Review
of 2007

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

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Review of 2007

Issue 39

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

Common blue damselfly (© Laurie Campbell)

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as at 1 January 2008

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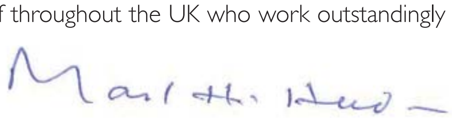
Chairman's report

It is not often one changes one's name, so the decision to become the Game & Wildlife Conservation Trust from October 2007 was not taken lightly. We wanted our name to reflect the breadth of our work better, and we hope it makes the link between game and wildlife showing that game management is truly part of nature conservation.

People often think that because we are a registered charity we can't get involved in politics. This is untrue, and we can certainly lobby on behalf of our charitable objects. For example, last year for the first time we attended all three main party conferences. Joining forces with the Country Landowners & Business Association and Campaign for the Protection of Rural England, we staged fringe meetings to discuss farmland conservation and the loss of set-aside. It is particularly important that Defra understands our concerns during its negotiations with the EU on the Common Agricultural Policy – the so called "health-check". We also held several functions at Westminster for MPs and Peers on a similar theme, as well championing the cause of gamekeeping as an enhancer of wildlife.

We work closely with other conservation groups and agencies to resolve differences where we have them. No more so than over the difficult issue of hen harriers and grouse. We are part of the Environment Council's conflict resolution discussions and, with the RSPB, Scottish Natural Heritage, Natural England and the Buccleuch Estates, are joint partners in the Langholm Moor Demonstration Project, which Scotland's Minister for the Environment, Michael Russell, launched in September. This project includes a pivotal test of diversionary feeding to reduce harrier predation on grouse.

No charity can operate without supporters and we are lucky to have so many members, donors, sponsors, trustees and volunteer fundraisers in every county. My heartfelt thanks to all. I also wish to thank Teresa Dent and her team of directors and staff throughout the UK who work outstandingly hard towards the success of the Trust.



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

Chief Executive's report

KEY ACHIEVEMENTS

- Grey partridge conference, *Back from the brink,* attracts 300 delegates.
- We increased public awareness through seminars in Westminster and TV coverage.

Teresa Dent

Above: Our conference covered habitat needs for the grey partridge. © Neville Kingdon/GWCT

One of my highlights of 2007 was the grey partridge conference *Back from the brink* in October. This celebrated both the success of our grey partridge recovery project at Royston, and the 30 years of grey partridge research. It was a day to remember and it epitomised everything that is best about the Game & Wildlife Conservation Trust, together with the conservation work done by farmers, landowners and the shooting fraternity.

Nearly 300 people attended from the UK and Europe and the conference talks took us on a fascinating journey from our very early research into the causes of grey partridge decline in the late 1950s up to the present day. That first step was a seminal piece of work which revealed why so many farmland birds (not just grey partridges) were declining. The impact of modern herbicides, fungicides and insecticides on the supply of chick-food insects was exposed for the first time. I think it is a great compliment to game conservation, and those who funded that work, that such a crucial piece of science was done by our organisation.

Our journey continued with the Salisbury Plain experiment, which was the first piece of serious science showing the importance of predator control for ground-nesting birds in the UK. This project showed that predator control improved the breeding success of grey partridges, which in turn led to an improved breeding stock. These conclusions, published in 1996, have recently been referred to by the RSPB in a report which concluded that predation can seriously reduce numbers and breeding success of many ground-nesting birds.

We then retraced the path that led to the invention of habitat prescriptions to help grey partridge such as beetle banks, conservation headlands, managed field margins, and wild bird cover crops. These now pepper farmland across the country, endorsed by Government and financed in many cases through agri-environment schemes. Why? Not because they benefit game, but because they have proven to be good for much other wildlife on farms.

There are now 2,000 farmers and land managers who have joined our grey partridge count scheme, and who are making changes that have led to grey partridge numbers increasing by some 40% on their land. In the process they have created the largest farmer-led bird monitoring scheme in Europe. They are doing more than anyone to reverse the continuing decline in grey partridge numbers.

