980s to supplement the existing practice of setting snares, and the banning of Cymag poison in the mid-1980s to kill foxes.

Stoat (see Figure 3)
The stoat is found across Britain and is relatively plentiful. Its primary food source especially in lowland Britain is rabbit. Populations crashed as myxomatosis wiped out rabbits in the late 1950s. Between 1961 and 2007 there has been an overall significant 118% increase in bags, but with a broad-based dip during the 1980s followed by recovery during the 1990s, reflecting the fortunes of its main prey, the rabbit.

Weasel (see Figure 4)
The weasel is also widespread. Its diet comprises field voles in the main, and weasel abundance rose in response to increased vole numbers within ungrazed grassland owing to the decline in rabbit numbers from myxomatosis. There has been a significant 43% overall decline in weasel bags across the UK between 1961 and 2007, but a significant 40% increase in the phase 1986 to 2007. The overall decline is probably due to the recovery in rabbit numbers.

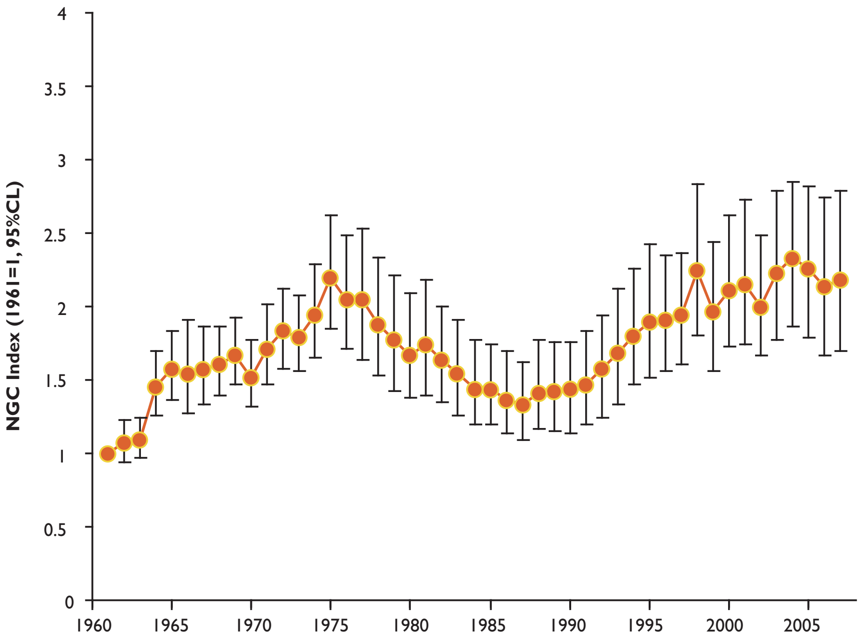


Figure 3

Changes in number of stoats culled per square kilometre in the UK, 1961-2007

NATIONAL GAMEBAG CENSUS PARTICIPANTS

We would like new participants to our National Gamebag Census. If you manage a shoot and do not already contribute records to our scheme, please contact the National Gamebag Census Co-ordinator, Gillian Gooderham, in Fordingbridge on 01425 651019.

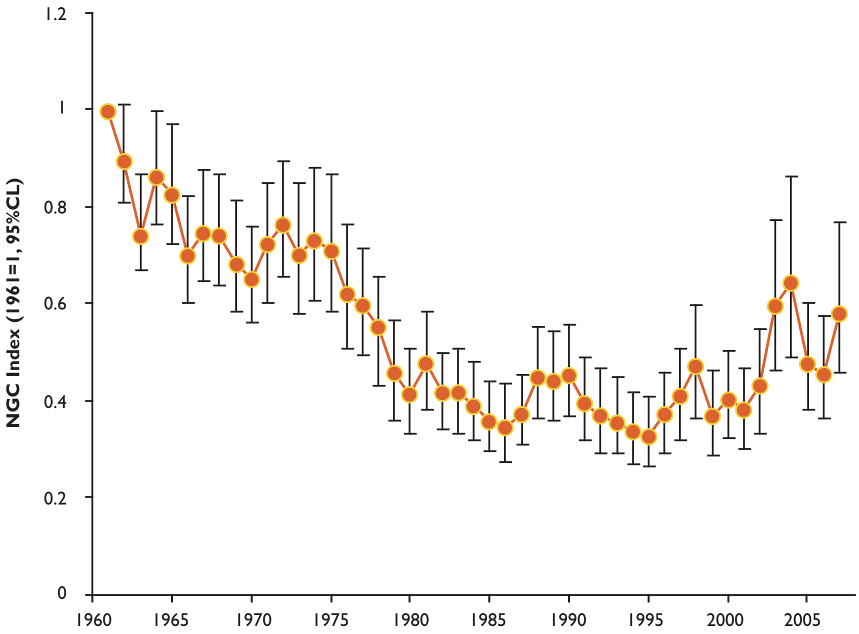


Figure 4

Changes in number of weasels culled per square kilometre in the UK, 1961-2007

The weasel population rises and falls with vole numbers. © Laurie Campbell

© Peter Thompson/GWCT

Summary of uplands research

KEY ACHIEVEMENTS

- We completed the upland predation experiment at Otterburn.
- The Langholm Moor Demonstration Project started this year.
- Research has led to new highly effective medicated grit.

David Baines

Our biggest achievement of the year was the completion the Upland Predation Experiment (see page 44). Kathy Fletcher, Craig Jones and their teams have clearly shown that predator control as part of grouse moor management can have measurable benefits to many other moorland birds, whose future may well depend on the continued success of grouse moors. One such bird is the black grouse and, led by Philip Warren, we continue to strive to meet BAP targets through research and conservation for this red-listed bird and the related capercaillie.

Raptors are key predators of grouse and our next big project, staffed by Damian Bubb, is to see whether grouse and raptors, particularly harriers, can live side by side at Langholm now that gamekeepers have been re-employed and diversionary feeding is being used to reduce harrier predation on grouse (see page 46). Parasites are also a factor that can limit the sustainability of grouse moors.

Our work on parasitic strongyle worms led by David Newborn and Mike Richardson has led to the development of a new medicated grit (see page 50), which appears to be highly effective in suppressing worm numbers, thus enabling many estates in northern England to shoot record bags this year. If we have at last cracked the worm problem, then we desperately need to do likewise with sheep ticks. Ticks, often carrying the virus louping ill, are increasing in numbers and range throughout much of the UK. Developing methods to reduce ticks, whether by treating sheep with acaricides to act as tick mops, reducing numbers of the tick's alternative mammal hosts, or by equipping grouse with acaricidal leg-bands (see page 48) are all being tested, either in the Angus Glens by Laura Taylor, or in Glentruim by David Howarth and Allan MacLeod.

Next in 2009, new experiments on heather burning will consider the effects of fires on moorland vegetation, carbon budgets, peat accumulation and erosion. Further, there will be new studies at Otterburn, with *Molinia* grass control trials, more wader counts and winter feeding of grey partridges. These are some new areas for us, with new skills to be learned. Many challenges lie ahead.

UPLANDS RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Strongylosis research (see page 50)	Development of strongylosis control techniques	David Newborn, David Baines, Mike Richardson	Core funds	2006-2011
Grouse monitoring (see page 40)	Annual long-term counts and parasite monitoring	David Newborn, David Baines, Mike Richardson, Adam Smith, David Howarth	Core funds, Gunnerside Estate	1980- on-going
Black grouse research	Ecology and management of black grouse	David Baines, Mike Richardson	Core funds	1989- on-going
North Pennines Black Grouse Recovery Project	Black grouse restoration	Philip Warren, Kim McEwen	MoD, NE, RSPB, Northumbrian Water, North Pennines AONB	1996-2011
Black grouse translocation	Translocating males to achieve range expansion	Philip Warren, Kim McEwen	SITA Trust	2007-2010
Upland Predation Experiment (see page 44)	Effects of grouse moor management on other bird species - linking productivity to subsequent density	Kathy Fletcher, David Baines, Craig Jones, Philip Chapman	Upland Appeal	1998-2009
Otterburn Demonstration Moor	Predator and habitat management for conservation benefits	David Baines, Craig Jones, Paul Bell, Philip Chapman	Landmarc/Defence Estates	2008-2011
Tick control	Tick control in a multi-host system	David Baines, David Howarth	Scottish Trustees, Various Trusts	2000-2009
Woodland grouse - Scotland	Ecology and management of woodland grouse	David Baines, Allan Macleod	SNH	1991-2011
Grouse ecology in the Angus Glens (see page 48)	Roles of parasites, predators and habitat in determining grouse abundance in the Angus Glens	David Baines, Laura Taylor	Various	2006-2009
Langholm Moor Demonstration Project (see page 46)	Moorland restoration to achieve economically-viable driven grouse shooting and sustainable numbers of hen harriers	David Baines, Damian Bubb	Core funds, Buccleuch Estates SNH, RSPB, NE	2008-2018
Mountain hares	Developing a reliable method for estimating mountain hare numbers	Scott Newey/MLURI Rob Raynor/SNH, David Baines	SNH, MLURI	2008-2009

Key to abbreviations:
AONB = Area of Outstanding Natural Beauty; MoD = Ministry of Defence; MLURI = Macaulay Land Use Research Institute; NE = Natural England; RSPB = Royal Society for the Protection of Birds; SNH = Scottish Natural Heritage.

© Peter Thompson/GWCT

Uplands monitoring in 2008

KEY FINDINGS

- There were record bags for red grouse in England.
- Spring and summer red grouse densities in England were even higher than in 2007.
- In Scotland breeding success was similar to 2007, but densities in the summer were higher.
- It was a poor breeding year for black grouse in northern England and capercaillie in Scotland both owing to cool wet weather in June.

David Baines

2008 was a record year for red grouse in parts of northern England. © Peter Thompson/GWCT

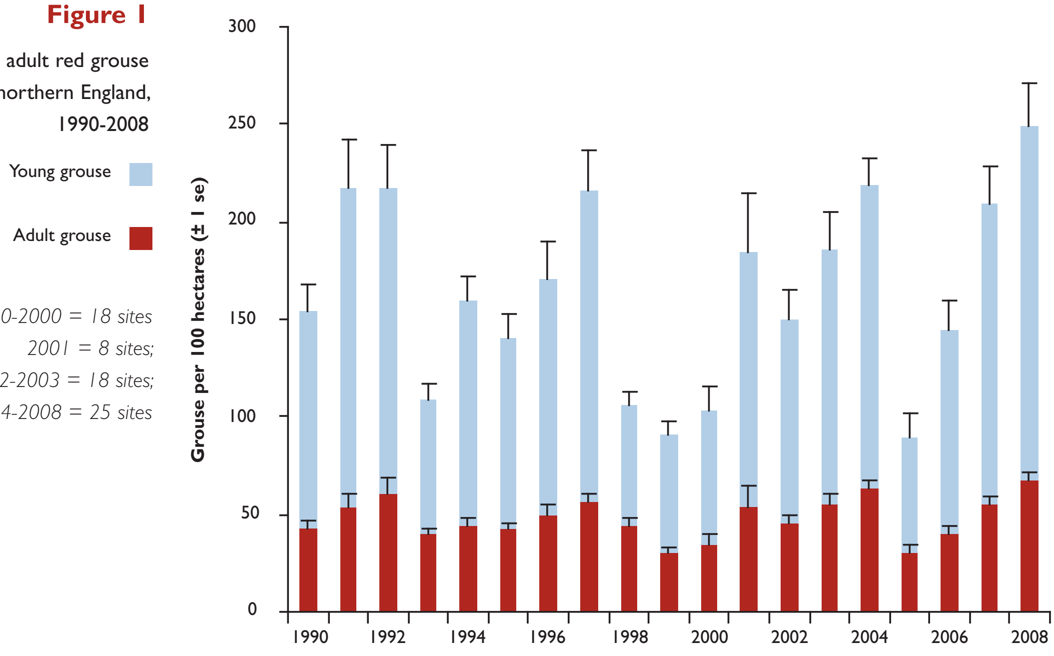
Red grouse in northern England

The year will be remembered as one of the greatest for red grouse in the Yorkshire Dales and North Pennines, with several estates shooting record bags.

We continued our long-term monitoring during the year by counting red grouse at 25 sites in northern England, spread across the Peak District, Bowland Fells, North York Moors, Yorkshire Dales and North Pennines. Spring densities averaged 87 birds per 100 hectares, a significant 21% increase on equivalent densities in 2007. The previous

Figure 1

Average density of young and adult red grouse in July from 25* sites across northern England, 1990-2008



** 1990-2000 = 18 sites*
2001 = 8 sites;
2002-2003 = 18 sites;
2004-2008 = 25 sites

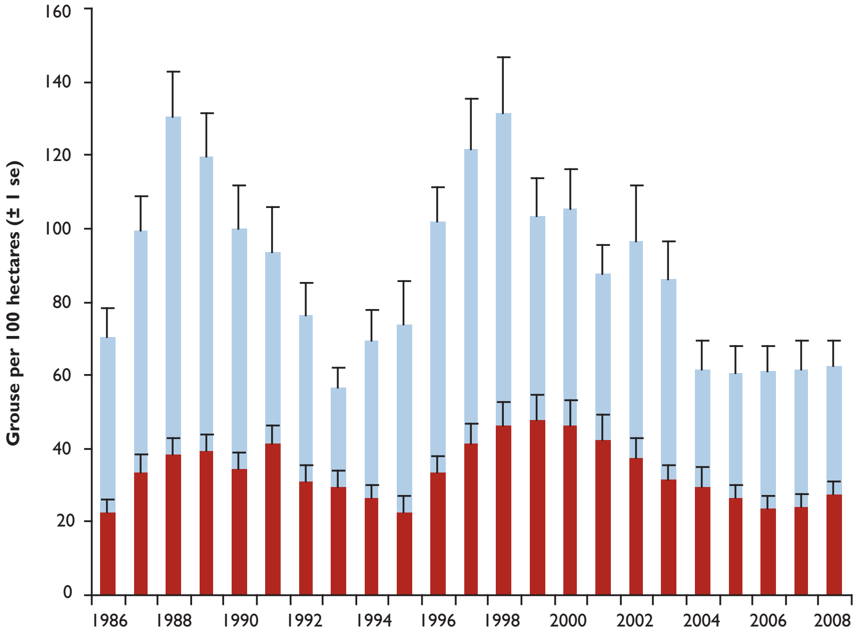


Figure 2

Average density of young and adult red grouse in July/August from 24 sites across Highland Scotland, 1986-2008

Young grouse

Adult grouse

good breeding season in 2007 (2.7 young per old) was repeated with an average of 2.5 young per old. Good breeding success combined with high spring densities resulted in average July densities of 250 grouse per 100 hectares (see Figure 1), up 15% on 2007, with densities in excess of 500 birds being found on several Pennine moors. This figure represents a three- to four-fold increase since the population crash in 2005 and the highest mean density recorded since our monitoring programme was expanded to 25 sites in 1992.

In spite of the record bags, high densities of grouse remained by the end of the shooting season. Where medicated grit was used and used well, worm burdens are still low (see article on page 50) and prospects for 2009 remain good. In contrast, on moors that have not used medicated grit, worm burdens are high and population crashes in spring 2009 are likely.

Red grouse in Scotland

We counted 24 long-term monitoring sites in 2008. In spring, densities averaged 33 grouse per square kilometre, compared with 35 in spring 2007. Overall, Scottish spring grouse densities were almost a third of those in northern England. Birds in Scotland bred less well than in northern England with less than half as many young per adult grouse, 1.2 young per adult compared with 2.5. Breeding success was similar to 2007 (1.4 young per adult). These rates of breeding success resulted in average densities of 66 grouse per 100 hectares (see Figure 2), 13% higher than equivalent values in 2007.

Scottish red grouse densities in July were only a quarter of those in northern England.
© Peter Thompson/GWCT

Poor breeding success in 2007 and 2008 has caused the black grouse population to drop.
© Laurie Campbell

Black grouse

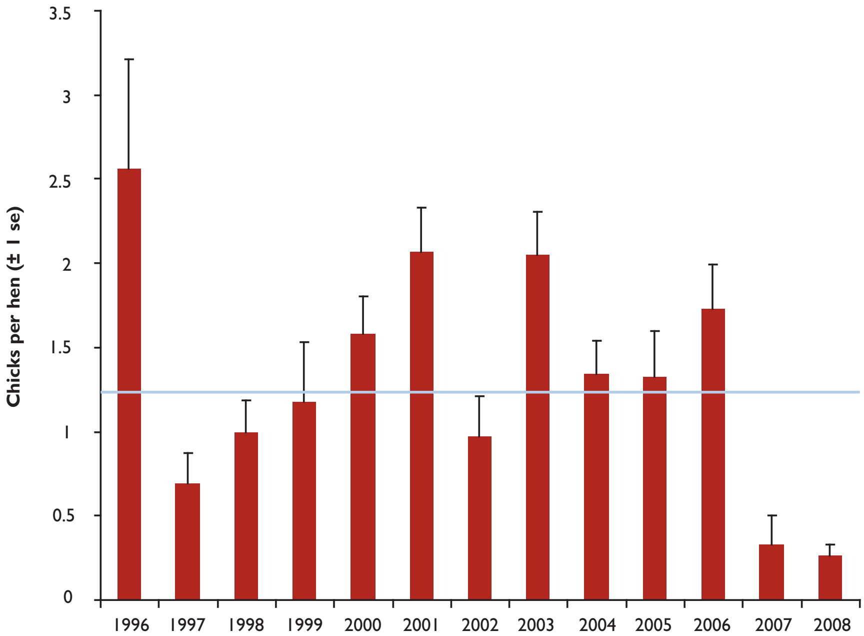
In the North Pennines we surveyed black grouse leks as part of our Black Grouse Recovery Project. We surveyed 54% of known leks in England, with the numbers of males attending these leks down 13% on 2007. We now estimate the English population to be around 1,070 males. This decline in numbers is linked with the poor breeding success in 2007, when there were only 0.3 chicks per hen owing to the cold and wet weather in June. This is well below the 1.2 chicks per hen required to sustain the population.

Sadly, 2008 was another poor breeding year in the North Pennines, owing to the cold, wet June. Summer brood surveys showed that only 10% of 69 greyhens raised broods, at an average of 0.3 chicks per hen (see Figure 3). This is again well below the 1.2 chicks needed to sustain the population. We expect male numbers at leks to be down again in 2009.

Figure 3

Black grouse breeding success in northern England between 1996 and 2008

The horizontal line at 1.2 indicates the estimated level of productivity required to maintain a stable population.



Capercaillie

Capercaillie have also had two consecutive bad breeding years. Both 2007 and 2008 were poor following wet weather in June just after the chicks hatch. Only 20% of the hens we found in 2008 had broods and breeding success averaged 0.4 chicks per hen (see Figure 4), compared with rates of 15% and 0.3 in 2007. Fortunately, capercaillie adult survival rates are high, especially now that recent efforts have been devoted to removing redundant fences and limiting the number of new ones. Fewer deaths from fence collisions means that capercaillie should be better able to tolerate several years of poor breeding. New studies in 2009, part-funded by Scottish Natural Heritage, will allow us to consider changes in annual breeding success in relation to forest habitats. Particular consideration will be given to how capercaillie breeding success is affected by changes in pine marten abundance over the last 14 years.

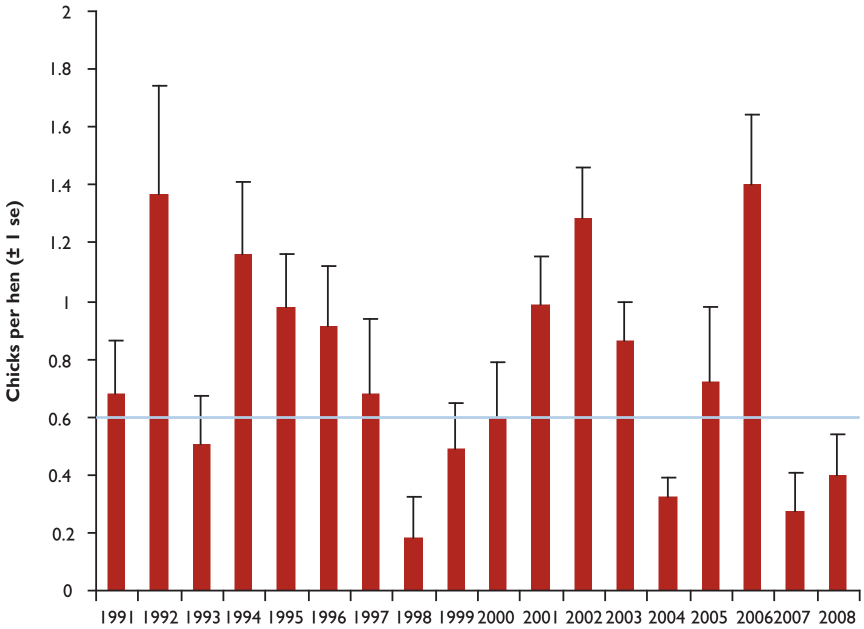


Figure 4

Capercaillie breeding success between 1991 and 2008* sampled from 14-20 forests per year in the Scottish Highlands

The horizontal line at 0.6 indicates the estimated level of productivity required to maintain a stable population.

** Apart from 2003 to 2008, capercaillie breeding success was derived from a different subset of forest areas each year.*

New research will look at how capercaillie abundance is related to that of pine martens, which are know predators of capercaillie nests.
© Laurie Campbell

Predator removal benefits moorland birds

Breeding abundance of curlews improved where predators were removed. © Peter Thompson/GWCT

KEY FINDINGS

- The Upland Predation Experiment (2000-2008) aimed to quantify the effect of predator removal on moorland ground-nesting birds.
- Gamekeeping significantly reduced the abundance of foxes and crows and maintained low levels of weasels in spring.
- Waders, gamebirds and meadow pipits showed a three-fold improvement in breeding success on sites with predator removal.
- In the presence of predator removal lapwing, curlew and red grouse showed increases in breeding abundance, which differed significantly from the declines in abundance recorded in the absence of predator removal.

Kathy Fletcher
Craig Jones
David Baines

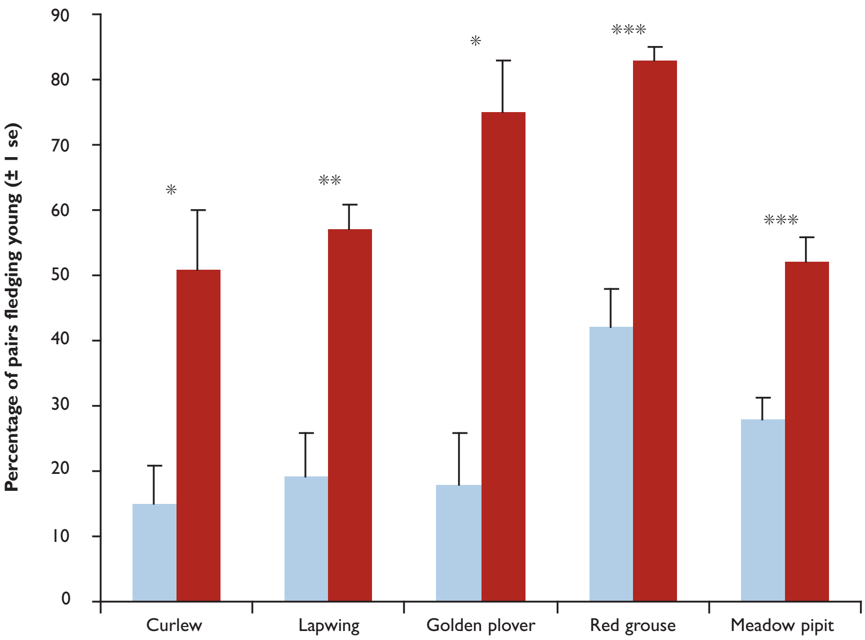
The Upland Predation Experiment based at Otterburn in Northumberland aimed to test whether predator removal by moorland gamekeepers (ie. killing foxes, crows, stoats and weasels) improved breeding success and abundance of moorland birds. Species of conservation concern in the UK, such as curlew, lapwing, red grouse and skylark, are of particular interest. The project area consisted of four plots, each about 1,200 hectares, on which bird numbers and their breeding success have been monitored since 2000. There are two long-term plots which remained under the same regime for the duration of the project. The other two plots were switched over, so that Otterburn had a full-time keeper from autumn 2000 to autumn 2004, and Bellshiel was the unkeepered comparison. In the autumn of 2004, predator control started on Bellshiel and stopped on Otterburn. The switch-over allows us to look at breeding success and abundance on the same plot with and without predator removal.