The conference culminated in a sunny afternoon standing under a hedge watching a "fly by" above our heads of some of the 200 wild grey partridges on the study area. Certainly a masterpiece of organisation, since there were far more observers behind the hedge than there were beaters to drive the partridges.

Overall, 2007 was a busy and productive year and I am exceedingly grateful for the hard work and commitment of our staff and trustees. We continue to work hard to use our research to influence practice, policy and public awareness. Our courses and training days are now attracting many wildlife managers from nature reserves, as well as gamekeepers and farmers. In addition, we have expanded our educational programme to include lecture programmes at nearly 30 universities and colleges around the country. We hosted three major events at Westminster and had politicians and policy makers visit our projects and our demonstration farm.

Finally, we were delighted that game featured so prominently in two episodes of the BBC2 programme *The Nature of Britain* in the autumn. Many of our staff in Scotland, as well as those based in Fordingbridge and elsewhere, devoted considerable time to helping BBC producers setting-up filming opportunities and providing information for the narrative. It was certainly worthwhile.

Back from the brink (from top): Nick Sotherton, Mark Hudson, Stephen Tapper, Ian Lindsay, Ian Monks, Peter Thompson, John Hutton, Teresa Dent. © Bidwells


© Laurie Campbell

Wildlife disease and epidemiology research

KEY ACHIEVEMENTS

- Disease outbreaks brought challenges to the countryside, but impacts were kept to a local level.
- Wet weather caused disease problems for game.
- Our study of bitting finished.
- Coccidiosis work continued.

Chris Davis

2007 was a year of Foot & Mouth, Avian Influenza, Blue Tongue and the introduction of the new Animal Welfare legislation, all of which brought challenges and opportunities. Avian Influenza in East Anglia presented the biggest threat to shooting. However, the control measures seemed to work and shooting was not greatly affected. The wild bird outbreak in Dorset occurred late in the season and its impact appears to have been local. These are both stark reminders of the threat that this disease offers to shooting should it occur in the wrong place at the wrong time, and we all need to play our part by improving biosecurity. The impact of Blue Tongue on our native deer species has yet to become clear.

The wet weather caused increased parasite burdens in our stock birds and we had to struggle to contain the problems. All birds were affected, the main pathogens being gapeworms, lice and mites, with coccidiosis and even harvest mites causing problems. One batch of bought-in day-olds were infected with the epidemic tremor virus resulting in a 20% mortality in this group. This disease only affects birds under three weeks old and vigorous biosecurity prevented its spread to other susceptible birds. The surviving birds were slow to feather up, but had few subsequent problems.

WILDLIFE DISEASE AND EPIDEMIOLOGY RESEARCH IN 2007

Project title	Description	Staff	Funding source	Date
Gamebird health	*Disease prevention and control in game and wildlife*	*Chris Davis*	*Core funds, Lord Iliffe Charitable Trust, Roxton Bailey Robinson*	*1998- on-going*
Bitting study (see page 10)	*To investigate the welfare aspects of bits and specs*	*Chris Davis, David Butler*	*Defra*	*2005-2008*
Rearing field	*Provision of research facility*	*Chris Davis*	*Core funds*	*2000- on-going*
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*	*2006-2008*

Key to abbreviations:
BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering; Defra = Department for the Environment, Farming and Rural Affairs.

Our Defra-funded study on the use of bits and spectacles has now ended (see page 10). We conducted this study to gather data to inform decisions to be taken under the new Animal Welfare legislation. The final report should be available in 2008.

In co-operation with Edinburgh University, Matt Ellis did a second year of work on 'maternal allocation of resource and its impact on offspring health and fitness'. His first year's work entailed setting up a coccidiosis infection model and devising techniques for rearing birds in disease-free units. This year's work was aimed at studying the efficacy of a novel coccidiosis vaccine. Although the study has not yet finished, early indications are that the vaccine did not protect the progeny of vaccinated dams.

Below: A pheasant rearing pen used in the study.
© Dave Butler/GWCT

Effects of bits in pheasants

Right: A feather pecked, non-bitted pheasant poult.
© Dave Butler/GWCT

KEY FINDINGS

- Bits prevented feather and skin damage.
- Bits had little effect on pheasant behaviour.
- Ill-fitting bits can cause injury to the bill.