The predator abundance indices, collected separately from the keepering activities, show significant reductions in spring abundance for foxes (-43%) and carrion crows (-78%). For the small mustelids, spring weasel abundance was at a low level on plots with and without predator removal (7-8% of tracking tunnels found with footprints) and stoat abundance was too low to allow us to look at trends in abundance. Extensive collection of vegetation parameters allows us to be confident that plot-years with and without predator removal did not differ in habitat. So any differences found in the ground-nesting birds are because of the predator removal treatment alone.

The breeding success of some species was significantly improved with predator removal (see Figure 1). For lapwing, golden plover, curlew, red grouse and meadow pipit, on average a three-fold improvement was seen, from 23% of pairs fledging

Figure 1

Breeding success of ground-nesting birds monitored as part of the Upland Predation Experiment after controlling for site and year effects



, **, * = levels of significance.*

As of June 2009, the lapwing is red listed and the remaining species in this graph are amber listed in the UK's list of species of conservation concern.

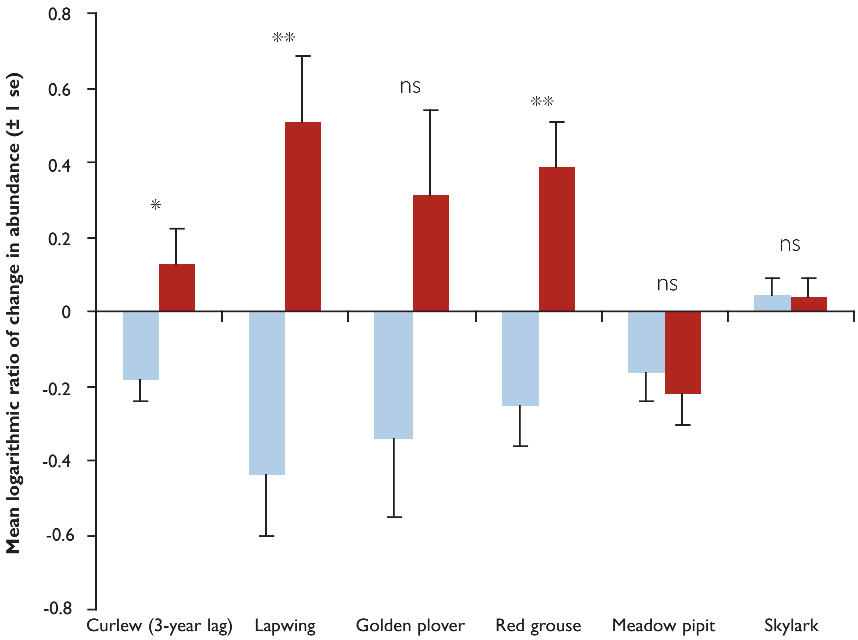


Figure 4

Changes in abundance of ground-nesting birds monitored as part of Upland Predation Experiment after controlling for site and year effects

No predator removal

Predators removed

The horizontal line is the line of no change in breeding abundance.

, **, * = levels of significance; ns = not significant.*

As of June 2009, the lapwing and skylark are red listed and the remaining species in this graph are amber listed in the UK's list of species of conservation concern.

young without predator removal to 64% of pairs fledging young with predator removal. Although similar trends showing improved breeding success were seen for black grouse and grey partridges, these species were only found on two plots and were not abundant enough to allow robust analysis.

An improvement in breeding success may lead to a subsequent improvement in the number of breeding birds, assuming that the young produced breed close to where their parents bred. Within the Upland Predation Experiment we analysed the trends in breeding abundance considering the annual change in abundance from one year (year 0) to the next (year 1) in relation to the predator removal treatment in year 0 for species that can breed when a year old. We considered a three-year lag for curlew as this species normally returns to breed when three years old. For all the wader species (curlew, golden plover, lapwing, we found increases in abundance with predator removal (mean annual change +37%) and decreases in abundance with no predator removal (mean annual change -28%), but the changes in abundance were statistically significantly different only for curlew (with a three-year lag) and lapwing (see Figure 2). Although red grouse also showed a significant difference (+47% annual change with predator removal, -22% annual change without predator removal), no such differences were detected in meadow pipit and skylark (see Figure 2).

This project highlights the benefits that predator removal can provide on moorland for bird species of conservation concern; providing clear evidence for us to show land managers and policy makers.

ACKNOWLEDGEMENTS

The Upland Predation Experiment would not have been possible without the generous contributions of the Upland Funding Appeal, support from the landowners (Ministry of Defence, Duke of Northumberland, Lord Devonport and Mr Edgar), advice from the Scientific Advisory Committee and the many seasonal staff who helped collect the data.

Lapwings bred more successfully where predator numbers were reduced. © Peter Thompson/GWCT

Langholm Moor Demonstration Project: the first year

Female hen harrier taking diversionary food from a feeding post. © A McCluskie

The Langholm Moor Demonstration Project was launched in September 2007 and work started in early 2008. The 10-year project aims to reconcile grouse moor and raptor interests with the core objective of re-establishing Langholm Moor as a driven grouse moor while maintaining a viable population of hen harriers.

The project is based on Langholm Moor partly because it was the principal site for the Joint Raptor Study between 1992 and 1997. During that project, hen harrier numbers increased, peaking at 20 breeding females in 1997. Because of predation by hen harriers, red grouse showed a corresponding decline in numbers and, as a result of the reduction in grouse numbers, the estate re-deployed or laid off the gamekeepers, and management of the moor largely stopped.

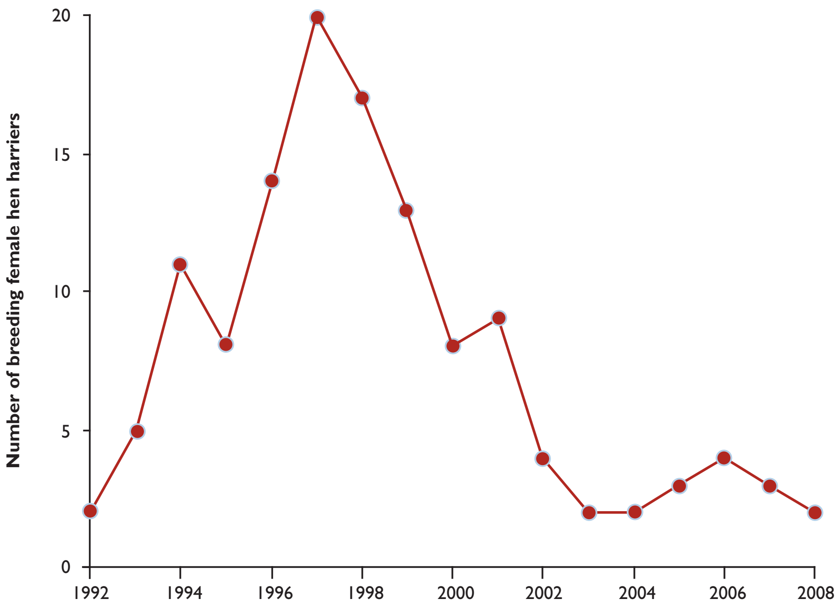


Figure 1

Number of breeding female hen harriers at Langholm from 1992 to 2008

KEY FINDINGS

- The Langholm Moor Demonstration Project began in spring 2008, employing five gamekeepers, a part-time project manager, an ecologist and two seasonal field assistants.
- Two pairs of harriers bred successfully with nine young fledged. Both nests were given diversionary food.
- Red grouse numbers are still low but spring counts showed a slight increase on recent years and breeding success was also better.

Damian Bubb

The new project has re-started intensive grouse moor management with a team of five keepers, under head keeper, Simon Lester. In addition to predator control, heather burning and use of medicated grit to control strongyle worms, diversionary food is being given to all breeding hen harriers to help reduce predation on red grouse. A team of ecologists counts the numbers of harriers, grouse, waders, other birds, small mammals and predators.

In 2008 four males, but only two female hen harriers appeared on the moor, similar numbers as observed in recent years (see Figure 1). Both females nested and fledged four and five young. This is the highest number of harriers that have fledged at Langholm since 2001. Both nests were given diversionary food (day-old cockerel chicks and white rats) and over 1,000 of these were taken from the feeding posts by the harriers. Nests were watched to identify prey delivered to the harrier chicks. Of 106 items observed, 103 were identified. Most were passerines (54%) or diversionary food (23%). No grouse, or grouse chicks were recorded being brought to the harrier nests, though grouse are still at low numbers on the moor.

Red grouse have been counted within the same 10 50-hectare areas in spring and July/early August since 1992 and this will continue throughout the project. In addition, we also survey grouse along 35 kilometres of transects running across the heather ground. From a low in 2003, the grouse at Langholm have shown several years of gradual increase, although they still remain at low numbers. This gradual increase continued in 2008 (see Figure 2). Breeding success in 2008 was reasonable with an average of 3.1 young per hen, compared with 1.9 in 2007. This is an improvement on recent years.

ACKNOWLEDGEMENTS

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

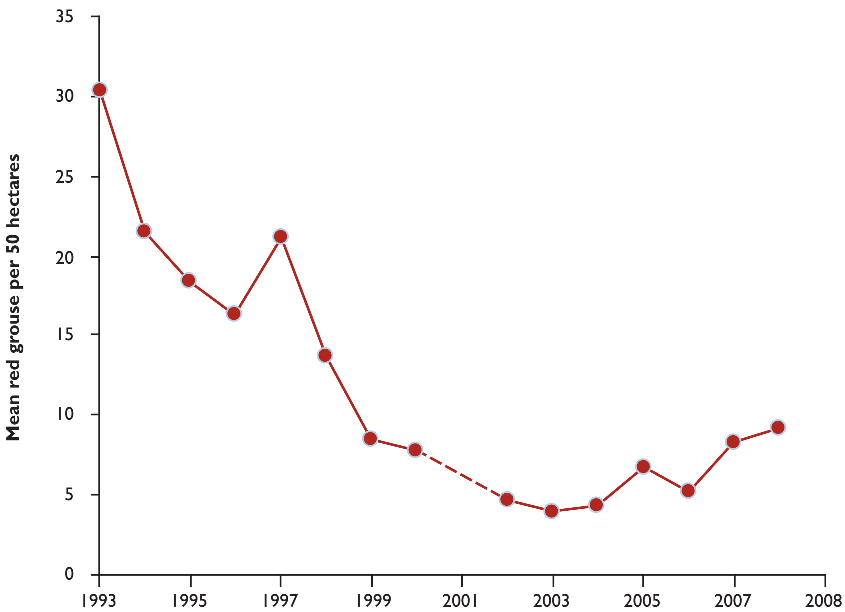


Figure 2

Mean number of grouse counted in 10 50-hectare blocks at Langholm during spring from 1993 to 2008 (average across 10 blocks)

There was no data collected in 2001 owing to Foot and Mouth Disease.

Using acaricidal leg bands to kill red grouse ticks

A leg band treated with acaricide and fitted to a red grouse. © Laura Taylor/GWCT

KEY FINDINGS

- Acaricidal leg bands attached to breeding hen red grouse appear to reduce tick burdens on their chicks.
- A further year of data collection is necessary to confirm our findings.

Laura Taylor
Dave Baines

In 2006 we conducted a trial on two moors in the Angus Glens to test the effectiveness of using acaricidal leg bands attached to hen red grouse in reducing the impact of sheep ticks on the survival of their chicks.

The leg bands, containing 8.5% alpha-cypermethrin, reduced tick burdens on chicks and increased their survival relative to broods from untreated hens. Treated hens were distinguished from untreated (control) hens by different coloured wing tags. However, low re-sighting rates of marked birds prevented us from detecting a significant difference between experimental groups. Consequently we conducted a second trial in the spring of 2008 on the same moors, but this time using radio-tagged hen grouse to ensure sufficient re-sightings.

We caught 40 red grouse hens at night in March and fitted them with radio collars. We tagged 10 hens at each of two sites on one moor and 20 hens on the other. At each site, we randomly selected half the hens and fitted them with acaricidal leg bands containing 8.5% cypermethrin, a synthetic pyrethroid, and fitted the remaining hens with placebo leg bands as controls.

We tracked the hens weekly until they laid clutches and began incubating. We disturbed the hens from their nests once, usually in mid-incubation, to count and measure the eggs. Neither clutch size, which averaged 9.0 eggs, nor hatch date, with a median date of 24 May, differed between experimental groups of hens. Before breeding, the transmitters or their signals were lost from four of the 40 hens, one was killed by a mammal and one probably died from disease. A further four hens were killed by raptors while foraging away from the nest during incubation and a final hen died immediately post-hatch for no apparent reason. All of the remaining 29 hens successfully hatched their clutches.

We caught chicks from each of the 29 broods when they were 10 to 12 days old and counted the number of ticks attached to their heads. The average tick burdens on chicks differed between the three study sites. On Moor A, only one tick on a treated chick was found at site 1 and two ticks, both on untreated chicks at site 2. However, Moor B proved very ticky and significantly more ticks were found on the chicks of untreated hens than on those from acaricide-treated hens (see Table 1).

At approximately seven weeks old, we relocated and flushed the broods to get a final count of the chicks. Across all sites, there was a tendency for higher chick survival from treated hens. However, this trend was not significant, with 36% of chicks from treated hens surviving and 20% of untreated chicks surviving at seven weeks old. However, when data from site 1, which had virtually no ticks, were excluded, survival of chicks from treated hens was 49% (+9 se) compared with only 18% (+8 se) from control hens (see Figure 1).

These data collected this year tend to confirm earlier findings in 2006; that is, equipping hen grouse with acaricidal leg bands helps to reduce tick burdens on their

TABLE 1

Average tick burdens on chicks of acaricide-treated and untreated hens on the two study moors

Moor	Site	Acaricide-treated chicks		Untreated chicks	
		Sample size	Ticks/chick	Sample size	Ticks/chick
A	1	(11)	0.1	(13)	0
	2	(12)	0	(14)	0.2
B	3	(13)	0.2	(29)	12.6

chicks and that this in turn results in higher chick survival. However, these findings are interim and we need to repeat it again in 2009. Given that two of our study sites had so few ticks, next year we will revise our site selection to ensure that all sites have tick problems. We cannot yet recommend the use of acaricide leg bands as a management tool to enhance grouse productivity in ticky areas.

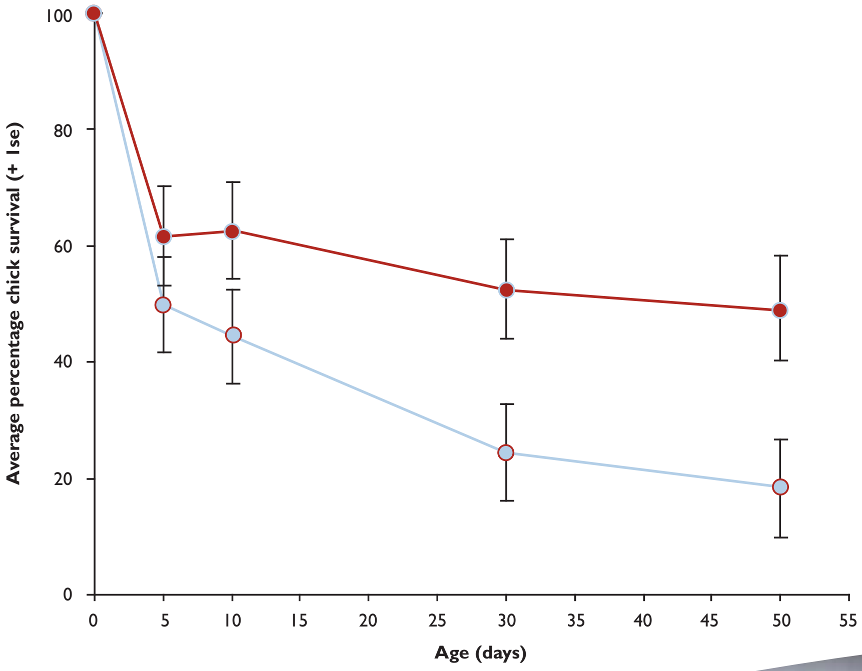


Figure 1

Chick survival from hen red grouse on sites 2 and 3 combined

Treated hens = 10; untreated hens = 11.

Red grouse chicks are particularly vulnerable to tick infestation © Peter Thompson/GWCT

Strongylosis ~ testing the new medicated grit

A twin compartment grit box with a sliding lid so that grouse can be denied access to the medicated grit in one compartment a month before and during the shooting season, but then allows them access to non-medicated grit in the other.

KEY FINDINGS

- On non-medicated grit plots numbers of worms found in caecal pats sharply rose during April and May but not on medicated grit plots.
- Worm burdens in adult shot grouse were higher on non-medicated than medicated plots.
- An extensive study of 25 moors shows fewer worms in grouse on moors using medicated grit than those not using it.

Mike Richardson
David Newborn
David Baines

A new form of medicated grit has been designed that weathers better on the moor and is consequently more effective than previous formulations. This new grit has to be withdrawn from grouse a month prior to, and during, the shooting season, so we have designed grit boxes equipped with a sliding lid that deny grouse access. Following a preliminary trial in 2007, we tested the system on a larger scale in 2008.

We used eight moorland plots, each of about 400 hectares, in the Upper Teesdale Estate, County Durham. Within each plot, we placed grit boxes 150 metres apart on a grid between January and March 2008. We randomly allocated medicated or non-medicated grit between the plots so that four contained medicated grit and four not.

We collected fresh grouse caecal pats monthly between January and May on each plot and counted their strongyle worm eggs. Worm egg counts showed a sharp increase in April and May on plots without medicated grit, but showed no change on the plots with medicated grit (see Figure 1).

We counted grouse in all eight plots in March and again in July, and using the method of distance sampling, we estimated densities. Neither grouse densities nor their breeding success differed between plots containing medicated grit and those that did not.

Given the relative lack of an intensive lattice system of grit heaps on the Upper Teesdale plots before we started this experiment, and the lateness of distributing the grit boxes in some plots in early spring, grit uptake by grouse may have been lower and later than expected. So, the increase in worm egg burdens on the non-medicated plots in April and May probably occurred too late to influence hen breeding condition and, subsequently, breeding success did not differ between the treatments in 2008.

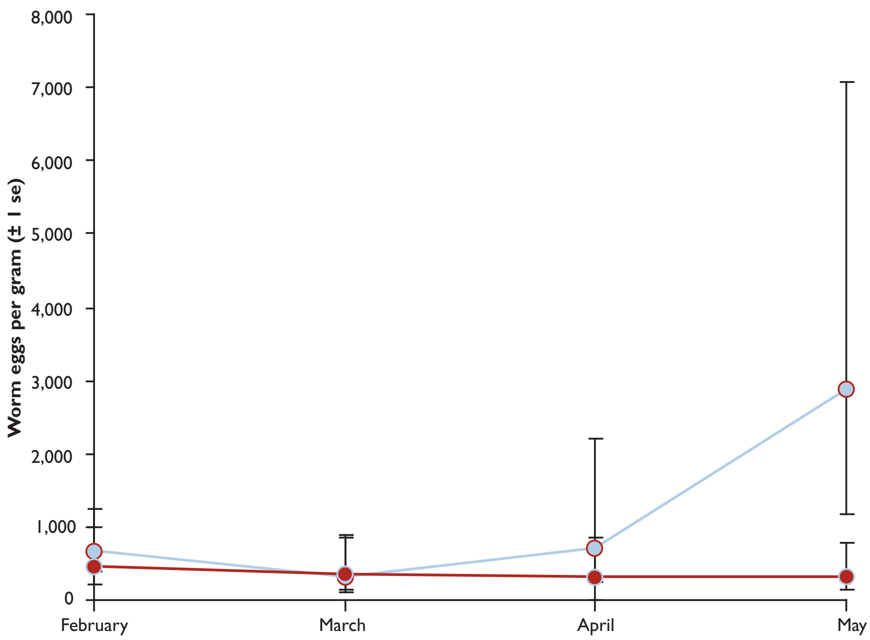
We attended all shooting days on the eight plots recorded the number of grouse shot on each day, as well as their age. We estimated worm burdens from freshly shot birds (at least 10 old and 10 young) monthly between August and November on each plot. Average worm burdens in adult grouse on medicated plots were less than on non-medicated plots (see Figure 2). There was no significant difference in worm burden in young grouse, because all birds got only non-medicated grit from the first week of July.

Figure 1

Number of worm eggs (geometric mean) per gram of caecal material from four untreated and four medicated plots in Upper Teesdale in spring 2008

Medicated

Non-medicated



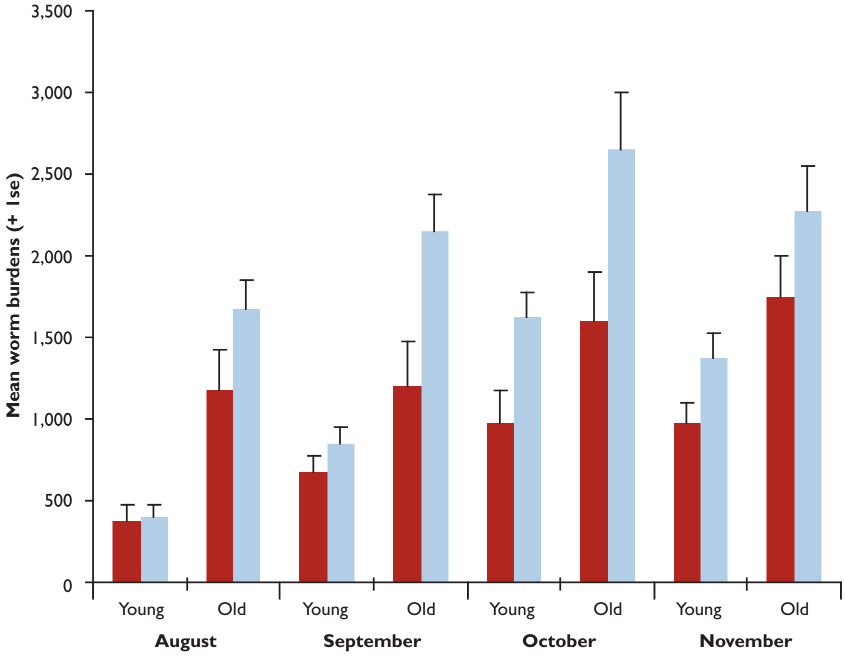


Figure 2

Worm burdens (geometric mean) in both adult and young grouse shot between August and November 2008 on four untreated and four treated plots in Upper Teesdale

Medicated

Non-medicated

Grouse were shot on all plots, but the harvest rate was low and winter grouse densities remain high. This, coupled with currently high worm burdens, suggests that in the non-medicated plots, birds will be in poor condition this spring and will either breed less well, or worse still, we will see the start of a worm-induced population crash. Within the medicated plots, medicated grit was restored to the grouse on 10 December (the last day of the shooting season) and is being taken up well. We anticipate that worm burdens will fall later this winter and into early spring so that grouse on these plots will endure neither suppressed breeding success nor a population crash. We will report whether these predictions come true in next year's *Review*.

Extensive comparisons of medicated and non-medicated moors
We count grouse annually and their strongyle worm burdens on 25 moors in northern England. Some of these moors regularly use medicated grit, and now use the new form of grit, whereas others do not. A comparison of worm burdens from grouse shot in August and September 2008 at 11 sites that use medicated grit and a further 11 sites that do not, clearly shows that medicated grit reduces worm numbers by over 90% (see Figure 3).

Both the experimental and extensive data strongly suggest that use of medicated grit can dramatically reduce worm burdens in grouse. In many parts of northern England, where very high densities of grouse remain following the end of the shooting season, they still have low parasite burdens. Typically, worms drive grouse cycles in this region. The data we present suggest that the new grit may either prevent or severely dampen cycles.

DOS AND DON'TS FOR MEDICATED GRIT

Do

- Have a gritting station per pair of grouse.
- Physically prevent grouse access to medicated grit one month before the shooting season and throughout the period when grouse are shot.
- Have plain grit available at sites when medicated grit is withdrawn. This keeps birds coming to gritting sites.
- Have double-sided grit boxes with sliding lids.

Don't

- Make medicated grit available to grouse during the shooting season.
- Withdraw all grit; give non-medicated before and during the shooting season.
- Use stocks of early formulations of medicated grit; use the new formulation.

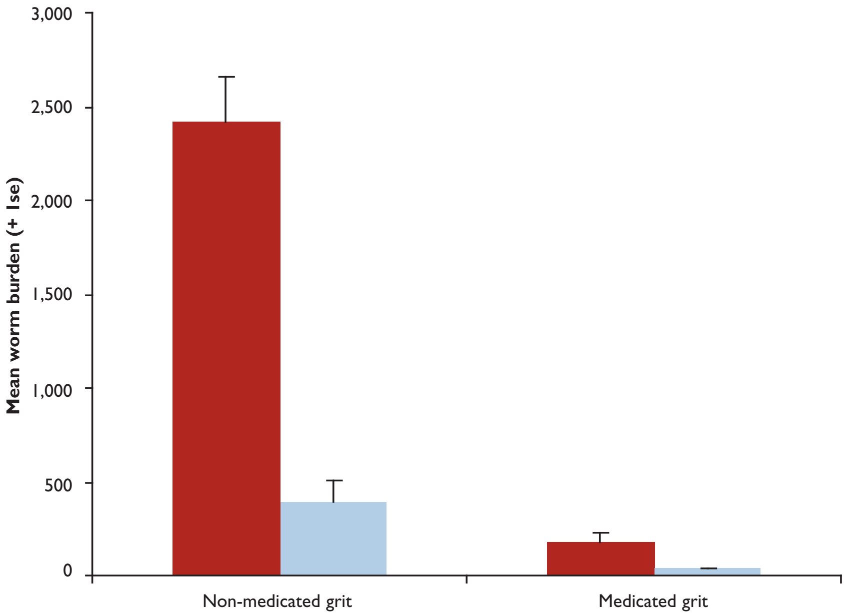


Figure 3

The mean worm burdens from grouse shot in August/September at 11 sites that use medicated grit and a further 11 sites that do not

Adult

Young

Summary of farmland research

KEY ACHIEVEMENTS

- We produced three factsheets and contributed to an HGCA guide on beneficial insects.
- We completed our field work on the re-bugging the system project.
- We completed a study comparing different insect sampling techniques.

John Holland

Top: Farm4bio habitats: fodder radish on left and flower-rich grass on right. © John Holland/GWCT

Right: Perennial grass/flower brood rearing cover. © Barbara Smith/GWCT

Insects are key components of the farmland ecosystem, helping pollinate crops, controlling crop pests and acting as food for other wildlife. To encourage insect conservation on farmland we produced three guides (sponsored by Bayer

CropScience Ltd) that help identify key beneficial insects. We also co-authored a Home Grown Cereals Authority publication *Beneficials on farmland: identification and management guidelines*.

Farmers can now obtain funding to establish a broad range of wildlife habitats on their farms, but ensuring these agri-environment options can be reliably established is essential if they are to be good for wildlife. The weather can sometimes make this difficult as was the case again in the third year of the Farm4Bio Project. The dry spring inhibited germination of our insect and wild bird covers, although fodder radish was able to cope and established well as wild bird seed crop. The perennial flower-rich grass produced prolific amounts of pollen and nectar showing the advantage of perennial covers in years when establishment of annuals is difficult. We are also starting to explore whether it is possible to develop a perennial brood-rearing cover that would be suitable for grey partridges. In 2007 we began a trial comparing nine different grass/flower mixes; three flower mixes combined with three different proportions of fine-leaved grasses. In 2008 we measured the botanical and invertebrate composition of these mixes, the composition of plant species differed between the mixes as expected but there no differences for the invertebrates.

We continued our work to evaluate an alternative to the D-vac suction sampler. This rather antiquated equipment has always been used in our long-term monitoring studies in Sussex and at Loddington, but more modern suction sampling devices (such as the Vortis) are now available, which may ultimately replace the D-vac. We evaluated both devices, along with sweep netting and a modified version of the Vortis that has a wider nozzle more suitable for sampling crops.

Field margins rich in flowers are also important for beneficial insects as they provide pollen and nectar for hoverflies along with alternative prey for the generalist predators. In the last year of our 'Re-bugging the System' project, Heather Oaten examined the extent to which beneficial insects are using field margins by spraying the margin with a trace element and subsequently tracking the spread of insects containing the element using a grid of sticky traps spread across adjacent fields.

Vortis suction sampler with a modified nozzle.
© Tom Birkett/GWCT

FARMLAND RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Sawfly ecology	*Investigate the ecology of over-wintering sawflies*	*Steve Moreby, Tom Birkett*	*Core funds*	*2000-2009*
Re-bugging the system (see page 58)	*To investigate large-scale habitat manipulation for biocontrol*	*John Holland, Imperial College, Rothamsted Research, University of Kent Heather Oaten, Louise Meylan, Heather Gurd*	*RELU*	*2005-2009*
Farm4Bio (see page 62)	*To compare different ways of managing uncropped land for farmland wildlife and to identify the proportion of land needed*	*John Holland & Rothamsted Research, BTO, The Arable Group, Tom Birkett, John Simper*	*Defra, HGCA, Syngenta Ltd, BASF plc, Bayer CropScience Ltd, Dow AgroSciences Ltd*	*2006-2010*
Perennial brood-rearing habitat	*To develop perennial brood-rearing habitat for grey partridges*	*Barbara Smith*	*Core funds*	*2007-2010*
Quarry restoration	*Measuring the success of quarry restoration using invertebrates as indicators*	*Barbara Smith, John Simper*		*2006-2009*
PhD: Invertebrate aerial dispersal (see page 58)	*To examine the dispersal of beneficial invertebrates within arable farmland*	*Heather Oaten Supervisors: John Holland, Barbara Smith Dr S Leather/Imperial College, London*	*RELU/CASE studentship*	*2005-2009*
PhD: Bumblebee nesting ecology (see page 54)	*To enhance bumblebee nest site availability in arable landscapes*	*Gillian Lye Supervisors: John Holland, Prof Dave Goulson/University of Stirling, Dr Juliet Osborne /Rothamsted Research*	*NERC/CASE studentship*	*2005-2009*
PhD: The population genetics of sawflies	*The impact of population dynamics on genetics and the implications for habitat management*	*Nicola Cook Supervisors: Dave Parish, Dr Steve Hubbard/University of Dundee, Dr Brian Fenton & Dr Alison Karley/ Scottish Crop Research Institute*	*BBSRC/CASE studentship, Scottish Crop Research Institute*	*2007-2010*
PhD: Beetle ecology (see page 60)	*Molecular analysis of intra-guild predation and invertebrate community structure*	*Jeff Davey Supervisors: John Holland, Prof Bill Symondson/University of Cardiff*	*BBSRC/CASE studentship*	*2006-2009*

Key to abbreviations:
BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering; Defra = Department of the Environment, Farming and Rural Affairs; HGCA = Home-Grown Cereals Authority; NERC = Natural Environment Research Council; RELU = Rural Economy & Land Use

Bumblebee use of farmland habitats

*The small garden bumblebee (*Bombus hortorum*).*
© Dave Goulson/Bumblebee Conservation Trust

KEY FINDINGS

- Scottish Rural Stewardship Scheme (RSS) farm management prescriptions can help to provide forage and nest sites for spring bumblebee queens on farmland.
- It is possible to design a land management scheme that can provide benefits for bumblebee queens searching for nest sites and foraging.

Gillian Lye

Bumblebees are beacons of spring and have a very special place in the hearts of the British public. However, they also play an important economic and ecological role by pollinating crops and wildflowers. The UK has 25 native bumblebee species, but many of these have declined in recent years.

Agricultural change has led to big decreases in floral abundance and diversity in the rural environment, reducing the availability of important bumblebee forage plants such as red clover. It has also caused the loss of many field boundary features such as hedgerows and stone walls, which are good nesting sites for bumblebees. This loss of habitat is thought to be the main reason why bumblebee numbers have declined.

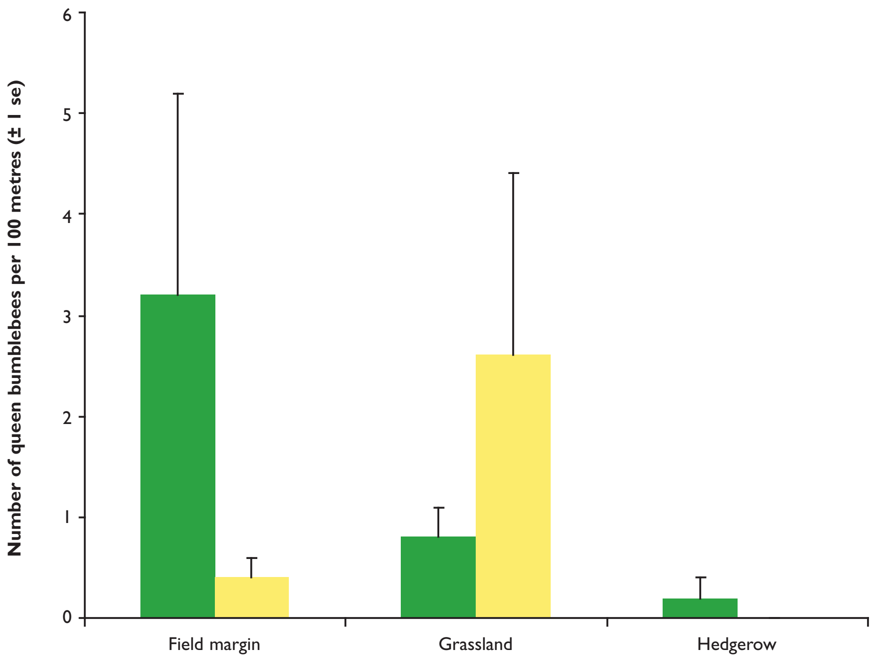
Bumblebees are active from early spring until late summer, but conservation efforts focus on providing forage for workers in the summer, although bumblebees are probably more sensitive during the period of nest foundation and early colony growth in the spring.

In 2008, we compared numbers of bumblebee queens foraging and searching for nest sites in three existing agri-environment habitats that were either managed conventionally or according to the Scottish Rural Stewardship Scheme (RSS) 2004. We surveyed 10 farms five times and, of these, five were participating in RSS and had at least two of the following RSS habitats: grass margins or beetle banks, managed hedgerows and species-rich grassland.

The grass margins or beetle banks were 1.5 to six metres wide, sown with a suitable grass mix and uncut or grazed until after harvest. The managed hedgerows were only cut once in every three years, any gaps were filled and the hedge base remained uncut. Species-rich grassland was either unimproved grassland or sown with a grass-flower mix which remained uncut or grazed between March and mid-August.

Figure 1

Average number of bumblebee queens seen foraging in five Rural Stewardship and 15 conventionally-managed habitats in Scotland in 2008



The number of queen bees foraging was significantly different in each habitat.

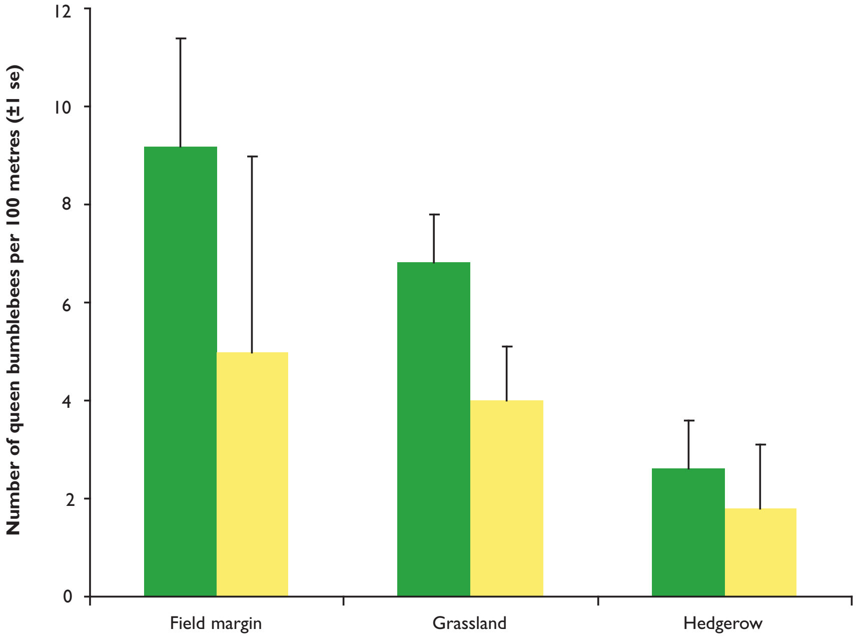


Figure 2

Average number of bumblebee queens seen searching for nest sites in five Rural Stewardship and 15 conventionally-managed habitats in Scotland in 2008

Rural Stewardship

Conventional habitat

Field margins and grassland habitat were not significantly different from each other in the numbers of queen bees searching for nest sites, but there were significantly fewer bees searching in hedgerows than in either grassland or field margins.

Hedgerows were least attractive to spring queens and RSS management made no difference to the numbers of bumblebees observed foraging or searching for nest sites (see Figures 1 and 2). Conventionally-managed (naturally-regenerated) grasslands contained many bumblebee forage plants and attracted high numbers of foraging bumblebee queens, whereas RSS managed species-rich grassland, attracted few foraging queens (see Figure 1), but many of those were searching for nest sites (see Figure 2). This was probably because the complex dense vegetation structure associated with RSS grassland attracted small mammals, the abandoned burrows of which provide nest sites for bumblebees, but also prevented spring-flowering bumblebee forage plants from invading. RSS management improved field margins for both foraging queens and those searching for nest sites (see Figures 1 and 2). The grass mix sown as part of the management prescription produced the complex dense vegetation structure attractive to bumblebees searching for nest sites whereas the regular disturbance as a result of the movement of farm machinery allowed invasion by spring-flowering plants.

These findings suggest that some simple management prescriptions can provide benefits for bumblebee queens foraging during the spring or searching for nest sites, whereas others can benefit both. Helping bumblebee queens early in the year should be rewarded with disproportionate benefits compared with provision for workers later in the year, as it encourages the foundation of bumblebee colonies and helps establish a robust local population which will pollinate crops later in the year.

ACKNOWLEDGEMENTS

We are grateful to the Scottish Executive, and landowners and managers of the farms included in the study, to the University of Stirling for facilities and the Natural Environment Research Council for part funding.

*The rare great yellow bumblebee (*Bombus distinguendus*) foraging on red clover.*
© Dave Goulson/Bumblebee Conservation Trust

The birds and the bees

For the early-flowering blackthorn, bumblebees appeared to be the primary pollinators.
© Rothamsted Research

KEY FINDINGS

- Blackthorn, hawthorn and ivy fruit set is increased by insect pollination, whereas fruit set of bramble and rose is not.
- Bumblebees are primary pollinators of blackthorn, solitary bees of hawthorn, and wasps of ivy.
- Blackthorn and hawthorn fruit set is limited by current pollinator abundance.
- Encouraging natural pollinators would enhance the food supply for fruit-eating birds.

Chris Stoate
Jenny Jacobs

Many pollinating insects have declined in abundance in recent decades. This has been well publicised for bumblebees, and more recently honeybees. Such declines could have ecological effects on other wildlife such as frugivorous (fruit-eating) birds if reduced pollinator abundance results in fewer hedgerow fruits. This project, carried out in collaboration with Rothamsted Research and Stirling University, investigated the role of pollinating insects in determining fruit set in five common hedgerow shrubs – blackthorn, hawthorn, ivy, bramble and dog rose.

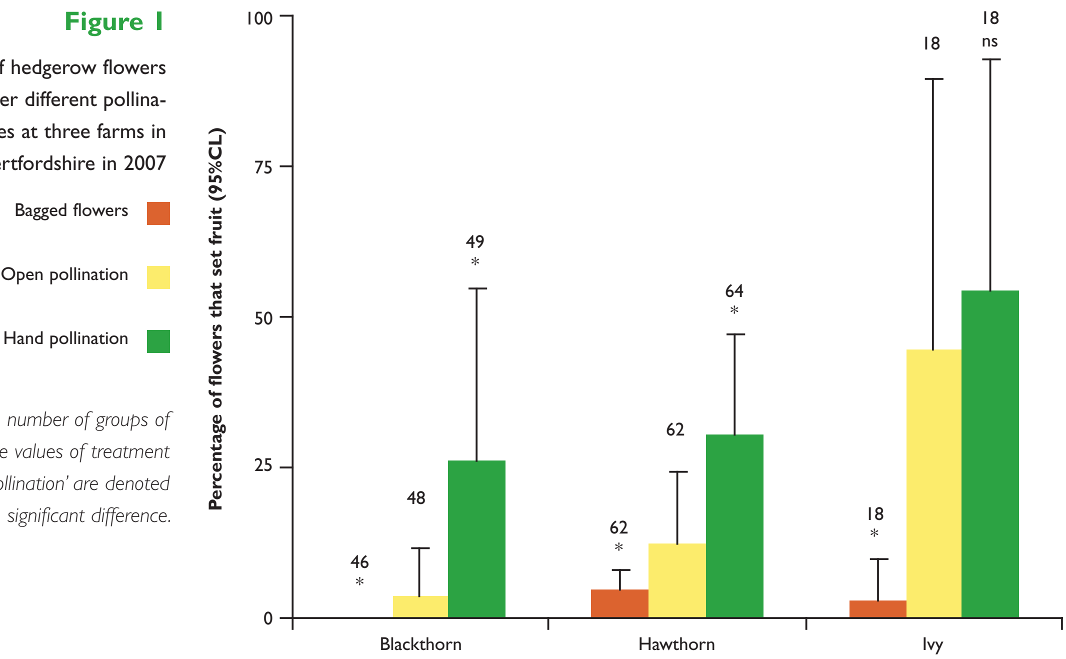
The research was carried out at Loddington, and at Rothamsted and three additional farms in Hertfordshire between 2004 and 2008. As well as transects along hedges to record abundance of insects, and (in winter) fruit-eating birds, the main focus of the research was to test each plant's requirement for insect pollination by excluding insects from flowers using fine mesh bags on wire frames, and examining the proportion of flowers that set fruit (see Figure 1). At the same time, we left some flowers unbagged to be pollinated by insects, and we pollinated some by hand to increase the chances of pollination. If hand-pollinated flowers had a higher fruit set than those that were left for insects, it would indicate that local insect abundance was insufficient for adequate pollination. We counted buds in each treatment before flowering, and later counted the mature fruit.

Bramble and dog rose produced fruit even when insects were excluded, indicating little need for insect pollination. For blackthorn, no mature fruits developed when insects were excluded, and only 4% of flowers formed mature fruit when left open for insects. Hand-pollination resulted in the highest fruit production of all (26%). These results suggest that blackthorn fruit production is strongly limited by pollinator abundance.

We obtained similar results for hawthorn. Hand-pollinated flowers set more fruit (31%) than those left open (12%), which in turn set more fruit than bagged flowers (5%). So for hawthorn as well, the abundance of pollinating insects limited fruit set. For ivy, hand pollination did not increase fruit set (56%) over that of flowers left open

Figure 1

Average proportion of hedgerow flowers setting mature fruit under different pollination treatments on hedges at three farms in Hertfordshire in 2007



*Values above columns are number of groups of buds per treatment. Significance values of treatment comparisons with 'open pollination' are denoted * = P<0.001, ns = no significant difference.*

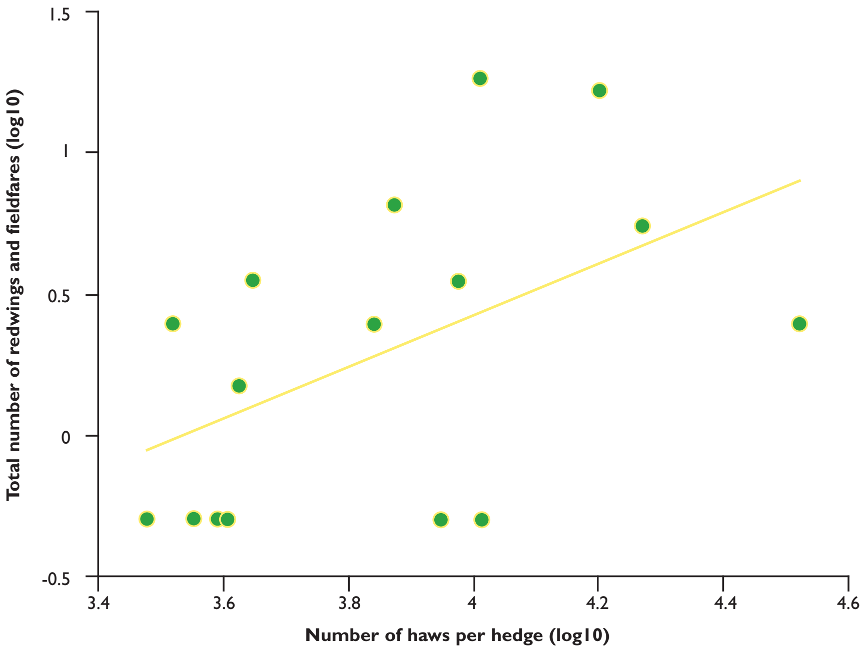


Figure 2

Abundance of redwings and fieldfares in relation to number (mean) of haws in 16 hedges over the winter

$\hat{y} = 3.23+0.914x$, $r^2adj = 0.20$, $P = 0.047$).

Hedgerow berries, such as these haws are important for birds. © Rothamsted Research

(45%), but fruit set of bagged flowers was significantly lower than in the other treatments (3%). This suggests that, although insects are essential for ivy berry production, natural insect abundance is not limiting.