Dave Butler

Like other poultry, pheasants are prone to feather-pecking when kept in captivity. This behaviour can quickly lead to poor feather and skin condition and eventually cannibalism. To prevent feather-pecking in pheasant poults during rearing, game farmers often fit small plastic 'bits' into their beaks at approximately three weeks of age (see photograph opposite). These prevent birds from closing their beaks fully and therefore from grasping and pulling feathers from another bird. The bits are removed just before the birds are released into the wild. Despite their widespread use, the effect of these anti-feather-pecking devices on the welfare of pheasants has received little attention. The aim of this study was to examine the effect of bits on the physiology and behaviour of pheasants on game farms across England and Wales.

Between 2005 and 2007, we collected data from 18 game farms. On each farm, we randomly allocated a treatment to two identical pens, either bitted or non-bitted. Management was according to normal practice on each study site and was identical for each treatment apart from bitting.

We assessed the body, feather and skin condition of 50 pheasants fitted with leg bands in each treatment pen on the day of bitting and weekly thereafter. We also noted any abnormalities of the bill or nostrils and signs of disease. We then assessed the behaviour of bitted and non-bitted pheasants weekly.

The Body Mass Index (weight divided by tarsus length) of pheasants in the bitted and non-bitted pens did not differ in any week. In all weeks after bitting (weeks two

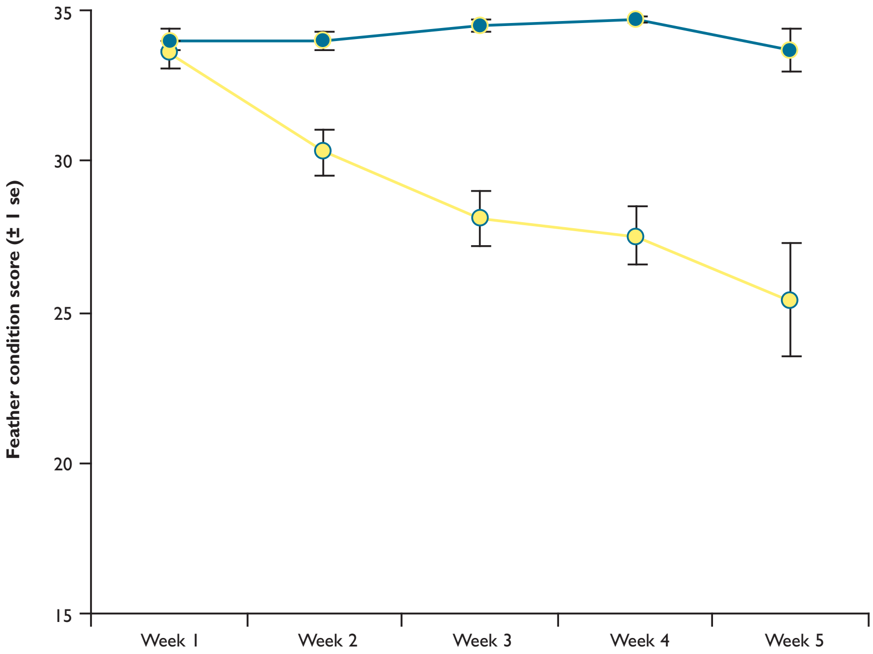


Figure 1

The mean weekly feather condition score of bitted and non-bitted pheasants. Week 1 is when birds were fitted with bits

Bitted

Non-bitted

A pheasant poult fitted with a bit. © Dave Butler/GWCT

to five), however, the feather condition of non-bitted pheasants was poorer than those fitted with bits (see Figure 1). Incidences of skin damage were also more frequent in the non-bitted pens than in the bitted pens in weeks two to five. In week five, 24% of non-bitted pheasants had skin damage compared with fewer than 1% of bitted birds. On five game farms, the non-bitted birds were bitted before the end of the trial to prevent further feather and skin damage. Bits did, however, cause inflammation of the nostrils and crossed mandibles in some birds, particularly after seven weeks of age. In the fifth week after bitting, we found that 12% of bitted birds had one of these conditions, indicating that their bills had outgrown the bits, which had begun to cause injury.