Observations of insect activity and counts of pollen grains carried by insects suggest that different insect groups are important for blackthorn, hawthorn and ivy pollination. For the early-flowering blackthorn, bumblebees appear to be the primary pollinators, whereas for hawthorn, solitary bees are more important, and for ivy, wasps are the main pollinators. The flowering periods of these plants coincide well with the major flight periods of their pollinators, suggesting that these are mutually beneficial relationships that have evolved over time.

In the winters of 2005/2006 and 2006/2007, we found a positive relationship between the abundance of thrushes (blackbird, song thrush and redwing) seen in 14 hedges (of similar height and width) during fortnightly surveys along 100-metre transects and the abundance of sloes, and on 16 hawthorn hedges we found a positive relationship between the abundance of the migratory thrushes, redwing and fieldfare and haw abundance (see Figure 2). These findings confirm the importance of hedgerow berries for wintering birds. These and other species are likely to benefit if management on farmland accommodates the pollinators of hedgerow plants identified by this project. Such management might include the provision of alternative foraging sites for insects (eg. appropriately designed pollen and nectar mixtures) and suitable nesting habitat for both breeding and over-wintering insects.

Encouraging insect pollinators should help boost berry supplies for farmland birds. © Rothamsted Research

Field margins, wheat fields and aerial insects

Lacewings stuck on a sticky trap.
© Heather Oaten/GWCT

KEY FINDINGS

- Aphid predators can respond to field margin densities over scales larger than the average arable farm.
- Field margins can both attract aphid predators and be a source of predators.

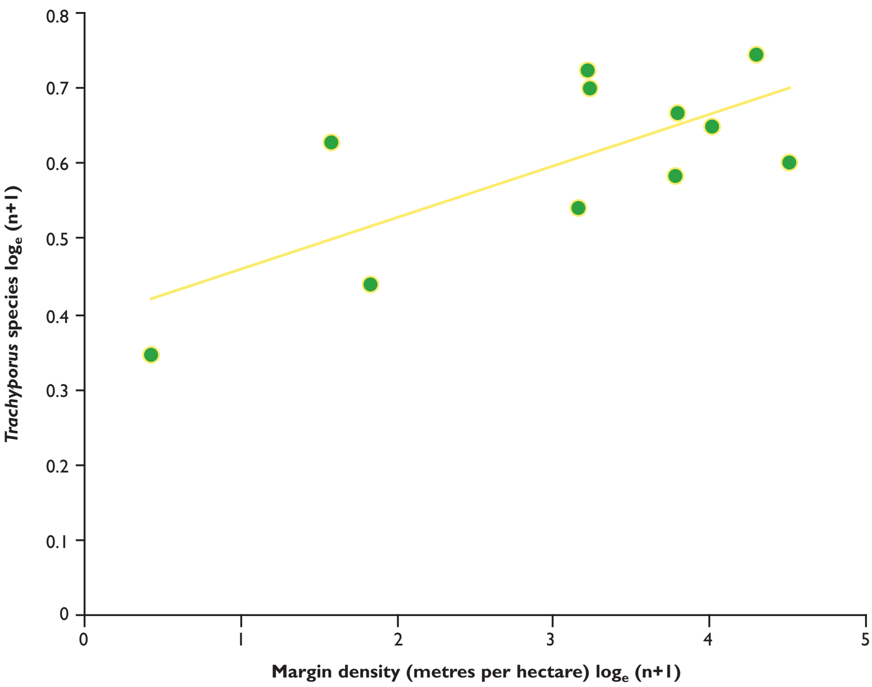
Heather Oaten

In past studies we have demonstrated that winter wheat fields with field margins contained higher numbers of some aerially-dispersing aphid predators such as money spiders, soldier beetles and *Tachyporus* species (aphid-eating rove beetles). However, as these predators are likely to disperse over large distances, studies of single fields may be inappropriate. Consequently we decided to look at this at a landscape scale.

Figure 1

Number of *Tachyporus* species found in 11 winter wheat fields in relation to surrounding field margin density within a 750-metre radius

r^2 adjusted = 0.46; P = 0.013



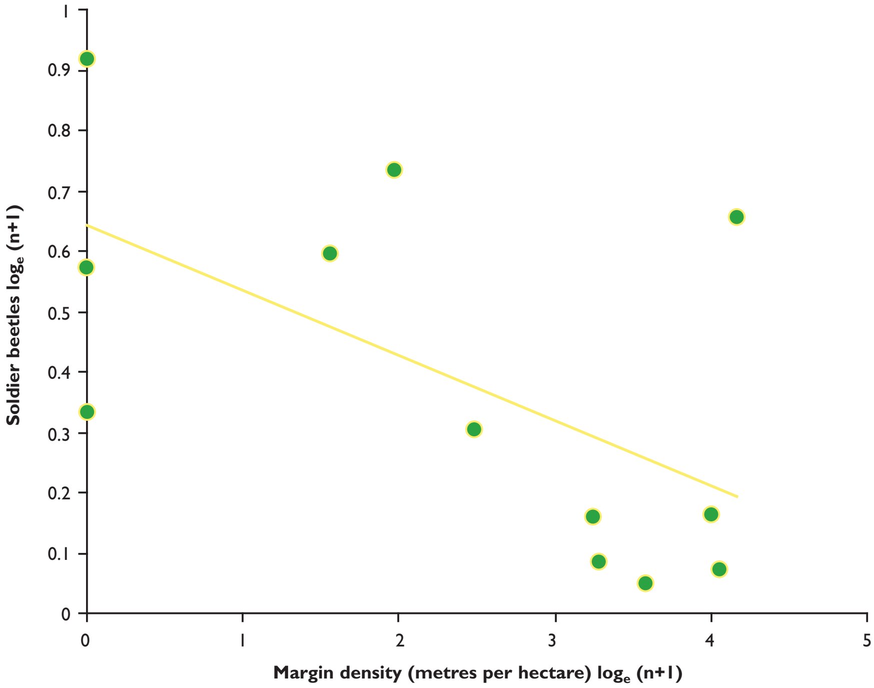


Figure 2

Number of soldier beetles found in 12 winter wheat fields in relation to surrounding field margin density within a 50-metre radius

r^2 adjusted = 0.29; P = 0.041

ACKNOWLEDGEMENTS

We would like to thank all the farmers who helped with these studies. The Re-bugging the System project was funded through the Research Councils UK Rural Economy and Land Use programme.

In our landscape scale study, we trapped insects on sticky traps in 12 winter wheat fields and mapped the field margins within a 750-metre radius of each field. The numbers of *Tachyporus* species increased with the total length of field margin per hectare within a 750-metre radius (see Figure 1). *Tachyporus* species typically over-winter in field margins and move into the fields in spring, so the additional field margin habitat appears to improve their numbers in winter wheat fields. However, soldier beetles in wheat fields showed a negative response to local field margin density at a 50-metre radius, so where there were more margins there were fewer soldier beetles found in the field (see Figure 2). The field margins may be drawing in and holding soldier beetles, or they may forage in margins where prey are likely to be more abundant than in the crop.

*A soldier beetle (*Rhagonycha fulva*) on black medic. © Heather Oaten/GWCT*

Do beetles eat spiders?

The Erigone *species of spiders were most vulnerable to predation by beetles.*

KEY FINDINGS

- Beneficial invertebrate predators that feed on crop pests were also found to prey upon each other.
- The common generalist ground beetle, *Pterostichus melanarius*, was shown to consume four common types of spider: *Tenuiphantes tenuis*, *Bathyphantes gracilis*, *Erigone* species and *Pachygnatha degeeri*.

Jeff Davey

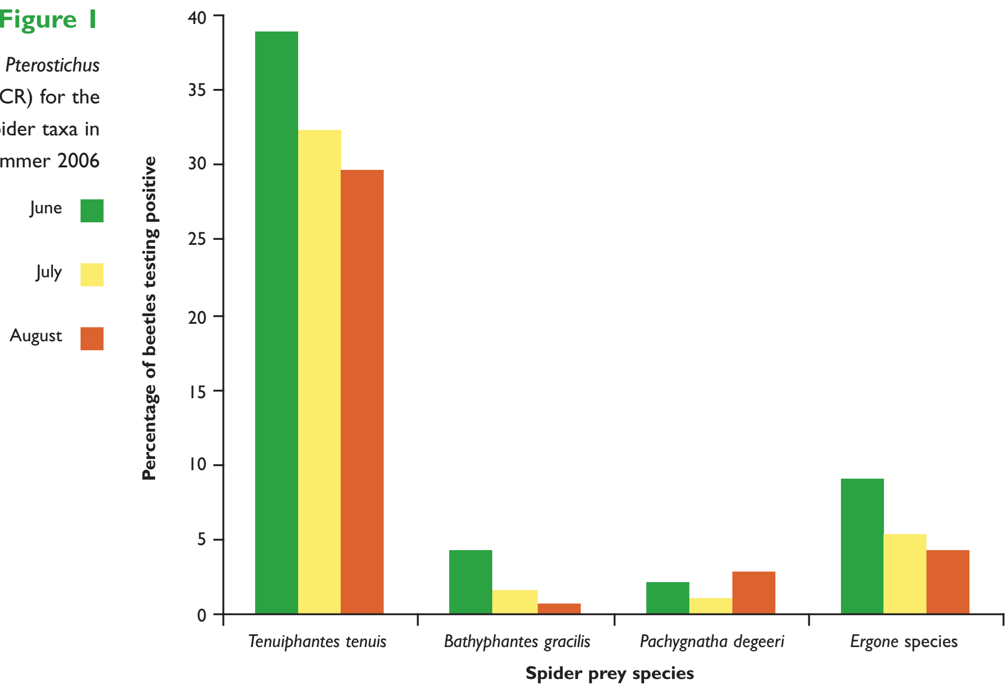
Insect and spider predators found in arable crops are known to consume crop pests, but also other invertebrates, known as alternative prey. These generalist natural enemies can attain high densities by feeding on alternative prey during the early growing season, before any pest outbreak occurs. This could be useful for pest control before specialist natural enemies, like parasitic wasps, appear. However, the alternative prey on which the generalist natural enemies feed also includes some species that are also pest natural enemies. This preliminary work looks at predation on money spiders (*Linyphiidae*), known to be effective aphid predators, by a ground beetle, *Pterostichus melanarius*, which consumes both slugs and aphids. We wanted to establish whether these beetles consumed any of these spiders and, if so, whether they show a preference for those species who also occur in the same places as the beetles.

Revealing patterns of predation among invertebrates is difficult. Analysis of gut contents is useful, but can be biased owing to differing levels of expertise among researchers and the fact that only hard parts of the prey can be detected. Our work relies on a technique called polymerase chain reaction (PCR), which allows prey DNA to be recognised in the gut contents of the predators. PCR is explained in the box.

Over June, July and August 2006, we caught a total of 622 *P melanarius* beetles using pitfall traps placed in a 16m x 16m grid in a field of winter wheat at Rothamsted Research Institute, Harpenden. We then removed the beetles' guts and extracted DNA.

Figure 1

Percentage of 622 ground beetles *Pterostichus melanarius* testing positive (PCR) for the consumption of four common spider taxa in winter wheat during summer 2006



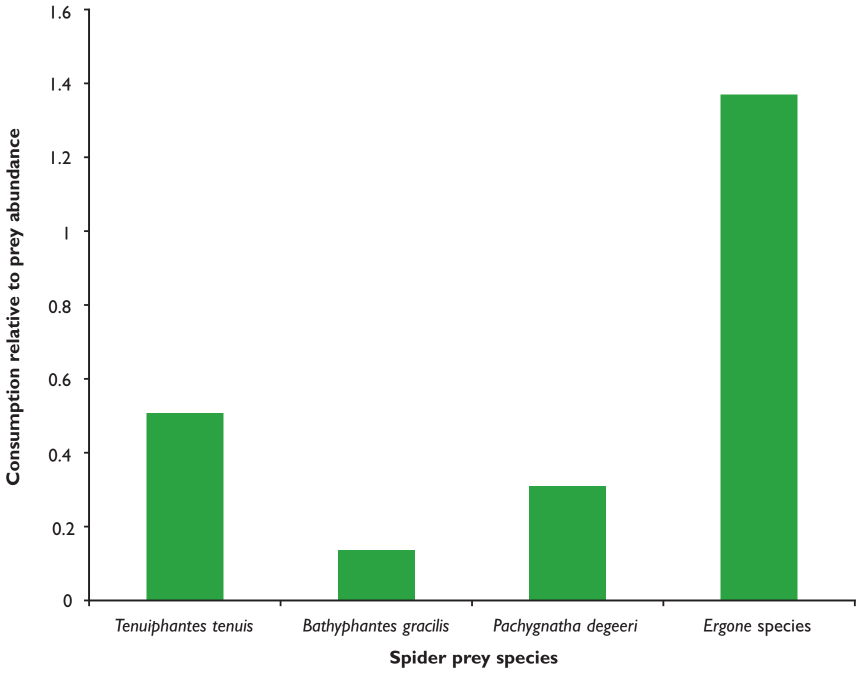


Figure 2

Consumption of four spider taxa by the beetle *Pterostichus melanarius* in relation to relative prey availability in winter wheat during June 2006

Values allow for detection times of DNA fragments

We then screened this DNA with prey-specific molecular markers (PCR primers) to determine whether they had eaten the money spiders *Tenuiphantes tenuis*, *Bathyphantes gracilis* and *Erigone* species, as well as the tetragnathiid spider *Pachygnatha degeeri*.

The sensitivity of the prey detection tests was calibrated using controlled feeding trials. We fed each beetle predator a single individual of the target spider species, after which we killed batches by freezing at regular time intervals following prey consumption. We screened DNA extracted from the guts of these beetles using PCR. We measured the rate of decay in detectability for each prey DNA as the time after prey consumption at which 50% tested positive. When a population of predators is screened, this can be used to weight the estimate (because the time since they last ate will vary) of the proportion of predators consuming each prey species.

We expected that spiders which lived closer to the ground would suffer from higher rates of predation by *P. melanarius,* and found that that this was generally the case. *Erigone* species spin their webs at ground level, whereas *T. tenuis* and *B. gracilis* attach theirs to the wheat stems, at around 36mm and 45mm above the ground, respectively. *Pachygnatha degeeri* hunts, without a web, in the crop foliage. *T. tenuis* was the spider most often detected (see Figure 1), but it was also the most common, so the impact of predation on it may not be as marked as in some other taxa, particularly the *Erigone* species (see Figure 2).

We will continue to investigate predation rates of different prey types by modelling encounter rates.

EXPLANATION OF PCR

PCR is a process in which, firstly, DNA is heated so that its two complimentary strands dissociate. The reagents are then cooled to such a degree that a pair of primers – sequences of single-stranded DNA, 20-30 base pairs long – bind to either end of a short, unique region of the genome. The temperature is then raised again to a level suitable for an enzyme, DNA polymerase, to extend a new copy of the target sequence. Cycles of these temperature changes doubles the amount of the target sequence, producing sufficient copies of a short, unique, DNA sequence to visualise under UV light.

ACKNOWLEDGEMENTS

This work was carried out by Jeff Davey as part of his NERC/GWCT CASE PhD studentship supervised at Cardiff University by Bill Symondson and John Holland from the GWCT. Predator samples were collected as part of a larger BBSRC-funded project between Bill Symondson at Cardiff and David Bohan at Rothamsted Research (*Dynamic responses of predators to biodiversity in sustainable agriculture: spatial and molecular analyses, BB/D001188/1*).

The beetle, Pterostichus melinarius, *was particularly partial to spiders living on the ground.*
© 2007 J K Lindsey

Seed resources for farmland birds

Yellowhammers and bramblings foraging for seeds.
© Peter Thompson

KEY FINDINGS

- There are insufficient weed seeds on the surface of most stubble fields to attract and hold farmland birds.
- Up to 87% of weed seeds in stubble fields disappear between early and mid-winter.
- Conservation headlands help provide a source of weed seeds for birds in winter.

John Holland

Weed seeds are one of the main foods for farmland birds and small mammals in winter. Rotational set-aside created a lot of winter stubbles, and with the loss of set-aside, there is debate over how best to replace it. There is evidence that a shortage of seeds in winter contributes to the decline of farmland birds.

We measured the abundance of weed seeds on the soil surface through the winter on 40 fields on each of three farms in Hampshire, Lincolnshire and Yorkshire. On half of these fields, we broadcast 36 kilogrammes per hectare of bird seed three times through the winter to determine the extent to which seed supplies could be limiting farmland birds. We measured seed abundance three times over the winter at the field edge, where small mammals and hedgerow birds feed and also mid-field, where buntings, finches and sparrows prefer to forage.

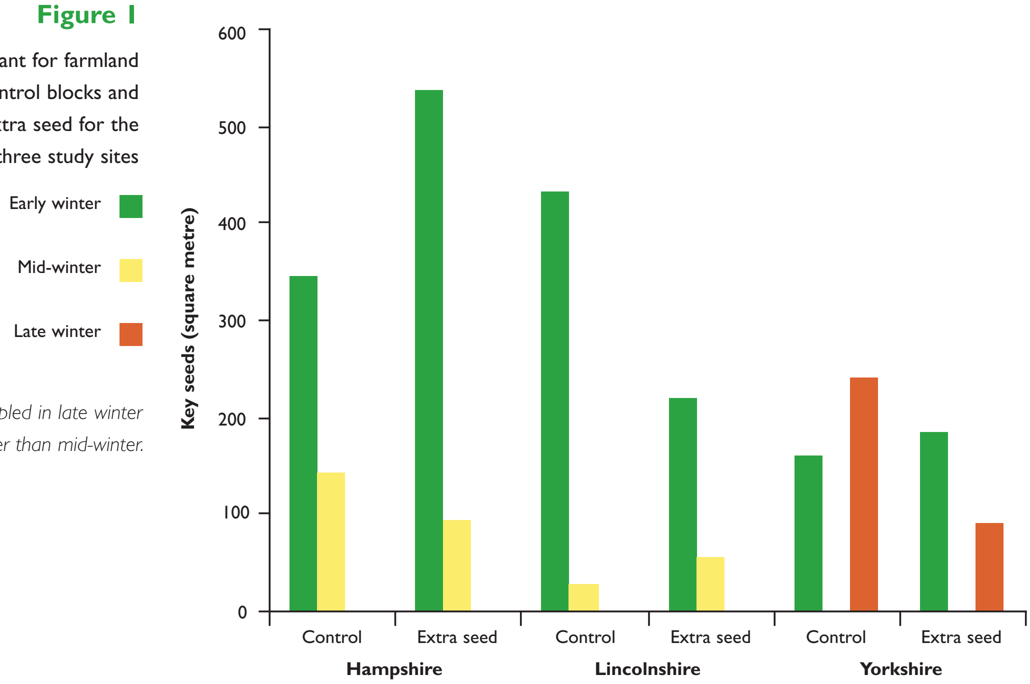
Overall, 80% of the seeds were of six species: chickweed, common orache, corn poppy, fat hen, field pansy and knotgrass. Seed densities fell (they were either eaten or moved deeper into the soil) by an average of 73% and 87% on two farms between early and mid-winter (see Figure 1). These two farms had a large number of stubbles so seeds were accessible to a lot of birds. Across all sites, we found that by January the density of the seeds from broad-leaved weeds at the field edge and mid-field was well below the levels (250-500 seeds per square metre) considered necessary to attract and hold farmland birds (see Figure 2); in fact 30% of all stubbles had insufficient seed. Modern herbicide programmes are highly effective and few weeds survive to produce seed. Seed densities were similar at the edge and mid-field except at one site where conservation headlands had been used.

The extra seed that was applied was rapidly depleted by large flocks of birds soon after the seed was broadcast. These birds also removed the larger weed seeds of common orache, fat hen, field pansy and knotgrass (see Figure 1).

Figure 1

Mean density of seeds important for farmland birds (key seeds) in 40 control blocks and those receiving extra seed for the three study sites

In Yorkshire fields were sampled in late winter rather than mid-winter.



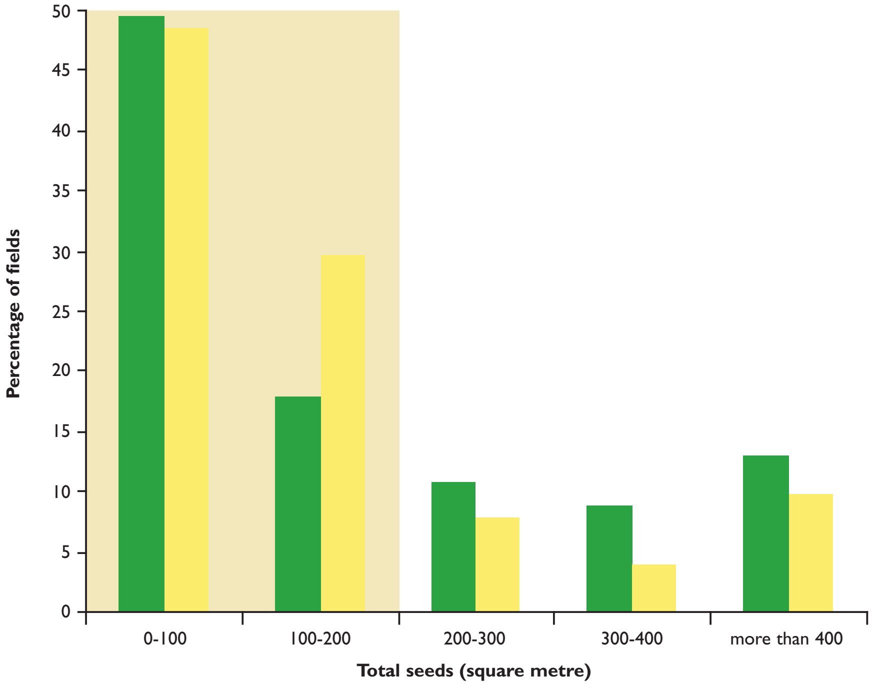


Figure 2

Proportion of fields with different total seed densities at 101 edge and mid-field sampling positions in mid-winter across all sites

Edge

Mid-field

Not enough seed for farmland birds

ACKNOWLEDGEMENTS

This work was funded by the Pesticides Safety Directorate.

Herbicides deplete the seedbank and, consequently, most stubbles now provide poor foraging for farmland birds and consequently the loss of set-aside may not have such an impact on farmland as anticipated. Thus, seed may be more efficiently provided by growing wild bird seed crops rather than reducing herbicide inputs or leaving more stubbles.

Weedy stubble after low herbicide inputs.
© Peter Thompson

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Summary of the Allerton Project

KEY ACHIEVEMENTS

- Three major projects looking at water and soil were completed.
- Long-term data has enabled us to complete two further studies.
- The farm continues to provide a case study of game, environment and farming business.

Alastair Leake

Some of our medium-term projects finished in 2008 and some of our continuing studies are now producing interesting results from our long-term data going back to 1992.

The Defra-funded Phosphorus from Agriculture: Riverine Impacts Study (PARIS) was completed (see page 74). The study explored the physical and chemical processes in the streams and their effects on wildlife. Results showed the negative effect of elevated phosphorus levels on invertebrates and diatoms in streams and ditches, but also identified the sources of this nutrient be it from arable, pasture or domestic septic tanks.

The EU- and Syngenta-funded Soil and Water Protection project (SOWAP) also finished. This was a demonstration project, although five students completed PhD theses as part of it. The results, which included data from four other European sites, demonstrated how soil erosion varies from field to field and annually owing to a combination of weather, soil management, soil type, cropping and slope.

The Mitigation of Phosphorus from Soil (MOPS) project also finished. This project investigated in-field erosion characteristics and demonstrated the significant contribution that tramlines can make to soil erosion on sloping fields. We are now part of a £1.2m LINK project to investigate this further.

In this *Review*, we feature two articles which cover our current research: first, the game species and how their numbers are faring in the absence of winter feeding (see page 70) and a study of pollination and fruit set in hedgerow shrubs (see page 56).

We have completed two studies of our long-term data. One compares the decline of the farmland birds nationally with wheat output since 1964 and with the situation at Loddington. The second is a remarkable study which charts the success, or otherwise, of more than 2,300 blackbird nests over 15 years (see page 72).

On the farming side, we include an article looking at the pressures facing British agriculture and our farm business (see page 66).

LODDINGTON RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Effect of game management at Loddington (see page 70)	*Effect of ceasing predator control and winter feeding on nesting success and breeding numbers of songbirds. Use of feed hoppers.*	*Chris Stoate, Alastair Leake John Szczur*	*Allerton Project funds*	*2001- on-going*
Monitoring wildlife at Loddington	*Annual monitoring of game species, songbirds, invertebrates and habitat*	*Chris Stoate, John Szczur, Alastair Leake, Steve Moreby, Sue Southway, Barbara Smith*	*Allerton Project funds*	*1992- on-going*
Grey partridge recovery project (see page 28)	*Restoration of grey partridge numbers: a demonstration project*	*Malcolm Brockless, Tom Birkett, Julie Ewald, Roger Draycott, Nicholas Aebischer*	*GC USA, Core funds*	*2001-2009*
PARIS: Phosphorus from agriculture: riverine impact study (see page 74)	*Impacts of agriculturally derived sediment and phosphorus on aquatic ecology in the Eye Brook catchment*	*Chris Stoate, John Szczur*	*Defra*	*2004-2008*
MOPS: Mitigation of phosphorus and soil loss to water	*Assessment of cultivation type and direction, as means of reducing soil erosion*	*Alastair Leake, Chris Stoate, Phil Jarvis*	*Defra*	*2005-2013*
Wetting up farmland for biodiversity	*Assessment of bird conservation potential of small wet features on farmland*	*Chris Stoate, John Szczur*	*Defra*	*2004-2010*
Eye Brook community heritage project	*Community-based research into natural and cultural heritage of catchment as foundation for future management*	*Chris Stoate*	*Heritage Lottery Fund*	*2006-2010*
ClimateWater	*Climate change impacts on water as a resource and ecosystem*	*Chris Stoate*	*EU*	*2008-2011*
PhD: Birds and bees (see page 56)	*The role of pollinating insects on autumn berry abundance as food for birds*	*Jenny Jacobs Supervisors: Chris Stoate, Dr Ian Denholm, Dr Juliet Osborne/Rothamsted Research, Prof Dave Goulson/University of Stirling*	*BBSRC/CASE studentship*	*2004-2008*
PhD: Songbird productivity and farmland habitats (see page 72)	*Influences on songbird nesting success in relation to habitat, predator abundance, and weather*	*Patrick White Supervisors: Chris Stoate, Dr Ken Norris/University of Reading*	*BBSRC/CASE studentship*	*2005-2009*
PhD: Game as food	*Rural networks and processes associated with the use of game as food*	*Graham Riminton Supervisors: Chris Stoate, Dr Carol Morris & Dr Charles Watkins/University of Nottingham*	*ESRC/CASE studentship Supported by the BDS*	*2007-2010*

Key to abbreviations:
BBSRC = Biotechnology and Biological Sciences Research Council; BDS = British Deer Society; CASE = Co-operative Awards in Science & Engineering; Defra = Department of the Environment, Farming and Rural Affairs; ESRC = Economic & Social Research Council; EU = European Union.

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The farming year at Loddington

Ploughing at Loddington. © Alastair Leake/GWCT

KEY RESULTS

- Unpredictable weather patterns made all aspects of farming challenging.
- Unusually volatile prices have prevailed but have created a welcome return to profitability for our arable crops.
- Livestock farming remains difficult, the return of Foot and Mouth Disease once again causing turmoil in a still depressed market place.
- The instant and total loss of set-aside creates particular concerns to our approach to enhancing biodiversity at Loddington.

Alastair Leake
Phil Jarvis

Agriculture is an industry that has always experienced periods of boom and bust. The extent of price fluctuation is seldom dependent on one factor alone and increasingly the factors that exert influence on the market are global. War, famine, drought, flooding, subsidies, taxation, politics, pestilence and market speculators cause prices to vary, to the extent that the price of the final product can bear little resemblance to the cost of production of its raw agricultural ingredient. If we take a five-year average price of milling wheat of £100 per tonne, the wheat cost element of a 750g loaf of bread is five pence. For a short period in 2008 the wheat price on world markets was double this with some analysts predicting £300 per tonne. As usual, a series of factors contributed; a drought in Australia, disease in parts of the USA and Europe, increased demand from India and China, flooding in the UK, news that world wheat stocks were at a 30-year low, export restrictions imposed by Kazakhstan – a leading grower of high quality wheat – and last, but not least, speculation.

TABLE 1

Arable gross margins (£/hectare) at Loddington 1994-2008

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007*	2008†
Winter wheat	773	1,007	981	551	668	723	572	603	518	836	536	591	837	772	778
Winter barley	596	877	802	625	478	534	403	315	328	-	-	-	-	-	-
Winter oilseed rape	520	808	868	593	469	468	523	329	611	614	477	381	362	596	1,075
Spring oilseed rape	433	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Winter beans	450	626	574	616	507	553	573	331	452	491§	415§	541§	409§	694§	663§
Winter oats	-	-	-	-	-	-	-	-	462	759	545	516	692	634	643
Linseed	473	535	-	497	-	477	-	-	-	-	-	-	-	-	-
Set-aside	301	331	335	326	296	317	205	204	251	247	217	194	213	194	199

* revised figures § spring beans †estimated figures

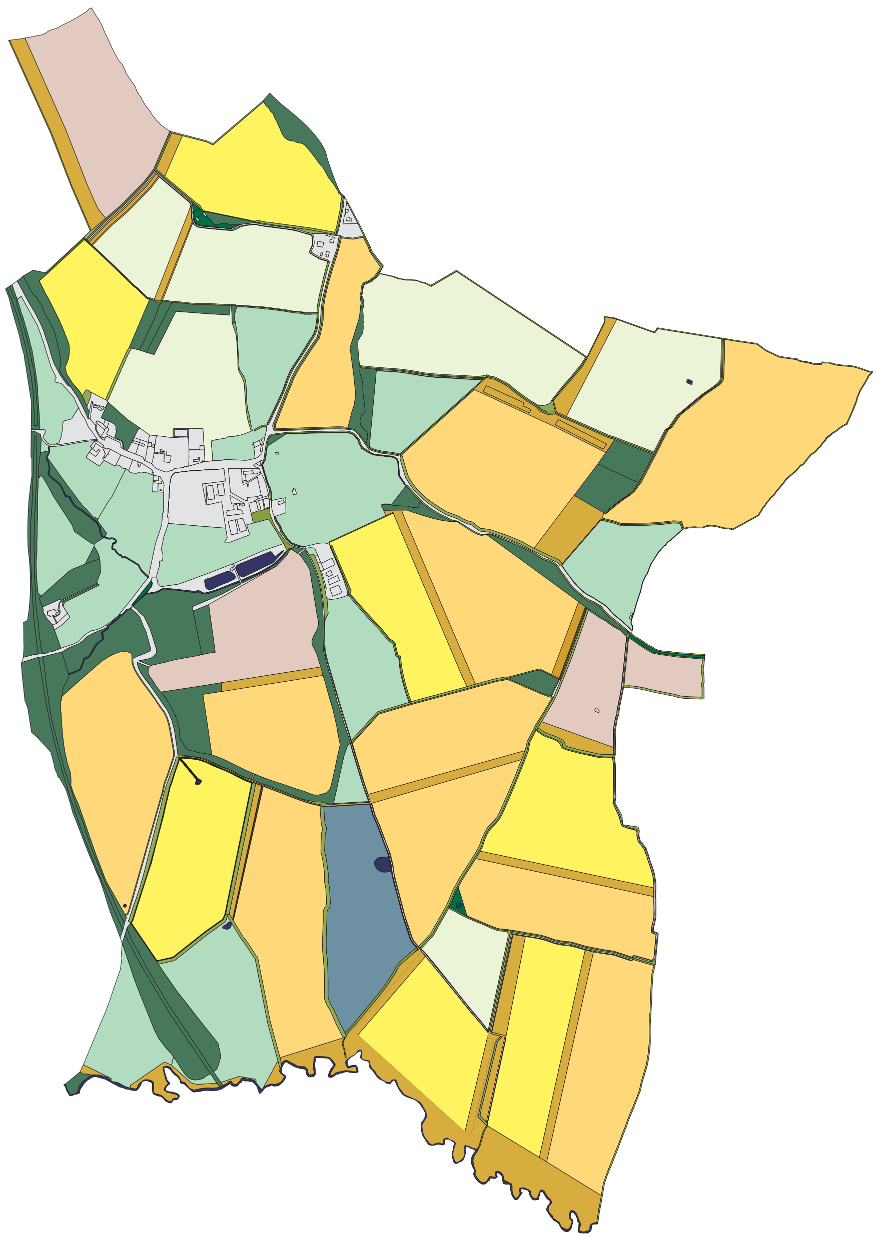


Figure 1

Loddington Estate cropping 2007/08

Woodland

Permanent pasture

Winter wheat

Spring beans

Winter oilseed rape

Winter oats

Set-aside

Hedgerow/verge

A year later and the price of wheat in the UK is back to around £80 per tonne. This was the result of a record world and European harvest, partially contributed to by the cessation of set-aside and a slow-down in demand in the Far East. A traumatic harvest due to persistent rainfall at Loddington typified harvest for many in the UK.

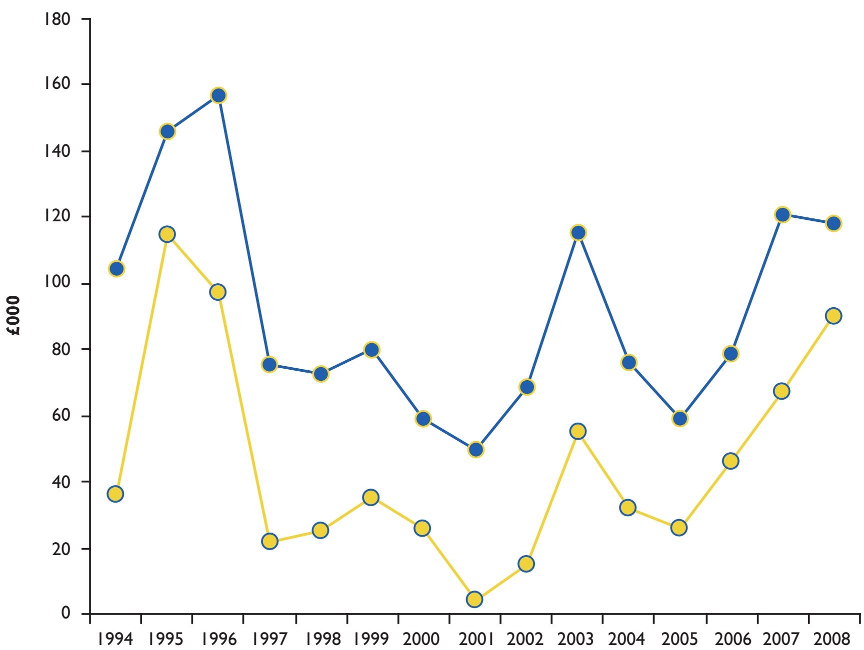


Figure 2

Gross profit and farm profit at Loddington 1994-2008

Gross profit

Farm profit

Figure 3

Crop yields at Loddington in 2007 and 2008

2007

2008 (estimated)

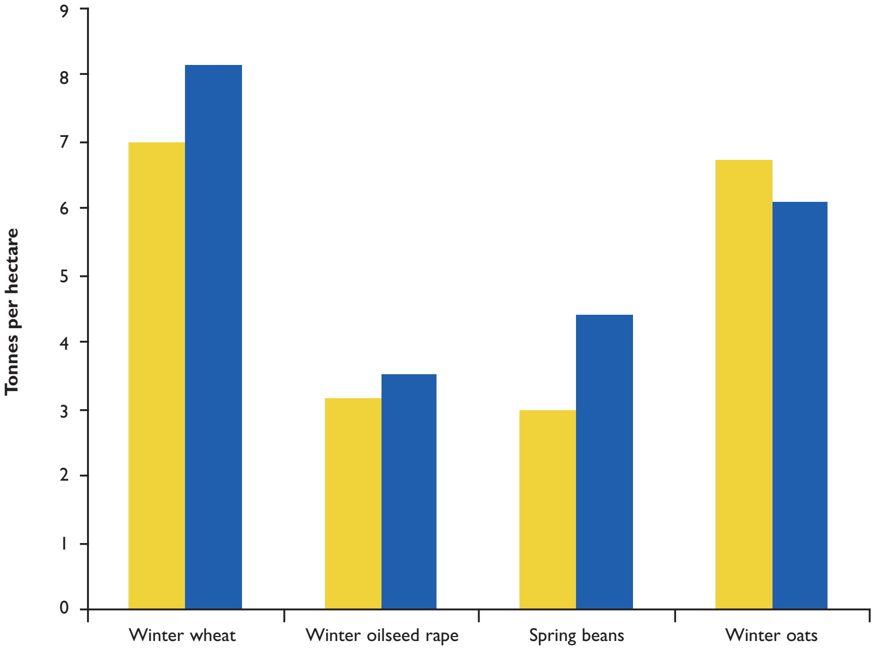


TABLE 2

Farm conservation costs at Loddington 2008 (£ total)

Set-aside (wild bird cover)[1]	
(i) Farm operations	879
(ii) Seed	699
(iii) Sprays and fertiliser	701
(iv) Extra set-aside	8,043
Total set-aside costs	**10,322**
Conservation headlands[2]	
(i) Extra cost of sprays	0
(ii) Farm operations	100
(iii) Estimated yield loss	1,044
Total conservation headland costs	**1,144**
Grain for pheasants	0
Grass strips	410
Stewardship (CSS & ELS)	12,905
Woodland	1,698
Total conservation costs	**26,479**
Stewardship income (CSS & ELS)	(14,505)
Total profit foregone	
- conservation	**11,974**
- research and education	**6,168**
	18,142

[1] Area of wild bird cover = 7.4 ha

[2] Area of conservation headlands = 4.4 ha

Further information on how these costs are calculated is available from the Game & Wildlife Conservation Trust

Continual rainfall over 15 days during the first half of September led to a dramatic reduction in crop quality, down-grading many crops to animal feed.

Meanwhile, fluctuations in the costs of energy have significantly increased the costs of inputs. The prices of fuel for cultivations and drying, crop protection sprays, and fertiliser have climbed steeply. About 40% of the total energy input required to grow a crop of wheat is expended in fertiliser manufacture, increasing the cost per hectare from £120 to £279 for fertiliser alone. It is difficult for farmers to turn production on and off or to switch crops. Most farms have invested heavily in equipment to grow a few specialist crops that suit their locations and soil types. Crop planning is rotational so sequences are planned years in advance and each crop is harvested only annually, so once the seed is in the ground the farmer is committed. There are steps a farmer can take to help smooth the peaks and troughs, which we implement at Loddington. Firstly, by purchasing inputs in advance, we can lock into a known price and ensure

Soil erosion demonstration plots in an oilseed rape crop at Loddington. © Alastair Leake/GWCT that we are not priced out if a key input goes into short supply or becomes unavailable. Tightening regulation, particularly from the European Union regarding pesticides, makes this an increasingly realistic danger. This can work against the farmer should the cost of an input subsequently fall. On the other hand, we can also forward sell part of our anticipated production. Where the market rises, again, this works against the farmer, but in the market conditions we experienced in 2008, having sold at 2007 prices was a very wise course of action.

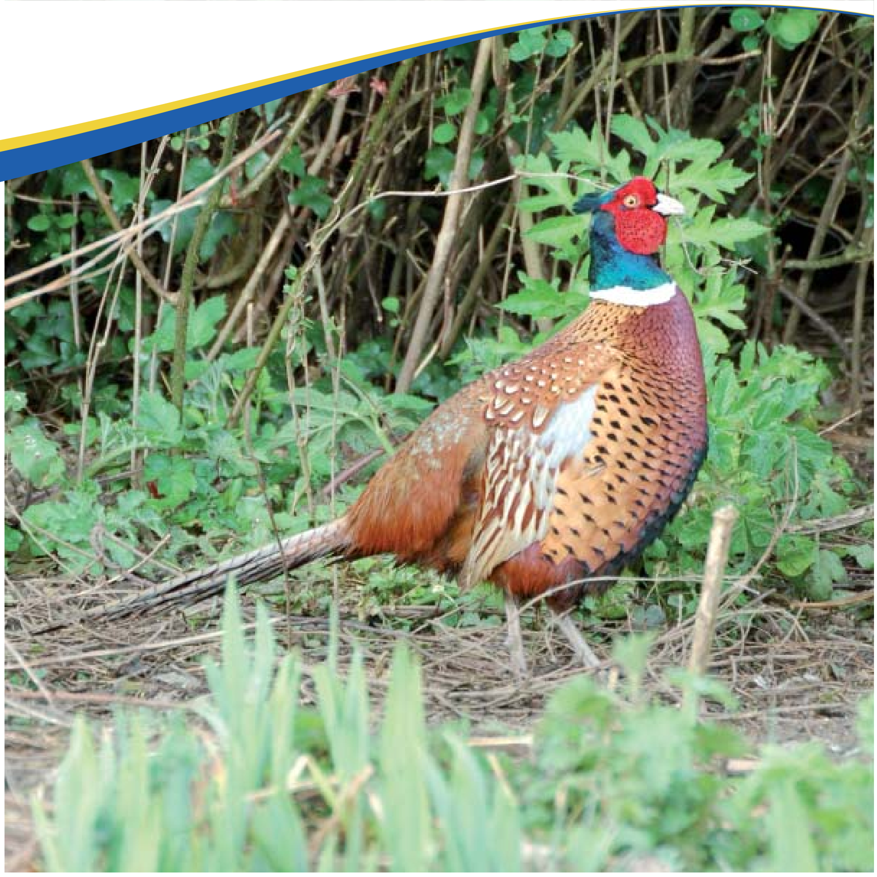
The fluctuations in wheat prices over the past 18 months have caused many hedge funds to lose large amounts. The best, most risk-averse approach, is a spread of sales. There is little doubt that the price at which you sell has more bearing on your profit than on either the crop yield or the cost of inputs.

The farming year at Loddington

But all this assumes the harvest is safely gathered in and in 2008 although the UK recorded the biggest wheat yield in the nation's history, harvest was a traumatic affair. At Loddington our harvest always begins later than most of the rest of the country. Being 500 feet up on a heavy soil means that our crops ripen later, indeed it is not uncommon for us to read in the agricultural press that some farms have finished harvest before we've even begun. This means that once the crops are ready, we need to be in a position to move rapidly, and consequently we used to operate two combine harvesters. But as these aged we replaced them with one much larger machine, releasing labour to help with corn carting, grain drying, of which there was much, and stubble cultivations. After seven season's work, even the best machines become vulnerable to wear and tear so any breakdown seriously threatens the harvest, which is what happened to us, and with a difficult harvest in progress across the nation, leasing, borrowing or even buying a combine harvester at short notice is a near impossibility. That said, we did get all our quality milling wheats into the shed before the worst of the weather and a new machine is on its way for harvest 2009.

Combining at Loddington. © Peter Thompson/GWCT

Game at Loddington



© Peter Thompson/GWCT

KEY FINDINGS

- Pheasant and red-legged partridge numbers remain low, in both autumn and spring, following the stopping of predator control. Hare numbers also remain low.
- There is no evidence of an increased decline in gamebird breeding numbers in response to the stopping of winter feeding, but numbers were already low.
- Plans are being developed to restore the shoot at Loddington.
- A new PhD project is exploring economic and cultural issues associated with game as food, based on social networks around Loddington.

Chris Stoate
John Szczur

Our monitoring of game at Loddington has demonstrated that numbers of pheasants, red-legged partridges and hares have all declined since we stopped predator control at the end of 2001. Winter feeding, normally in the form of feed hoppers, is another important component of most game management systems. In the 2005/6 winter, we reduced winter feeding to just 10 hoppers, and in the winters of 2006/7 and 2007/8 we stopped winter feeding completely to discover the effects on game and non-game species.

Pheasant, red-legged partridge and brown hare numbers have remained low in 2008, continuing the trend from previous years. Once again, hare numbers at Loddington are similar to those at the comparison site where no game management is practised (see Figure 1). There is little evidence from the latest figures that stopping winter feeding has had an effect on pheasant numbers in the subsequent springs. They continue the same trend as before (see Figure 2). Neighbouring shoots continue to feed through most of the winter and pheasants disperse the short distance to Loddington in late winter to exploit the better habitat.

Autumn numbers of pheasants present a slightly different story, with the lowest ever count being recorded in 2008 (see Figure 3) when no pheasant broods were seen on the farm. Although spring numbers appear to be maintained by immigration from neighbouring shoots, high levels of predation during the nesting season keep autumn numbers very low. It is clear that there would now be no pheasants at Loddington if there was no releasing on neighbouring farms.

We have not held a shoot at Loddington since 2001, but we now plan to reinstate game management and develop a shoot that will cover its costs and provide conservation benefits. The idea is that it will serve as a demonstration and can be replicated on similar sized farms across the country. What is clear from many aspects of our research is that Loddington cannot be considered in isolation, but is very much part of a wider farmland landscape. In the past, the shoot at Loddington played an important role in the rural community of which we are a part. One aspect of this which also has an economic dimension is the role of pheasants and other game as food.

A new PhD study by Graham Riminton of Nottingham University will explore the social networks associated with the procurement, processing, marketing and consumption of game around Loddington. The study is already revealing the very strong links between individuals and businesses in the area, contributing to the economic and social well-being of the rural community. It also identifies links with businesses outside our immediate area. Consideration of such socio-economic dimensions will be just as important as the ecological ones when it comes to restoring the Loddington shoot.