During the first week of observations, conducted only one or two hours after the bits had been fitted, bitted birds shook and scratched their heads more than non-bitted birds (see Figure 2). In all subsequent weeks, the prevalence of this behaviour in bitted birds was similar to those without bits, indicating that any initial discomfort caused by these devices persists for less than a week. We found that other behaviours, including feeding and drinking, were similar between bitted and non-bitted birds.

The results of this study suggest that bits are an important tool in preventing welfare problems caused by feather-pecking and cannibalism. Game farmers should give consideration to reducing these problems through changes wherever possible. Factors identified in the poultry industry as being stimuli for feather-pecking and cannibalism, including stocking density, light conditions and diet, should be further examined in relation to pheasants.

ACKNOWLEDGEMENTS

Many game farmers kindly allowed us to conduct these studies on their farms. Without their voluntary assistance and contributions, these studies would not have been possible. Funding was provided by Defra.

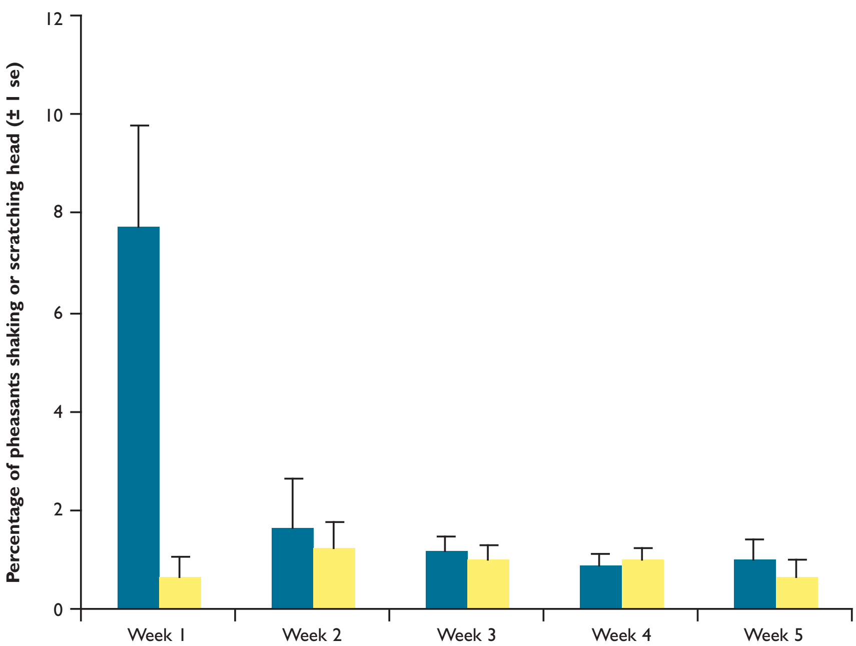


Figure 2

Mean percentage of observable bitted and non-bitted pheasants outside shaking or scratching their heads one hour after bitting (week 1) and then weekly thereafter

Bitted

Non-bitted

Summary of woodland game research

KEY ACHIEVEMENTS

- Game management improves woodland rides.
- We develop new technique for measuring woodland bird productivity.

Rufus Sage

As part of a series of studies looking at the impacts of releasing gamebirds for shooting on habitats and wildlife, in 2007 the Countryside Alliance funded a study of woodland rides. Although this is reported on fully on page 16, in a nutshell this work shows for the first time that rides in game-managed woods tend to provide better habitat for wildlife than rides in other woods.

In the summer of 2007, we undertook a study designed to assess the effectiveness of a new technique for measuring productivity of woodland birds. This work is described on page 18 and provides the basis for a study of grey squirrel predation of woodland birds planned for 2008.

Work on woodcock has involved further analysis of our breeding survey data (see page 14) and we secured funding for a new PhD study of woodcock migration and winter ecology.

We have overseen the first year of a PhD with Imperial College, London on human-imprinting gamebird chicks. The idea is to release the young birds for short periods and then recover them to see what insects they have eaten. This pioneering work is being undertaken at one of Europe's premier wild pheasant shoots at Seefeld Estate in Austria.