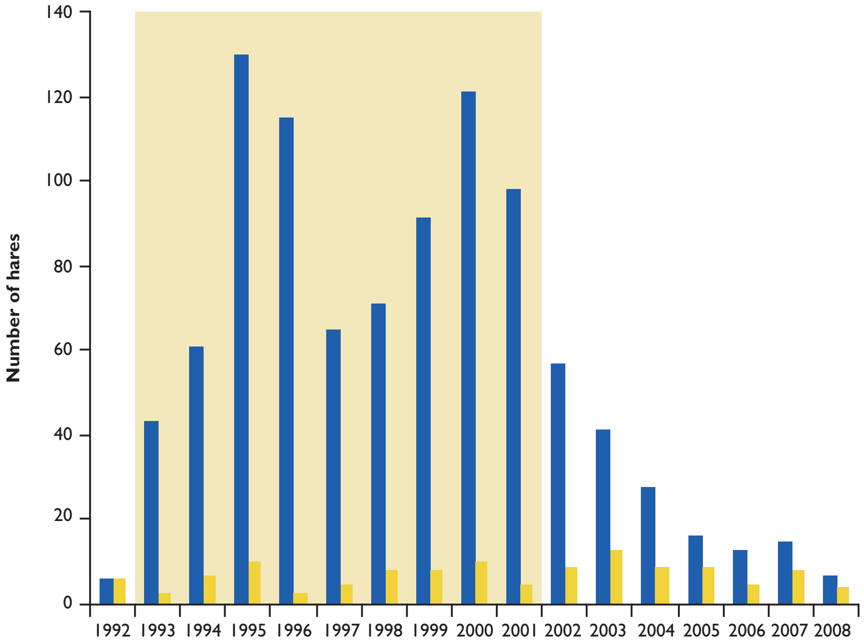


Figure 1

Hare count results for Loddington and the comparison site, five kilometres away, at Hallaton

Loddington

Comparison farm

Keepered period

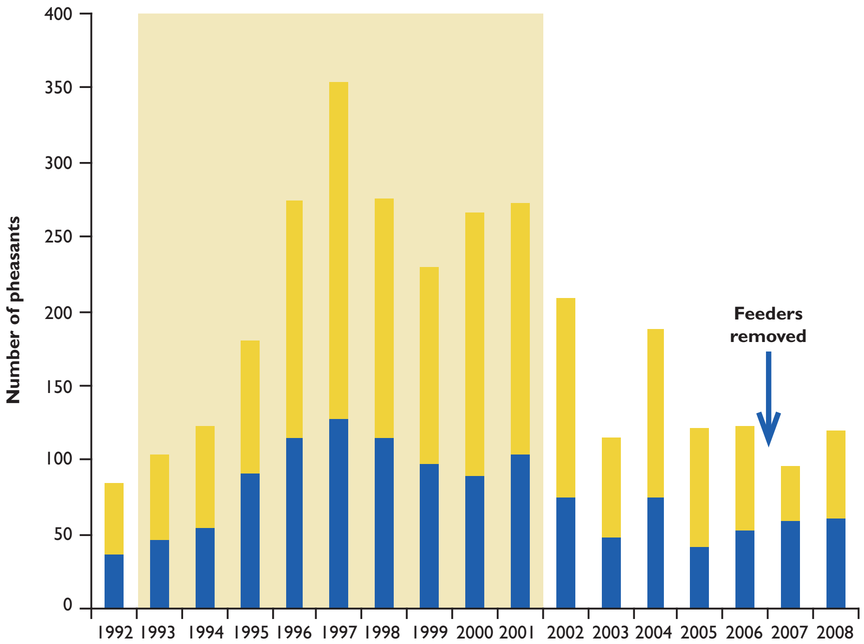


Figure 2

Total spring pheasant numbers at Loddington 1992-2008

Cocks

Hens

Keepered period

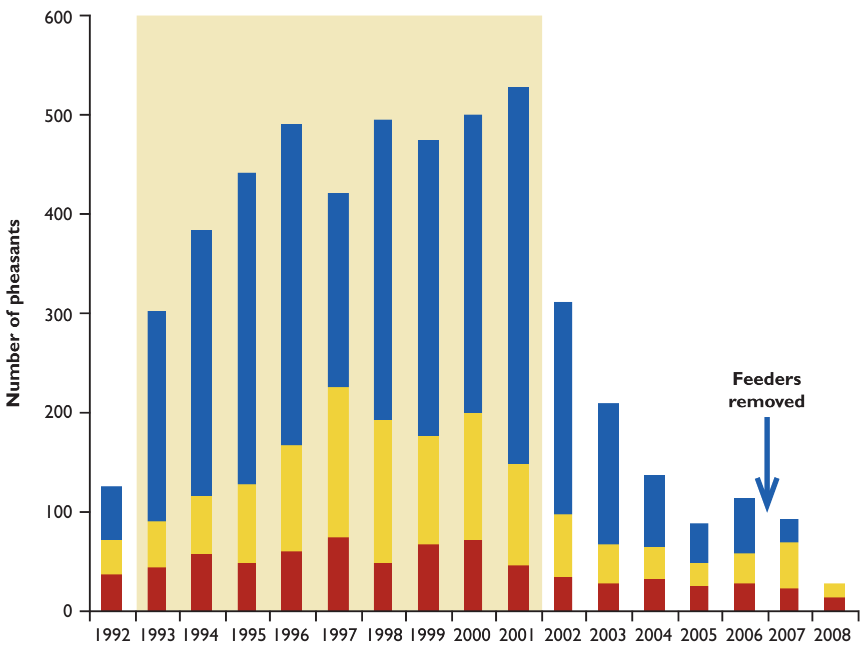


Figure 3

Total autumn pheasant numbers at Loddington 1992-2008

Young

Hens

Cocks

Keepered period

Blackbird habitat and predation

Blackbird breeding numbers increased during the period of predator control.
© Peter Thompson/GWCT

KEY FINDINGS

- Blackbird nest survival is improved and more young blackbirds fledge when predators are controlled.
- Blackbird nest site exposure has a negative effect on nest survival, but this negative effect is reduced when predators are controlled.
- Blackbird breeding numbers increased during the period of predator control and declined once predator control stopped.

Chris Stoate
Patrick White
John Szczur

Which is more important in terms of influencing songbird nesting success, controlling predators or getting the habitat right? Strong views are expressed in support of the two alternatives, but our long-running research into songbird nesting success at Loddington provides hard evidence to contribute to this debate. In particular, the combination of predator control (1993-2001) and habitat management (1993 onwards) at Loddington enabled us to investigate both the principal drivers of nest survival and the interactions between them. The results for blackbird, the species with the largest sample size, and the first to be fully analysed, were published in the ornithological journal, *Ibis*, in 2008.

We considered nest survival separately for the two main stages of the nest cycle: incubation of eggs and provisioning of young, as these may be influenced by different factors. Nest success was lower when there was no predator control than when there was (see Figure 1). During incubation, density of corvid territories had a negative influence on nest success, as did a number of habitat features such as conservation headlands and the proportion of cereal crop around the nest. This may be because the abundance of earthworms as food for adults is lower in arable land than in woodland or pasture. In previous research at Loddington, song thrush nests were more likely to fledge young if a large proportion of the area around them was pasture.

During provisioning of nestlings, control of nest predators had a positive influence and nest exposure had a negative influence on nest survival. There was an interaction between these two factors so that when predators were controlled, the negative effect of exposure was less extreme. This implies that predator control could allow birds to nest successfully in a wider range of locations than is otherwise possible, and that the provision of suitable nesting habitat is particularly important where there is no control of nest predators.

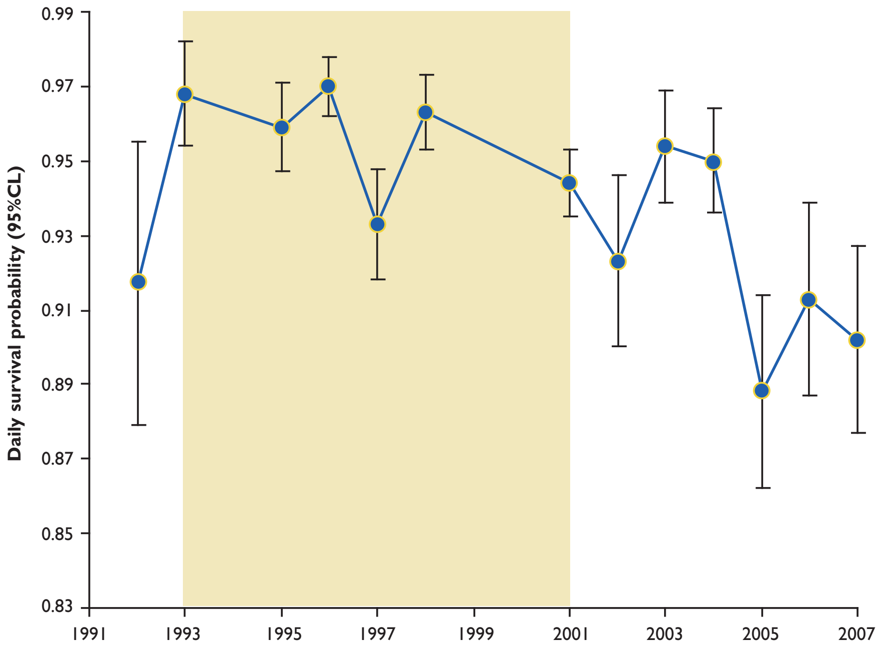
Constant-effort mist-netting during the summer in the two years before and the two years after stopping predator control revealed that the proportion of young birds

Figure 1

Annual variation in estimates of daily survival probability of blackbird nests during incubation between 1992 and 2007

Period of predator control

Daily survival probability is a measure of nest success, and represents the probability of a nest surviving one day within a period of the nest cycle, in this case during incubation.



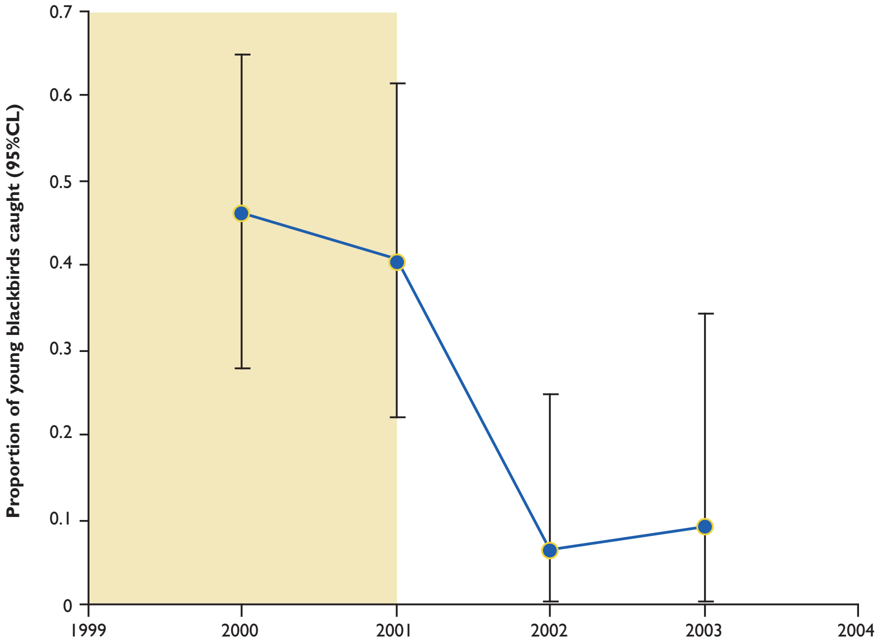


Figure 2

Proportion of young blackbirds caught in the two years before and two years after cessation of predator control at Loddington

Period of predator control

caught was significantly higher during the predator control phase than when there was no predator control (see Figure 2). Past studies have used this proportion as an indicator of productivity, and so when it is higher it suggests birds are managing to produce more independent young, whether through improvements in nest success, post-fledging survival or other breeding parameters. This is most likely to be related to on-site productivity rather than immigration of young from outside the farm and provides further evidence for a positive effect of predator control on productivity.

Transect data reveal an increase in blackbird breeding numbers through the predator control phase of the project, and a decline since cessation of predator control, relative to the regional trend (see Figure 3). The proportion of farmland territories did not change significantly across the two phases of the project, suggesting that there was no increased occupation of farmland as the population increased, or abandonment of farmland as it declined. Although it appears that abundance is influenced by predator removal, it is hard to prove a direct link through effects on nest success, especially as we cannot account for immigration to and emigration from Loddington. We continue to investigate this using population modelling.

These long-term data from Loddington provide convincing evidence for benefits to nesting success of blackbirds resulting from the implementation of a game management system, particularly from predator removal, but further analysis is required to investigate whether this improves abundance. What this study highlights is that both habitat and predator control can interact to influence nest survival and that neither can be considered in isolation.

A male blackbird in dense nesting habitat. © Peter Thompson/GWCT

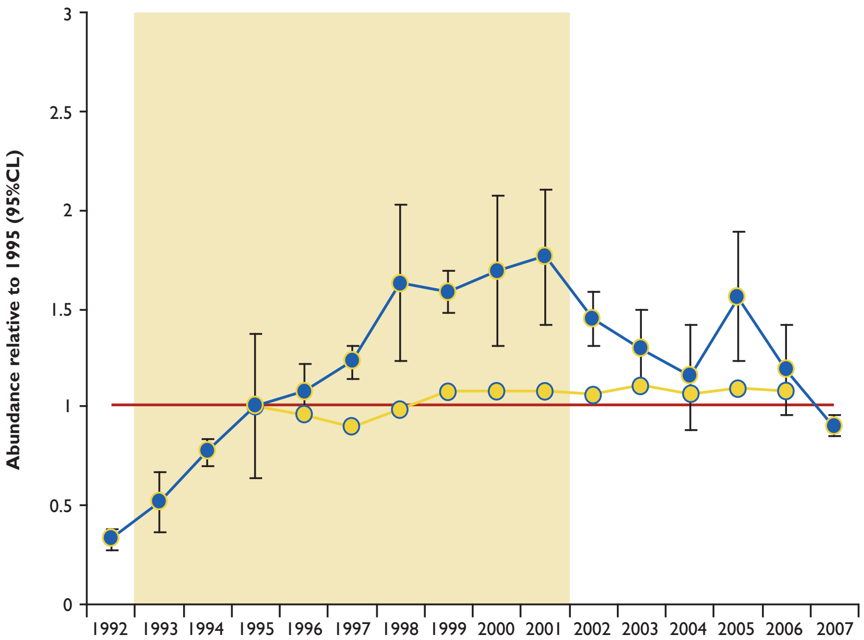


Figure 3

Breeding abundance of blackbirds at Loddington (from annual transects), relative to the regional trend*

Loddington

East Midlands

Period of predator control

** The regional population trend is based on the population index from British Trust for Ornithology (BTO) Breeding Bird Survey (BBS) data for the East Midlands, calculated from transect counts in between 122 and 264 randomly-chosen one-kilometre grid squares in the region annually.*

Phosphorus in the Eye Brook catchment

© Chris Stoate/GWCT

KEY FINDINGS

- Phosphorus concentration was correlated with sediment load.
- Sediment and phosphorus concentration was higher in the arable than grassland sub-catchment.
- Septic tanks contributed higher concentrations of phosphorus than agricultural sources.
- High phosphorus concentration was associated with low numbers of aquatic insect and diatom species, and with high diatom biomass.
- The PARIS project contributes important information to our wider community-based work in the Eye Brook catchment.

Chris Stoate

Farming is coming under increasing pressure to reduce its impact on water quality, especially through the requirements of the EU Water Framework Directive, and we intend our research at Loddington to assess this impact and help us prepare for future change. Loddington sits in the central section of the 67-square kilometre Eye Brook catchment and much of our recent research has been at the catchment and sub-catchment scale. One major Defra-funded project that has recently been completed is the Phosphorus from Agriculture: Riverine Impacts Study (PARIS). This has investigated the relationship between farming and stream nutrients, especially phosphorus. Whereas other projects have investigated processes, associated with soil erosion, PARIS explored the physical and chemical processes in streams and their impact on wildlife. The project concentrated mainly on two sub-catchments, one pasture in the Eye Brook headwaters, and the other mainly arable around Loddington.

The ecological part of the project looked at the effect of phosphorus on aquatic invertebrates and diatoms. At 80-100 µg/l (micrograms per litre) of phosphorus, the number of insect and diatom (silicaceous algae) species in the stream started to decline and the diatom biomass started to increase. This ecological tipping point is analogous to the development of blanket weed on the surface of farm ponds and has a profound impact on freshwater wildlife.

Phosphorus is strongly associated with eroded soil particles. Weekly sampling revealed that average concentrations of phosphorus were four times as high in the arable catchment (118 µg/l) as in the grass one (28 µg/l). Inevitably, soil erosion is more likely during storm events when surface run-off occurs and field drain flow is at its peak. Automated samplers set up in the grass and arable sub-catchments enabled samples to be taken in response to rainfall. The results illustrate the increase in sediment and phosphorus following rain (see Figure1). Grassland buffers the stream up to a point, but even here, phosphorus concentrations increase during extreme rainfall. Such intense storm events are predicted to increase under future climate change so understanding this relationship between land use and water quality is important.

We sampled water upstream and downstream of houses (which are potential sources of domestic phosphorus from septic tanks) to define the domestic and agricultural sources separately. The phosphorus concentration was three to four times higher

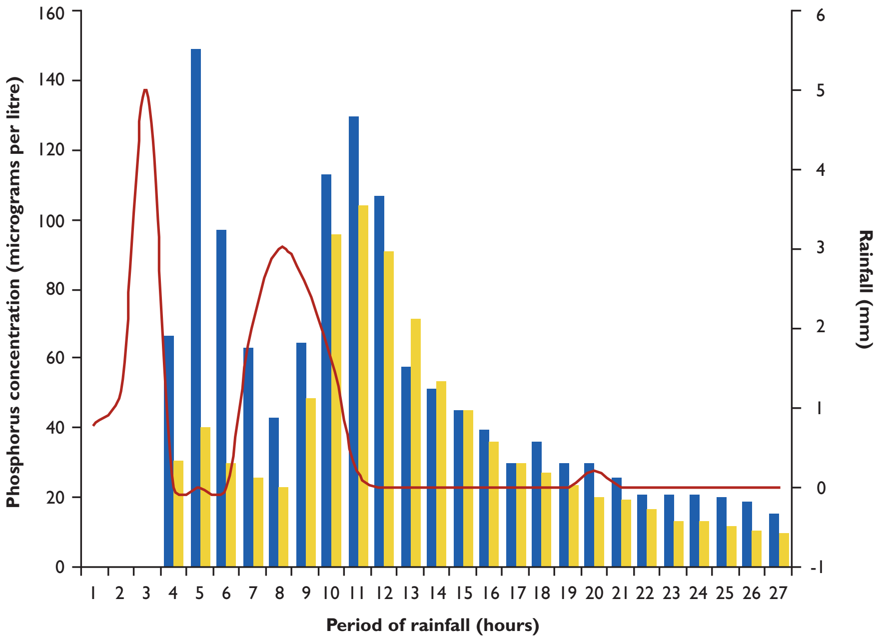


Figure 1

Phosphorus concentrations in the grass and arable sub-catchments in response to rainfall

Arable

Grass

Rainfall

The Eye Brook catchment. © Chris Stoate/GWCT

downstream of houses than upstream, where farming was the only source (see Figure 2). Further sampling revealed that phosphorus concentrations from roads and tracks were intermediate between concentrations associated with field drains and surface run-off from fields, and point sources such as farm yards and septic tanks. In terms of annual phosphorus yield, diffuse agricultural sources contributed more than 95%, but the small contribution from domestic sources was a major contributor at base flow when this continuous source was not diluted by water from the surrounding land.

These results suggest that agriculture is having an impact on stream ecology by delivering phosphorus to watercourses via a number of pathways. Through additional monitoring of Eye Brook tributaries, we identified which contribute most sediment to the stream. They are predominantly arable, but there is not a simple correlation between arable area within a tributary's catchment and the sediment produced by it. A more detailed understanding of individual pathways at the field scale is required to address diffuse pollution. Such field-scale knowledge is held largely by farmers themselves. The project also identifies domestic septic tanks as a source of phosphorus that can have even greater impact on stream wildlife, at least locally.

PARIS is one of several projects in the Eye Brook. Improving the Eye Brook as a habitat and a resource can only be achieved at the community level, and we work closely with other members of the catchment community, not least through the Eye Brook Community Heritage Project, which brings together research results (such as those from PARIS) with the local knowledge of farmers and others.

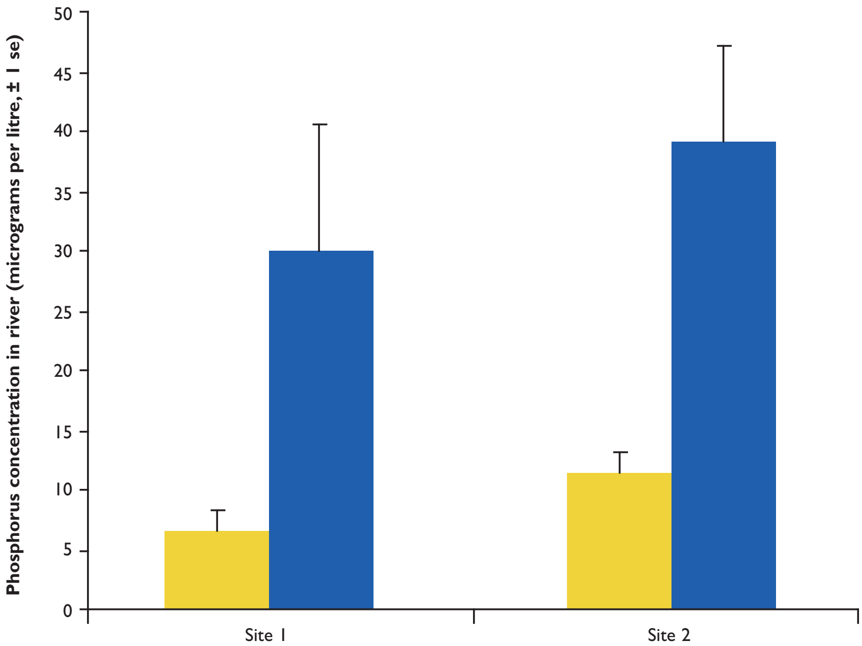


Figure 2

Mean phosphorus concentration upstream and downstream of two groups of houses at Loddington

Upstream

Downstream

Summary of predation research

KEY ACHIEVEMENTS

- We continued with a programme of field trials to improve traps and snares and the way they are used.
- We teach humane dispatch methods to conservation groups engaged in mink control.

Jonathan Reynolds

Above: the American mink has created a conservation headache throughout Europe.
© Laurie Campbell

The international debate about trap humaneness, which we first reported in the *Review of 1996*, drags on. It remains complex, political and illogical. Under trade agreements with other countries, the EU is committed to regulate the types of kill traps (spring traps) that may be used within the EU, at least for 11 native or introduced fur-bearing species. Of these, only the stoat is legally targeted in the UK. The UK waits on developments in Brussels, but leaves its future traps policy wide open. This actually discourages any advance in improvements to humaneness, because manufacturer, importer, retailer and trapper are uncertain about the standards they will need to meet. Currently, Defra approval signifies only that a new spring trap is at least as humane as those already approved. So a more humane trap must compete on the market on equal terms with older models, even though it typically carries a price handicap.

There are commonly trade-offs between humaneness, selectivity, effectiveness, and cost. So although a drive for greater humaneness claims moral high ground, there can be sound practical grounds for defending the status quo. At the same time, criticism has previously been the stimulus for improvement. The banning of the gin trap in England and Wales in 1954 led to the invention of the Fenn trap for control of small mammals like stoats, weasels, rats and grey squirrels. Today, most gamekeepers use Fenn traps or copies of them.

We assume that gamekeepers want dependable equipment that is not perpetually under threat of a ban. Specifically, that means an affordable suite of traps that reliably catch the target species, are easy to use, do not catch protected non-target species, and are as humane as possible consistent with these requirements. They probably don't want any further regulation; but if there is to be regulation, then their traps must pass muster.

PREDATION RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Fox control methods	*Experimental field comparison of fox capture devices*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2002- on-going*
River Monnow project	*Extension of mink control to the entire upper Monnow catchment, Herefordshire*	*Jonathan Reynolds, Ben Rodgers, Owain Rodgers*	*SITA Trust, John Ellerman Foundation, Core funds*	*2007-2009*
Tunnel traps (see page 78)	*Experimental field comparison of tunnel traps and methods of use*	*Jonathan Reynolds, Mike Short*	*Core funds*	*2008- on-going*
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*	*2006-2009*

But there is much more to trapping than the trap itself. In practical use, decisions have to be made about when to trap, how to construct tunnels, where to set the tunnel, and whether or not to use bait. These variables have a major effect on capture rate, selectivity, and humaneness, yet they cannot be tested in a laboratory. Through field research, our team can develop methods that spell improvement in every possible aspect. This, surely, is closer to the spirit of humane trapping than are the heavily political battles over regulation.

Our work on DOC traps is particularly relevant to controlling another import, the grey squirrel.
© Peter Thompson/GWCT

Light at the end? Towards better tunnel traps

A squirrel caught in a DOC 200 trap.
© Mike Short/GWCT

KEY FINDINGS

- Future regulation of traps in the UK remains uncertain because of international politics.
- DOC traps from New Zealand guarantee at least one future-proof tunnel trap in the UK.

Jonathan Reynolds

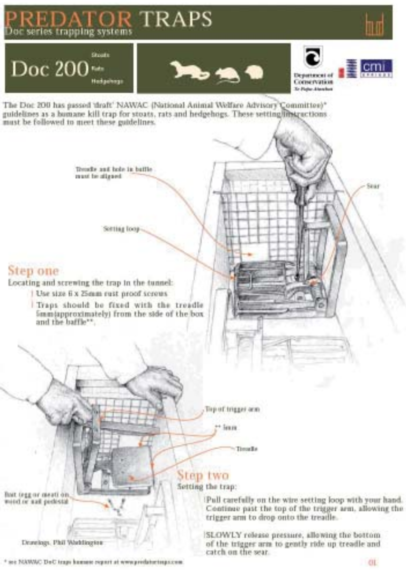
The international debate on trap humaneness began in the 1990s. Canada, as a major exporter of wild-caught fur, had a product to defend and it had, in fact, been working on its own voluntary standards for some years. Since the 1990s, the Fur Institute of Canada has tested 140 kill-traps and certified 18 models, most of them in several sizes, as passing humaneness standards agreed between the EU, Canada, Russia, and the USA. Many of these are new models.

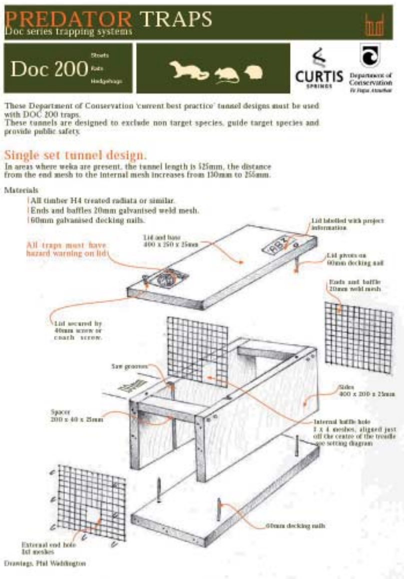
New Zealand, which imported stoats and weasels from the UK in the 1880s with disastrous consequences for its native birds, had adopted UK tunnel traps. Well aware of the humaneness debate, the New Zealand government tested Fenn traps for speed of kill, and found that they compared poorly against state-of-the art traps approved for other species in Canada. Their solution, a new series of tunnel traps developed by their Department of Conservation (DOC traps), were shown to pass the requirements of the EU agreement. Although there is as yet no compulsion to change in the UK, if we wanted future-proof traps, the DOC series seemed ideal for the UK too.

The greater humaneness of DOC traps was dependent on an integral tunnel design, for which the NZ Department of Conservation gave detailed specifications. This needed further development for UK conditions, because our stoats and weasels are larger than in New Zealand and we have a different list of non-target species. In 2006 we submitted three sizes of DOC traps and tunnels to Defra for approval. This was granted for England in 2007. Approval indicates only that DOC traps in their tunnels are at least as humane as traps already approved.

A generic limitation with Fenn traps and other 'body-grip' traps (including rotating-jaw traps such as the Conibear and Magnum) is that they kill by striking and crushing the body of the animal. The most humane death would result from a strike to the head sufficient to fracture the skull, causing instant irreversible loss of consciousness. This rarely happens in body-grip traps, in which the best outcome is that the body is gripped in the chest or neck, with brain death following as a consequence. In other traps, like the Kania and the DOC series, a head-strike is the intended norm. In 2008 we conducted field trials to compare the DOC 200 with its designated single-entry tunnel against No 4 Springer traps (Fenn copies) in customary run-through tunnels to represent current practice. DOC 200 traps almost always struck squirrels across the head, or head and neck, whereas Springer traps almost never struck the head. However, the DOC trap/tunnel made 30% fewer captures. An obvious suspicion was that, because the DOC tunnel was single-ended, it discouraged entry.

In fact, we are now working with DOC traps in revised tunnels that seem to match the Springer No 4 at catching squirrels. All the same, we want to clarify why the original tunnel was a deterrent, so that future attempts to improve trap humaneness will not be made at the expense of efficiency. Clearly, laboratory trap testing is not the end of the matter. Without field testing to verify effectiveness, well-meaning regulations could potentially have serious consequences for the gamekeeper.





FURTHER INFORMATION

- The European agreement on international humane trapping standards (AIHTS) is available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:042:0043:0057:EN:PDF
- DOC traps: www.predatortraps.com. As yet, DOC traps are not on sale in the UK. The Spring Traps Approval (Variation) (England) Order 2007 is available at: www.opsi.gov.uk/si/si2007/uksi_20072708_en_1

Left: A leaflet produced by New Zealand Department of Conservation for the use of the DOC 200 trap.

Below: a Springer No 4 trap, similar to the Fenn Mk IV. Such traps have been the basic tunnel-trapping tool for 50 years. © Jonathan Reynolds/GWCT

A decent end for mink

Plywood 'combs' are used to restrain the captured mink, allowing accurate shot placement.
© Ben Rodgers/GWCT

KEY FINDINGS

- We describe a method for dispatch of live-caught mink that is humane, cheap, discreet and requires no firearms licence.
- The method matches the needs of conservation workers.

Jonathan Reynolds

We have held workshops on mink control using the GWCT Mink Raft all over Britain since 2002, mostly for conservation organisations such as Wildlife Trusts. This training allows us to address sensitively the subject of killing things: first, whether killing mink is going to achieve the desired conservation aims; and second, how to kill a mink humanely. Both are unfamiliar and significant issues for people who otherwise take no part in harvesting game or controlling predators or pests.

Early on, we concluded that for such people, the most acceptable approach was live-capture trapping, avoiding non-target worries. On catching a mink, the most appropriate means of dispatch was an air pistol. It is small, quiet and easily carried (discreet), doesn't require a Firearms Certificate, and is cheap (£50-60). But dispatching a mink is close to the limits of capability for such a modest weapon. Hence, our carefully researched 'prescription' included minimum specifications for the pistol and specified a particular pellet type. At their local gun shop, though, our trainees were sometimes persuaded to buy a quite different combination. In the field, they discovered that this didn't do the job, with distressing consequences, and loss of faith. So now we make sure that trainees understand the ballistics behind our advice.

The danger is to think in terms of hunting or target shooting, and therefore in terms of the energy a projectile carries at some distance from the gun. Heavier pellets store and retain more energy than do light ones, so they have more impact when they strike the target. Lighter pellets 'fade' more quickly. On this reasoning, gun shop salesmen would recommend a .22 calibre air pistol and a heavy (10-14 grain) lead alloy pellet, expecting it to deliver more 'clout' when it hit the target. In practice, the soft, heavy pellet often flattened out on the skull of the animal, causing a non-fatal injury.

We prescribe the smaller .177 calibre pistol, and a light 6-grain steel pellet, a combination we can vouch for. Why the difference? First, we use plywood combs to restrain the mink within the cage trap. This allows careful placement of the pellet in a stationary target at point-blank range. Then, the pellet must punch through the skull of the animal before it can destroy the brain. A lighter pellet accelerates faster, achieving a higher velocity by the time it leaves the muzzle of the gun. Furthermore, a steel pellet does not deform when it strikes bone, and – aided by its pointed shape – penetrates easily through the skull to destroy the soft brain tissue.

For those who already have them, air rifles or shotguns are also humane options, but both are much less discrete and introduce more serious safety issues. An air rifle is more unwieldy than an air pistol, and can be rather over-powered for the job – you need to beware of a steel pellet going right through the mink and ricocheting off the trap. With the shotgun, it's important to set the trap containing the mink against a safe background and get any bystanders behind the gun. Shoot from 10 metres for safety and to avoid damaging the trap. Aim carefully to ensure the mink is caught in the centre of the pattern.

Drowning is not recommended. It is unclear whether death by drowning could be considered acceptably humane, and you therefore risk prosecution under the Animal Welfare Act 2007. We understand that currently most expert opinion would deem drowning to be less humane than the easily available alternative of shooting.

The plastic skirt of the Prometheus® pellet remains at the surface, but the steel pellet itself punches through the skull and tumbles through the soft brain tissue. In this case it has finally lodged in the windpipe. © Mike Short/GWCT

Incubator boxes containing triploid brown trout eggs.
© Dylan Roberts/GWCT

Summary of fisheries research

KEY ACHIEVEMENTS

- We started projects on juvenile brown trout stocking.
- We started a project measuring the effects of pike removal on juvenile salmon and brown trout.
- We investigated the effect of cold water discharge from a hydro power station in Scotland on salmon smolt migration.
- We completed work on the effects of catchment management on trout egg survival.

Dylan Roberts

In 2008 we developed new projects on brown trout stocking. This work will provide information on the most suitable time to stock domesticated strains of triploid swim-up brown trout fry. It will also measure the survival of triploid brown trout eyed eggs from incubator boxes (see picture above), which are becoming more popular. This work will be done on the Rivers Allen and Piddle in Dorset. In addition, we are working in partnership with the Environment Agency and the Vitacress Conservation Trust to monitor the survival of stocked native strain swim-up fry (the stage at which they start searching for food) reared in incubator boxes on the Candover Brook, a tributary of the River Itchen. This work will also compare their retention in fenced and unfenced stretches of the river.

In the spring, in conjunction with the River Tay District Salmon Fishery Board, we investigated the effects of cold water discharge from a hydro power station on salmon smolts. This involved radio-tracking a number of salmon smolts in a tributary of Loch Tay in Scotland. This project is explained in an article on page 84.

In another project, we have started to measure the effects of pike removal on the abundance of trout and juvenile salmon. This work is on the River Avon in Hampshire where pike removal is current practice.

We completed our work on the effects of soil erosion on the survival of brown trout eggs in the south west of England. This was a PhD project for Dominic Stubbing, who submitted and defended his PhD at the end of 2008. He explains his project in an article on page 86.

FISHERIES RESEARCH IN 2008

Project title	Description	Staff	Funding source	Date
Fisheries research	*Develop wild trout fishery management methods including completion of write up/reports of all historic fishery activity*	*Dylan Roberts, Dominic Stubbing, Ravi Chatterji*	*Core funds, London Committee Fish Group, Fisheries Funding Appeal*	*1997- on-going*
Monnow habitat improvement project	*Large-scale conservation project and scientific monitoring of 30 kilometres of river habitat on the River Monnow in Herefordshire*	*Dylan Roberts*	*Defra, Rural Enterprise Scheme, Monnow Improvement Partnership*	*2003- on-going*
Salmon habitat	*Pilot study to investigate bankside habitat*	*Dylan Roberts, Dean Sandford*	*Atlantic Salmon Trust*	*2006-2009*
Pike management	*Impacts of pike removal on the ecology of chalkstreams*	*Dylan Roberts, Dominic Stubbing, Dean Sandford*	*Core funds*	*2007-2011*
Releasing trout fry	*Survival of domesticated triploid farmed trout fry stocked from incubator boxes in chalkstreams and their impacts on wild trout*	*Dylan Roberts, Dominic Stubbing, Dean Sandford*	*Core funds, London Committe Fish Group, Fisheries Funding Appeal*	*2008-2013*
Salmon smolts and hydro (see page 84)	*Movements of salmon smolts past hydro dams cold water discharge*	*Dylan Roberts, David Summers, Dean Sandford, Ravi Chatterji*	*Tay District Salmon Fishery Board, Core funds*	*2008-2009*
Survival of native trout fry	*Survival of native trout fry stocked from incubator boxes on the Candover Brook*	*Dylan Roberts, Dominic Stubbing, Dean Sandford*	*EA, Vitacress Conservation Trust, Core funds*	*2008-2010*
PhD: Effects of siltation on trout egg survival (see page 86)	*Comparisons of the survival of trout eggs in managed and unmanaged catchments in the South West of England*	*Dominic Stubbing Supervisor: Prof Peter Williams, Dr Tony Bark/Kings College London*	*Core funds*	*2003-2009*

Key to abbreviations: Defra = Department for Environment, Farming and Rural Affairs; EA = Environment Agency

A southern chalk stream.
© Sophia Gallia/Natterjack Publications

Salmon smolts on the River Lochay

The hydro power station and the point at which it discharges cold water into the River Lochay. © Dean Sandford/GWCT

KEY FINDINGS

- The downstream migration of tagged smolts was significantly delayed at the hydro power station discharge point.
- Nine (47%) of the 19 smolts released approached the discharge point and eventually passed through successfully.
- Smolts mainly migrated during the hours of darkness.

Dean Sandford

In the spring of 2008, we joined forces with the Tay and District Salmon Fisheries Board to do a pilot study to investigate the impacts of cool water discharge from a Scottish hydro-electric power station on the downstream migration of Atlantic salmon smolts.

As salmon smolt migration is triggered by day length and increasing water temperatures in the spring, the concern was that a sudden cold water barrier may restrict their downstream migration and possibly survival. Possible effects on smolt migration may include them not being able to pass through the colder water discharge. This could cause them to be held up for some time in a small area, increasing the chance of being predated. For smolts that do make it through, but have had the timing of their migration hindered and endured increased levels of stress and fatigue, this could effect their survival in the sea and reduce numbers returning as adults.

Our study area was based at the Scottish and Southern Energy hydro power station located on the lower reaches of the River Lochay (Grid ref: NN 545 349), a tributary of Loch Tay. This station is powered by water diverted from storage reservoirs in the neighbouring River Lyon catchment. The water is piped downhill to the power station and then discharged into the River Lochay. Data recorded in previous years has shown that the water temperature at the discharge point can be 9°C lower than in the receiving river during smolt migration.

We used 19 salmon smolts of between 129 mm and 159 mm in length. Each smolt had a radio transmitter (Biotrack Ltd, UK) surgically implanted within the abdominal cavity, with the antenna of the transmitter being left exposed via a small piercing into the body cavity (as shown in the picture opposite).

View of pipe leading to power station from Loch Lyon. © Dean Sandford/GWCT

TABLE 1

Time taken by each smolt (in minutes) to pass the 130 metre detection range of ALS 1, 2 and 3

Smolt	ALS 1	ALS 2	ALS 3
1	2	265	2
2	2	161	2
8	2	36	2
9	2	-	-
10	6	38	2
12	2	82	-
13	6	25	6
16	8	-	2
17	21	1,039	256
18	2	220	2
19	8	177	2

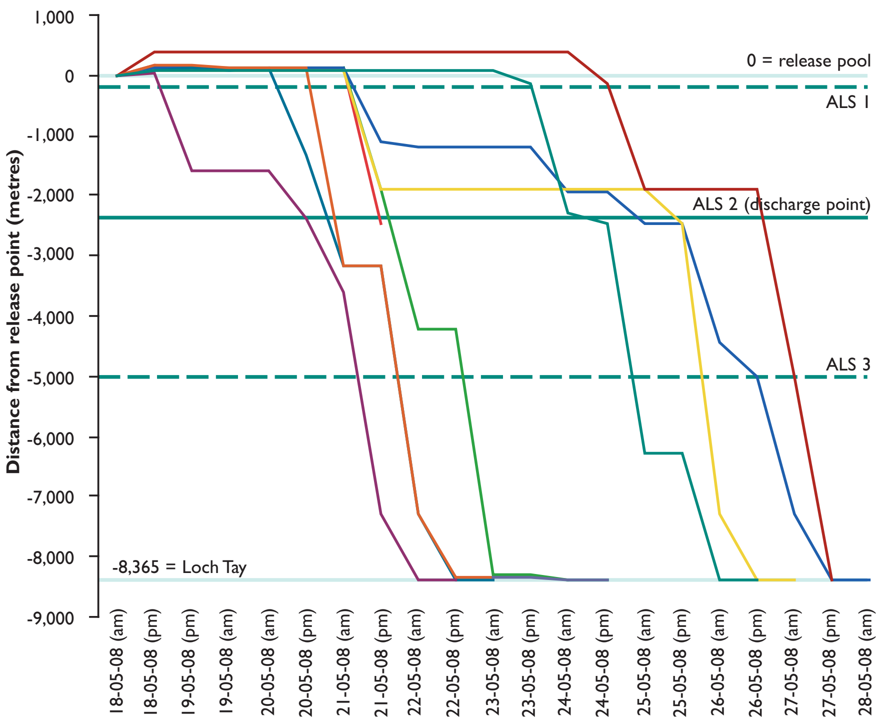


Figure 1

Movements of the nine salmon smolts tracked from the release pool, past the discharge point and into Loch Tay

The 0 point on the y-axis represents the tagged smolt release point. The solid bar (at 2,485 metres) represents the hydro discharge point and ALS 2. The two dashed lines situated at 145 metres and 5,020 metres indicate the positions of the ALS 1 and ALS 3. Loch Tay starts at 8,365 metres from the release point.

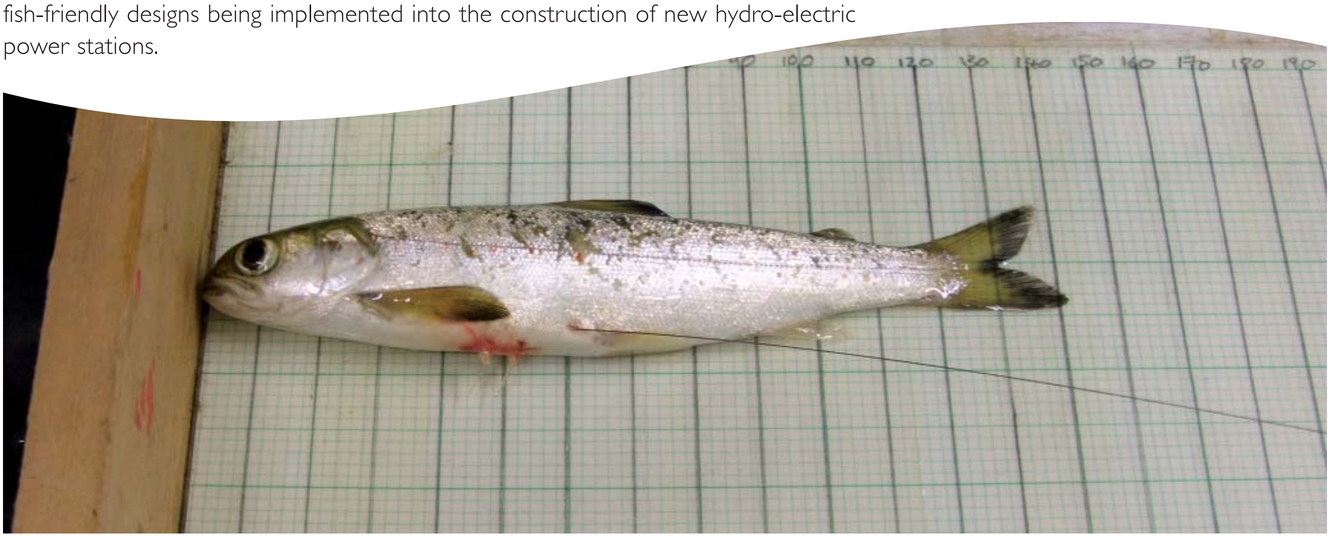
We released the smolts on 18 May 2008 approximately 2.5 kilometres upstream of the power station. Each smolt was located twice daily (morning and night) using hand-held receivers. We used three automatic listening stations (ALS), placing ALS 1 upstream to signal the beginning of a smolt migratory movement, ALS 2 at the discharge point to record smolts approaching and passing through the cold water and ALS 3 downstream, 3,345 metres above Loch Tay. The total journey to Loch Tay was 8,365 metres from the initial release point.

Of the 19 smolts released, nine (47%) passed the hydro discharge point successfully (see Figure 1). The remaining 10 were recorded either as dead (one smolt), missing – either because of tag failure or predation (five smolts), or did not migrate from the release site during the two-week tracking period (four smolts).

The migrating smolts generally moved quickly past both the upstream (ALS 1) and down stream (ALS 3) loggers. However, they took considerably longer to migrate past the logger at the discharge point (ALS 3) as shown in Table 1.

This pilot study suggested that the cold water discharge from the power station could be delaying the downstream progression of migrating salmon smolts in the River Lochay. However, there was no evidence of increased mortality due to the delay, and eventually smolts passed through the discharge and continued their downstream migration successfully reaching Loch Tay.

Although, the results from this initial first year study show that the power station could be negatively effecting the successful migration of the salmon smolts, no firm conclusions can be made from one year's data. These results will benefit from repeat studies in the near future and could potentially confirm the real impacts of hydro-electric power stations. Possible future conclusions from this study could lead to fish-friendly designs being implemented into the construction of new hydro-electric power stations.



Salmon smolt post surgery. The transmitter antenna is visible beneath the fish. © Dean Sandford/GWCT

Farm practice and trout egg survival

Planting a sedimentation pot with baskets of eggs and a pipe for measuring dissolved oxygen.
© Dominic Stubbing/GWCT

The deterioration of trout and salmon populations in UK rivers is a long-standing problem. Poor egg survival is believed to be a major contributory factor. It has been suggested that this is caused by the effect of increased sediment on conditions for eggs in the redds (nests) during incubation. Increased sediment load is believed to occur through changes in farm practice.

Trout and young salmon are typically residents of clean, fast-flowing streams that are well oxygenated and have areas of gravel substrate, which form the spawning grounds of the adult fish. The female constructs a redd in the gravel using her tail. The incubating eggs are totally dependent on river gravel conditions for their survival. Factors that can reduce survival include floods, which may dislodge the redd, predation within the gravel, and a deterioration in oxygen levels within the gravel caused by sediment load or organic pollution.

The amount of sediment in rivers depends on erosion occurring from land surfaces in the catchment and on river bank and riverbed sources. Transport is then by suspension or bed-load movement.

Some farming practices have been shown to increase bank-side erosion, leading to sediment deposition. It has been shown that simply fencing river banks can increase riparian vegetation, decrease erosion and even narrow the river. This study investigated the impacts of farm practice on river gravel conditions within streams and the impact of these conditions on trout egg survival. The results will provide guidance on what good farming practices can be used to reduce siltation and increase egg survival.

The study was based on eight catchments in North Cornwall, which are tributaries of the rivers Tamar and Neet. The area benefited from farm practice improvement initiatives generated by the Westcountry Rivers Trust and the catchments represented different levels of improved farm practice. The study was divided into three parts: a pilot study in 2002 to 2003 to investigate appropriate sampling methodology, a baseline study also during 2002-2003 to field-test the methods, and a main study in

KEY FINDINGS

- Sediment reduced oxygen and egg survival within the riverbed.
- Livestock were the main agents for sediment deposition.
- Fencing livestock away from banks reduced sediment by a third and improved egg survival by a half.