Annual pheasant counts

Spring counts of wild pheasants on our long-term pheasant monitoring sites revealed slightly higher numbers of breeding pheasants in 2007 than in 2006 (see Figure1),

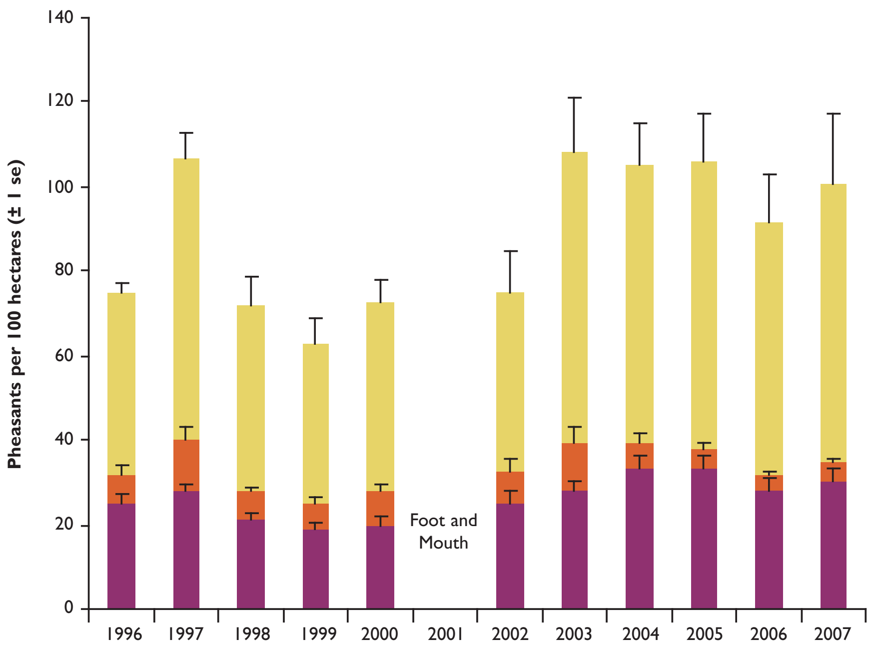
Figure 1

Spring counts of breeding pheasants on long-term monitoring sites, 1996-2007

Hens

Non-territorial cocks

Territorial cocks



which was encouraging considering that the 2006 breeding season was poor. In spring 2007, many early pheasant nests were successful and young broods made the most of the exceptionally dry warm weather in April and early May. However, persistent heavy rain in June and July resulted in significant losses of nests and young broods. Several sites also reported that many adult pheasants succumbed to the wet weather too. Consequently, overall breeding success was poor, with an average young-to-old ratio of 1.3:1, the same as in 2006. This resulted in disappointing numbers of birds counted on the ground in August and September with average figures of only 35 adults and 45 young per 100 hectares. As a result, wild pheasant shoots reduced the number of planned shoot days to maintain breeding stocks.

LOWLAND GAME RESEARCH IN 2007

Project title	Description	Staff	Funding source	Date
Pheasant population studies (see page 12)	*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, Pam Marshall-Ball, Maureen Woodburn*	*RELU*	*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*
Releasing and woodland rides survey (see page 16)	*Comparing woodland rides with and without game management*	*Rufus Sage, Andrew Hoodless, Roger Draycott*	*Countryside Alliance*	*2007*
Grey squirrels and woodland birds	*Does grey squirrel control increase productivity in woodland birds?*	*Rufus Sage, Andrew Hoodless*	*European Squirrel Initiative*	*2007-2008*
Origins of wintering woodcock	*Pilot study of use of stable isotopes to study woodcock migration*	*Andrew Hoodless, Newcastle University*	*Private Donors*	*2006-2007*
Woodcock monitoring (see page 14)	*Examination of annual variation in breeding woodcock abundance*	*Andrew Hoodless, with BTO*	*Shooting Times Woodcock Club*	*2003- on-going*
Testing the effects of unharvested crops on song-bird populations (see page 62)	*Large-scale field experiment investigating the impact of winter feeding on songbird populations*	*Dave Parish, with RSPB Scotland*	*SEERAD*	*2004-2008*
Monitoring SEERAD's agri-environment schemes	*Comparing biodiversity on in- and out-scheme farms across Scotland*	*Dave Parish, various collaborators*	*SEERAD*	*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, SEERAD*	*2008-2010*
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*	*2006-2008*
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: Dispersal in released pheasants	*Radio-tracking of released pheasants – mortality and dispersal in relation to density and habitat quality*	*Clare Turner Supervisors: Rufus Sage, Dr Simon Leather/Imperial College*	*Research Funding Appeal*	*2001-2007*
PhD: Lees Court Estate Project	*To quantify 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, Canterbury*	*John Swire Charitable Trust, Lees Court Estate, Holland & Holland*	*2000-2007*
PhD: Bobwhite quail	*To investigate the ecology of bobwhite quail chicks*	*David Butler Supervisors: Rufus Sage, Prof John Carroll/ University of Georgia, Dr Simon Dowell/ Liverpool John Moores University, Dr Bill Palmer/Tall Timbers Research Station*	*Tall Timbers Research Station*	*2005-2007*