Dominic Stubbing

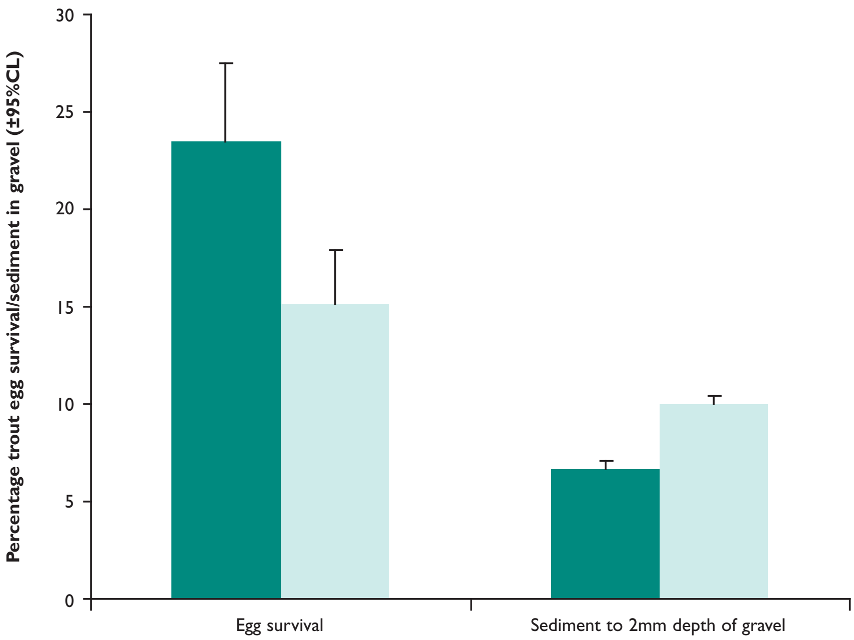


Figure 1

Mean trout egg survival and sediment load in three fenced and three unfenced sites of North Cornwall, 2004-2006

Fenced

Unfenced

2004 to 2006 to test relationships between trout egg survival, sediment deposition and farm practice.

In the main study (2004-2006), we placed eyed trout eggs in special mesh capsules in sediment baskets at sampling sites at the base of each of eight catchments. We measured survival, oxygen, temperature and sediment load at the end of incubation (six to 10 weeks) in each of the three years and collected data on the extent of farm plan improvements during the three years. We took physical measurements of the river at each site and obtained river flow data. In the autumn of each year we collected invertebrates at all sites and surveyed the bank habitat at four sites in the final year.

The major influence on egg survival was reduced oxygen within the baskets buried in artificial redds owing to increased sediment. The farm practice of fencing river banks reduced sediment by 30% and improved trout egg survival by 53% (see Figure 1). We found that the majority of the sediment in the redds was derived from within the river gravel rather than from suspended sediments carried by the river.

Trampling and grazing by cattle and sheep was the main reason why banks collapsed and local fencing brought about a major reduction in sediment movement to the redds with consequent improvements in trout egg survival.

Improvements in methodology and more detailed research are required, but this study has begun to address the complex relationship between livestock farming in a catchment and the impact this is having on streams. Most importantly, however, it shows that fencing river banks can be used to improve egg survival.

ACKNOWLEDGEMENTS

Westcountry Rivers Trust.

A fenced river bank which is now stable and covered in vegetation. © Dominic Stubbing/GWCT

Scientific publications

by staff of the Game & Wildlife Conservation Trust in 2008

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Note: the publications listed as 2007 did not appear in print before the Review of 2007 went to press. For a complete record of the scientific publications by staff of the Game & Wildlife Conservation Trust, we therefore include them here.

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Financial report
for 2008

KEY POINTS

- Expenditure on charitable objects increased by 8% to £4.2 million.
- Income decreased by 7% as a result of the economic downturn.
- The overall decrease in the General Fund was restricted to 4% of income.

The summary report and financial statement for the year ended 31 December 2008, set out below and on pages 92 to 93, 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 and Game Conservancy Events Limited. They do not comprise the full statutory Trustees' report and accounts, which were approved by the Trustees on 22 April 2009 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.

Review of financial performance

The Trust's results for 2008 should be seen in the light of the global economic situation. Following the banking crisis in September, fundraising became extremely difficult and, as a result, income from both donations and events were significantly lower than in 2007, while there was not time to reduce expenditure correspondingly before the end of the year. Nevertheless the Trust managed to carry out its planned programme of research and further develop its public education role, increasing its expenditure on its charitable activities to £4.2m (64% of total expenditure).

The general fund investments produced a return of +18% which was remarkable in a year when almost all markets declined dramatically. The overall decrease in the General Fund was therefore limited to 4% of income, and the Trust continued to meet its reserves target. The endowed investments generated their target income of £85,000, but saw a decrease of 20% in the capital value, an overall return of -16%.

The trustees have reassessed the Trust's financial expectations for 2009 in the light of the continuing economic downturn. While we are cautious about the prospects for fundraising, we remain confident that the Trust's financial security can be preserved without compromising its charitable activities.

Plans for future periods

A new five year business plan was prepared in March 2008. 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 and to make us a more relevant organisation to a broader range of stakeholders.

Those continue to be our aims and we will implement the Business Plan in the light of the change in economic circumstances. Our research and policy initiatives will look at how to deliver effective wildlife conservation alongside economic land use and in the light of the new challenges of food security and climate change. Our emphasis on practical conservation in a working countryside makes our work even more relevant as these challenges unfold.

M H Hudson
Chairman of the Trustees

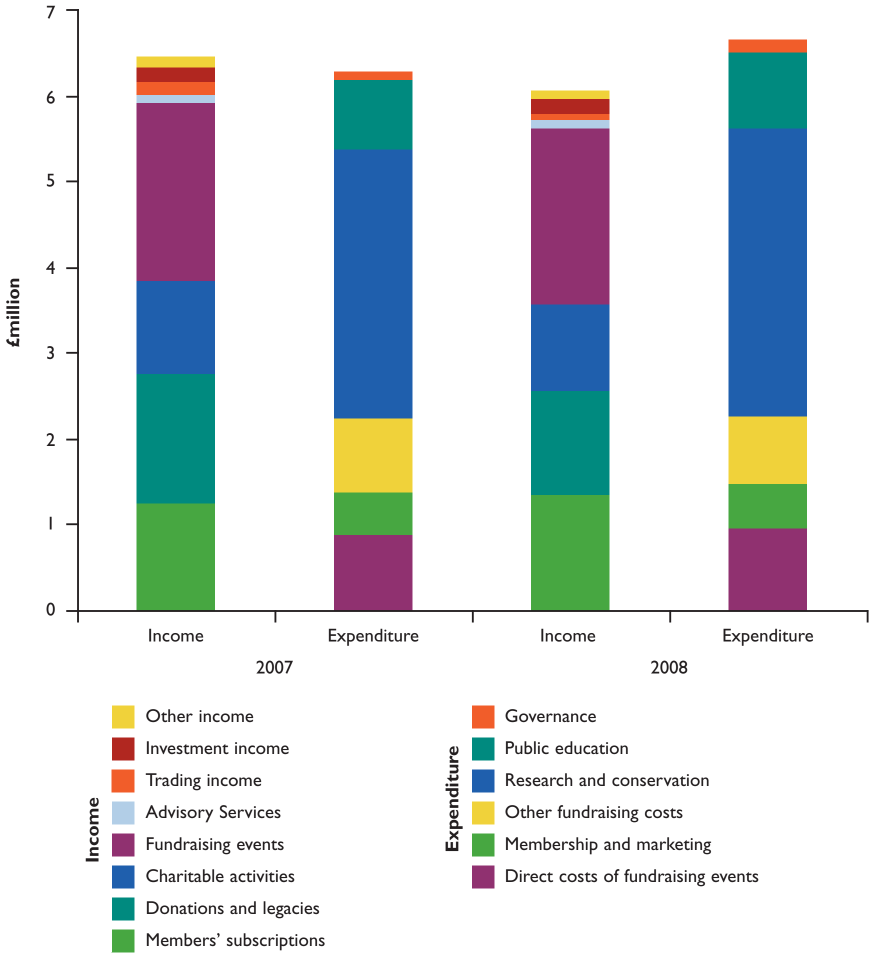

Figure 1

Incoming and outgoing resources in 2008 (and 2007) 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 2008 which is set out on pages 92 and 93.

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 2008 and complies with the applicable requirements of Section 427 of the Companies Act 2006 and the regulations made thereunder.

FLETCHER & PARTNERS
Chartered Accountants and Registered Auditors
Salisbury, 30 April 2009

Consolidated

Statement of financial activities

	General Fund £	Designated Funds £	Restricted Funds £	Endowed Funds £	**Total 2008 £**	Total 2007 £
INCOME AND EXPENDITURE						
INCOMING RESOURCES						
Incoming resources from generated funds						
Voluntary income						
Members' subscriptions	1,351,299	-	4,064	-	**1,355,363**	1,267,645
Donations and legacies	674,516	-	530,517	-	**1,205,033**	1,498,832
	2,025,815	-	534,581	-	**2,560,396**	2,766,477
Activities for generating funds						
Fundraising events	2,025,775	-	5,174	-	**2,030,949**	2,053,559
Advisory Service	97,146	-	-	-	**97,146**	119,385
Trading income	94,485	-	-	-	**94,485**	143,381
Investment income	43,071	-	110,632	-	**153,703**	172,283
Charitable activities	150,319	-	871,030	-	**1,021,349**	1,085,259
Other income	101,491	-	-	-	**101,491**	112,855
TOTAL INCOMING RESOURCES	4,538,102	-	1,521,417	-	**6,059,519**	6,453,199
RESOURCES EXPENDED						
Costs of generating funds						
Direct costs of fundraising events	955,660	-	-	-	**955,660**	898,445
Membership and marketing	516,064	-	-	-	**516,064**	491,106
Other fundraising costs	794,868	-	-	-	**794,868**	847,141
	2,266,592	-	-	-	**2,266,592**	2,236,692
Activities in furtherance of the charity's objects						
Research - Lowlands	1,131,866	-	611,176	-	**1,743,042**	1,762,178
Research - Uplands	452,662	-	401,122	-	**853,784**	711,461
Research - ARET	106,494	-	518,620	-	**625,114**	553,057
	1,691,022	-	1,530,918	-	**3,221,940**	3,026,696
Conservation	93,432	-	42,567	-	**135,999**	110,091
Public education	771,823	-	113,810	-	**885,633**	806,185
	2,556,277	-	1,687,295	-	**4,243,572**	3,942,972
Governance	103,107	33,851	-	-	**136,958**	110,227
TOTAL RESOURCES EXPENDED	4,925,976	33,851	1,687,295	-	**6,647,122**	6,289,891
NET INCOMING/(OUTGOING) RESOURCES	(387,874)	(33,851)	(165,878)	-	**(587,603)**	163,308
OTHER RECOGNISED GAINS AND LOSSES						
Realised gains/(losses) on investments	71,732	-	-	1,215	**72,947**	2,166
Unrealised gains/(losses) on investments	144,284	-	-	(464,149)	**(319,865)**	(21,365)
NET MOVEMENT IN FUNDS	(171,858)	(33,851)	(165,878)	(462,934)	**(834,521)**	144,109
BALANCES AT 1 JANUARY	2,488,994	227,737	673,327	4,541,953	**7,932,011**	7,787,902
BALANCES AT 31 DECEMBER	£2,317,136	£193,886	£507,449	£4,079,019	**£7,097,490**	£7,932,011

Consolidated

Balance sheet

		2008		2007
	£	£	£	£
FIXED ASSETS				
Tangible assets		3,216,364		2,991,422
Investments		3,284,470		3,744,028
		6,500,834		6,735,450
CURRENT ASSETS				
Stock	196,773		198,223	
Debtors	922,588		1,053,860	
Cash at bank and in hand	370,205		868,849	
	1,489,566		2,120,932	
CREDITORS:				
Amounts falling due within one year	566,068		622,564	
NET CURRENT ASSETS		923,498		1,498,368
TOTAL ASSETS LESS CURRENT LIABILITIES		7,424,332		8,233,818
CREDITORS:				
Amounts falling due after more than one year		326,842		301,807
NET ASSETS		£7,097,490		£7,932,011
Representing:				
CAPITAL FUNDS				
Endowment funds		4,079,019		4,541,953
INCOME FUNDS				
Restricted funds		507,449		673,327
Unrestricted funds:				
Designated funds	193,886		227,737	
Revaluation reserve	446,695		344,683	
General fund	1,914,816		2,265,149	
Non-charitable trading fund	(44,375)		(120,838)	
		2,511,022		2,716,731
TOTAL FUNDS		£7,097,490		£7,932,011

Approved by the Trustees on 22 April 2009 and signed on their behalf

M H HUDSON

Chairman of the Trustees

Staff

of the Game & Wildlife Conservation Trust
in 2008

CHIEF EXECUTIVE	Teresa Dent BSc, ARAgS
Personal Assistant	Wendy Smith
Head of Finance	Alan Johnson ACMA *(until February);* James McDonald ACMA *(from March)*
Finance Assistant - Trust	Stephanie Slapper
Finance Assistant - Limited	Lin Dance
Accounts Clerk (p/t)	Sharon Duggan
Head of Administration & Personnel	Ian Collins MCIPD, BA
Administration & Personnel Assistant (p/t)	Jayne Cheney
Receptionist/Secretary	Joanne Hilton
Head Groundsman	Craig Morris
Headquarters Cleaner (p/t)	Rosemary Davis
Headquarters Janitor (p/t)	Chris Johnson
Head of Information Technology	James Long BSc
IT Assistant	Caroline Townend *(from August)*
DIRECTOR OF POLICY AND PUBLIC AFFAIRS	Stephen Tapper BSc, PhD
Head of Media	Morag Walker MCIPR
Publications Officer	Louise Shervington
PR Assistant (p/t)	Jane Bushnell *(from January)*
DIRECTOR OF RESEARCH	Nick Sotherton BSc, PhD
Secretary (p/t)	Lynn Field
Head of Fisheries Research	Dylan Roberts BSc
Fisheries Biologist	Dominic Stubbing HND, MIFM
Fisheries Research Scientist	Ravi Chatterji BSc, MSc, PhD *(until April)*
Fisheries Biologist	Dean Sandford BSc
Research Assistants	Caitlin Pearson; Michelle Phillips *(July-August)*
Head of Lowland Gamebird Research	Rufus Sage BSc, MSc, PhD
Ecologist - Pheasants, Wildlife (p/t)	Maureen Woodburn BSc, MSc, PhD
Senior Ecologist - Partridges, Pheasants	Roger Draycott HND, MSc, PhD
Senior Scientist - Pheasants, Woodcock	Andrew Hoodless BSc, PhD
Project Ecologist - Energy Crop Studies	Mark Cunningham BSc, MSc *(until December)*
Bird Surveyors	Chris LeClare *(April-July);* Sue Wilson *(April-August)*
PhD Student *(Imperial College, London)* - pheasant chick foraging	Gwen Hitchcock BSc
PhD Student *(University of Exeter)* - antioxidants in pheasant feeds	Josie Orledge BSc
DPhil Student *(University of Oxford)* - woodcock migration	Adele Powell BSc, MSc *(from April)*
MSc Student *(University of Reading)* - lapwings	Annalea Beard BSc
MSc Student *(University of Reading)* - lapwings	Vicky Buckle BSc
MSc Student *(University College, London)* - pheasant releasing & inverts	Naomi Collingham BSc
MSc Student *(University of Southampton)* - pheasant releasing & inverts	Samantha Bull BSc
Placement Student - *(University of Plymouth)*	Nia Denman *(until July)*
Placement Student - *(Writtle College)*	Alex Keeble *(August-December)*
Placement Student - *(University of Bath)*	Matt Cooke *(from December)*
Placement Student - *(University of West of England)*	Sammy Veater *(from September)*
Senior Scientist - Scottish Lowland Research	David Parish BSc, PhD
PhD Student *(University of Dundee)* - population genetics of sawflies	Nicki Cook BSc
Head of Wildlife Disease & Epidemiology	Chris Davis BVM&S, MRCVS
Rearing Field Technician	Matt Ford
Rearing Field Assistants	Matthew Bird *(March-September);* Matthew Walker *(June)*
Head of Predation Control Studies	Jonathan Reynolds BSc, PhD
Research Assistant	Mike Short HND
Research Assistant	Thomas Porteus BSc, MSc
Research Assistant	Suzanne Richardson BSc, MSc
Research Assistant	Ben Rodgers BSc
Research Assistant	Owain Rodgers
Head of Entomology Farmland Ecology	John Holland BSc, MSc, PhD
Post-Doctoral Senior Scientist - Entomologist	Barbara Smith BSc, PhD
Senior Entomologist	Steve Moreby BSc, MPhil
Entomologist	Sue Southway BA
Ecologist	Tom Birkett BSc, PgC
Ecologist	John Simper BSc, MSc
PhD Student *(Imperial College, London)* - insect dispersal	Heather Oaten BSc, MSc
PhD Student *(University of Stirling)* - bumblebees	Gillian Lye BSc
PhD Student *(University of Cardiff)* - predatory insects	Jeff Davey BSc
Placement Student *(University of Plymouth)*	Charlotte Harris *(until August)*
Placement Student *(University of Exeter)*	Heather Gurd *(July-August)*
MSc Student *(University of Southampton)* - re-bugging the system	Louise Meylan *(from May)*
Director of Upland Research	David Baines BSc, PhD
Office Manager, The Gillett	Julia Hopkins
Black Grouse Recovery Officer	Phil Warren BSc, PhD
Research Assistant - Black Grouse	Michael Richardson BSc
Black Grouse Recovery Assistant	Kim McEwen (née Anderton) MSc *(until December)*
Senior Scientist - Upland Predation Experiment	Kathy Fletcher BSc, MSc, PhD *(until July)*
Research Assistant - Upland Predation Experiment	Robin Foster HND *(until January);* Catherine Barlow *(March-August)*
Seasonal Research Assistants - Upland Predation Experiment	Nina O'Hanlon BSc, Karen Ramoo BSc, MSc, Andrew Cristinacce BSc *(March-July)*
Placement Student *(Harper Adams University College)*	Thomas Hornby *(until July)*
Placement Student *(Kings College, University of London)*	Liam Stokes *(until July)*

Placement Student *(University of East Anglia)*	Richard Francksen *(from August)*
Placement Student *(University of York)*	Joanna Greetham *(from August)*
Head Gamekeeper - Upland Predation Experiment	Craig Jones
Assistant Gamekeeper - Upland Predation Experiment	Paul Bell *(until May)*
Assistant Gamekeeper - Upland Predation Experiment	Tony Jenkins *(until May)*
Assistant Gamekeeper - Upland Predation Experiment	Joe Pattison *(until January)*
Gamekeeper - Upland Predation Experiment	Pam Staley *(February-August)*
Beatkeeper - Upland Predation Experiment	Phil Chapman *(from July)*
Senior Scientist - North of England Grouse Research	David Newborn HND
Policy Officer - Scotland	Adam Smith BSc, MSc, DPhil *(from August)*
Senior Scientist - Scottish Uplands Research	Adam Smith BSc, MSc, DPhil *(until July)* Kathy Fletcher BSc, MSc, PhD *(from Aug)*
Research Assistant - Scottish Upland Research	David Howarth
Research Assistant - Scottish Upland Research	Allan MacLeod BSc
Placement Student *(Harper Adams University College)*	Ross Hancocks *(until August)*
Placement Student *(University of Leeds)*	Susannah Harrison *(until August)*
Placement Student *(University of Plymouth)*	Robert Dunn *(from September)*
Placement Student *(University of Durham)*	John Woods *(from September)*
Research Assistant - Scottish Uplands	Lois Canham MSc, PhD *(March-August)*
Research Ecologist - Langholm	Damian Bubb BSc, PhD *(from April)*
Project Scientist - Angus Glens	Laura Taylor BSc *(from January)*
Head of the Allerton Project	Alastair Leake BSc (Hons), MBPR (Agric), PhD, ARAgS, MIAgM, CEnv
Secretary (p/t)	Natalie Augusztinyi
Head of Research for the Allerton Project	Chris Stoate BA, PhD
Ecologist	John Szczur BSc
PhD Student *(University of Nottingham)* - game as food	Graham Riminton BSc
PhD Student *(University of Stirling)* - birds and bees	Jenny Jacobs BSc
PhD Student *(University of Reading)* - songbirds and farmland	Patrick White BSc
MSc Student *(University College, London)* - Eye Brook historical land use	Pippa King BSc *(May-August)*
Placement Student *(Unviersity of Northampton)*	Celia Mitchell *(August-September)*
Game Manager - Royston	Malcolm Brockless
Farm Manager	Philip Jarvis HND
Farm Assistant	Michael Berg
Placement Student *(Harper Adams University College)*	Oliver Barter *(until July)*
Placement Student *(Harper Adams University College)*	Ben Hazell *(from September)*

DEPUTY DIRECTOR OF RESEARCH	Nicholas Aebischer Lic ès Sc Math, PhD
Secretary & Librarian	Gillian Gooderham
Assistant Biometrician	Peter Davey BSc
Grey Partridge Ecologist	Francis Buner Dipl Biol, Cand Dr Phil II
DPhil Student *(University of Oxford)* - Released grey partridges	Elina Rantanen MSc
Placement Student *(Sparsholt College)*	Megan Cameron
Head of Geographical Information Systems	Julie Ewald BS, MS, PhD
Partridge Count Scheme Co-ordinator	Neville Kingdon BSc
Research Assistant - GIS	Vikki Kinrade BSc, MSc *(until December)*
Placement Student *(John Moores, Liverpool)*	James Connell *(until August)*
Placement Student *(University of Bath)*	Marc Edwards *(until August)*
Placement Student *(John Moores, Liverpool)*	Laura Brown *(from September)*
Placement Student *(University of Plymouth)*	Hayley New *(from September)*

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Co-ordinator Advisory Services (p/t)	Lynda Ferguson
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Field Officer – Farmland Ecology	Peter Thompson DipCM, MRPPA (Agric)
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Regional Advisor - Central & Southern Scotland & Northern England	Hugo Straker NDA[2]
Regional Advisor - Eastern & Northern England (p/t)	Martin Tickler MRAC
Regional Advisor - North East (p/t)	Henrietta Appleton BA, MSc *(from October)*

[1] Ian McCall is also Regional Advisor for Tayside, Fife, Northern Scotland & Ireland; [2] Hugo Straker is also Development Officer for Central and Southern Scotland; [3] Ian Lindsay is also Regional Advisor - Wales, Midlands; [4] Mike Swan is also Regional Advisor for the South of England.

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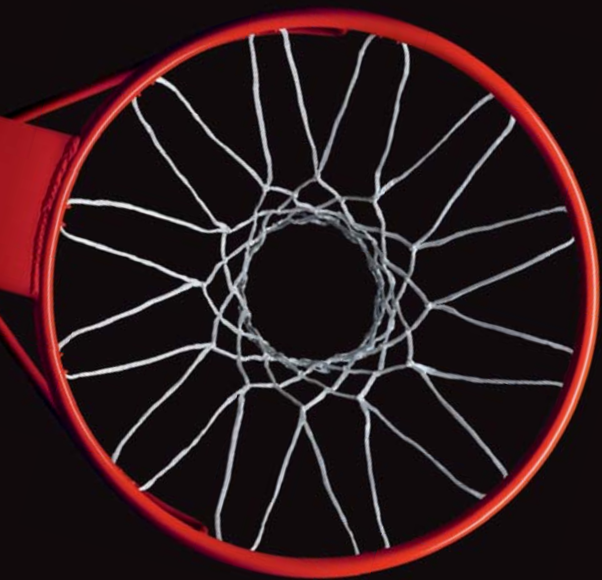

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