Key to abbreviations:
BBSRC = Biotechnology and Biological Sciences Research Council; CASE = Co-operative Awards in Science & Engineering; DTI = Department of Trade and Industry; NERC = Natural Environment Research Council; RELU = Rural Economy and Land Use; SAC = Scottish Agricultural Colleges; SEERAD = Scottish Executive Environment and Rural Affairs Department; SNH = Scottish Natural Heritage.

How many woodcock?

The cryptic camouflage of woodcock make them particularly challenging to study.
© Louise Shervington/GWCT

KEY FINDINGS

- The breeding woodcock population in Britain was estimated by a new, species-specific method at 78,000 males, significantly greater than the 5,000-12,500 pairs estimated by general bird surveys.
- There were substantial differences in densities between regions and woodland types.

Andrew Hoodless

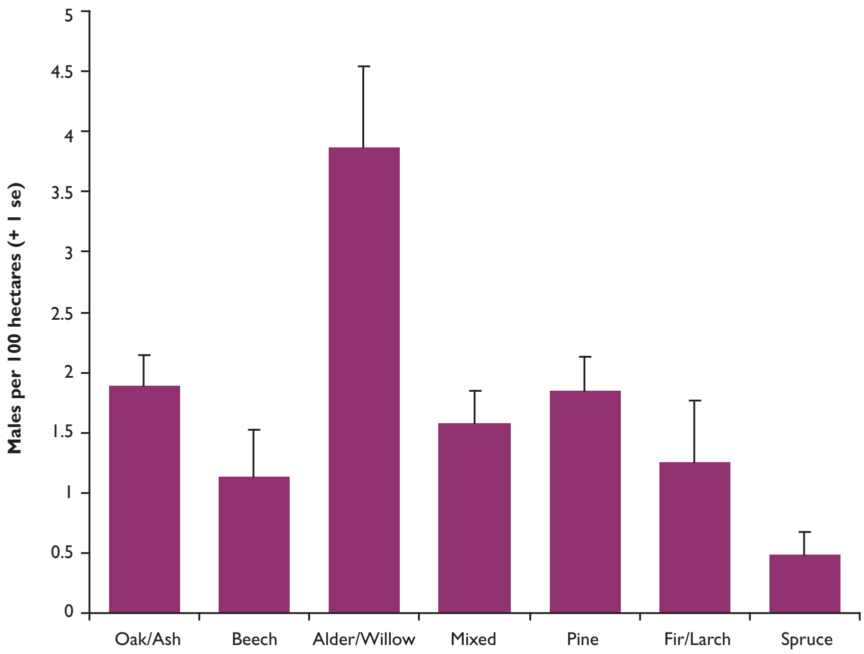
Owing to its cryptic plumage, secretive behaviour and nocturnal habits, the woodcock is a difficult species to survey. The breeding population size is currently estimated at 5,000-12,500 'pairs', based upon sightings made during the course of general bird surveys. Counts of passes by roding woodcock (males in display flight) provide the only feasible method for any dedicated large-scale survey, but their interpretation has been hindered by the fact that they represent multiple registrations of an unknown number of males. Recently, we have demonstrated a relationship between counts of passes and numbers of males and hence the validity of roding woodcock counts for population monitoring (see *Review of 2003*). Here we update the preliminary results from our 2003 breeding survey (see *Review of 2004*), providing revised population estimates and examining woodcock densities in further detail.

The survey involved volunteer observers making three counts of woodcock passes in the largest wood within 807 randomly selected one-kilometre squares that were stratified by 11 regions and four wood size classes. The number of individual male woodcock at each survey site was estimated from the maximum number of registrations using our calibration equation. The estimated number of males at each site was assumed to be equivalent to the density in the one-kilometre survey square, because the average roding area of woodcock is known to be 88 hectares.

Woodcock presence varied between regions and wood size classes, with higher occurrence in larger woods. Breeding woodcock were more widely distributed in Scotland and northern England than in southern England and Wales. Weighting by the availability of one-kilometre squares within each region-wood size class gave a national estimate of 35% presence in squares containing at least 10 hectares of woodland. Average woodcock density in occupied woods was 2.76 males per 100 hectares, but there was large regional variation, ranging from 0.87 males per 100 hectares in Wales to 4.10 males per 100 hectares in East Anglia. Perhaps not surprisingly given that we employed a dedicated survey method, our estimate of the national woodcock

Figure 1

Male woodcock density in relation to woodland stand type



population at 78,000 males (95% confidence interval 62,000-96,000) is far higher than the general bird survey estimate. Our survey showed that Scotland (39,000 males, 95% confidence interval 24,000-57,000) and England (37,000 males, 95% confidence interval 30,000-44,000) support similar numbers of woodcock, with only 2,000 males (95% confidence interval 1,000-3,000) in Wales.

Several aggregations of breeding woodcock were apparent in large forests, such as Kielder Forest, Dalby and Newtondale Forests, Thetford Forest, Forest of Dean and New Forest, and heavily wooded regions, such as Derbyshire and Nottinghamshire, West Sussex and north Hampshire. These appear to be important strongholds for breeding woodcock and ensuring appropriate management of these forests will be an important step towards securing breeding woodcock populations in the future.

Our overall estimate of 35% woodcock presence suggests that there remains much potential woodland habitat that currently supports no woodcock. Absences from woods larger than 50 hectares, in particular, suggest unsuitable habitat structure or local population decline. Woodland occupancy in Britain is comparable to that in France (20-30%) and Switzerland (19-31%), but in Russia, which is believed to be the main stronghold for the species in Europe, woodcock are present in 85-95% of forests.

By classifying records of dominant trees and vegetation at count sites into stand types, we were able to examine woodcock densities in relation to different habitats. This revealed that, in conifer forests, stands of Scots/Corsican pine supported higher densities than those of Douglas fir/larches or Norway/Sitka spruce, whereas among deciduous woods, alder/willow had higher densities than oak/ash or beech (see Figure 1). Overall alder/willow woodland was the best habitat, supporting woodcock densities eight times higher than in spruce, the worst habitat. It should be borne in mind that this information relates to displaying males and does not necessarily reflect where females choose to nest, although males are thought to rode most intensively over the best nesting habitats. These results are in broad agreement with our earlier intensive studies of radio-tagged woodcock, which showed that stand use was related to habitat structure and earthworm availability.

ACKNOWLEDGEMENTS

We are grateful to the volunteers who participated in the survey and to the BTO Regional Representatives who organised the survey coverage. This work was funded by the Shooting Times Woodcock Club and an anonymous English charitable trust.

A wet woodland, typical of the type that woodcock favour. © Andrew Hoodless/GWCT

Pheasant releasing and woodland rides

A brimstone butterfly, a species often found in woodland rides. © Andrew Hoodless/GWCT

KEY FINDINGS

- Rides comprised a higher proportion of woodland area in game woods (13%) than non-game woods (8%).
- Ride canopy closure was 1.3 times greater in non-game woods.
- Erosion caused by vehicles was higher in game woods, but that caused by horse riding and footpaths was higher in non-game woods.
- Arable weeds and plants of high fertility and disturbed soil were more common along rides in game woods.

Andrew Hoodless
Roger Draycott

Rides typically comprise only a small part of most woods, but their value to wildlife can be disproportionate to the area that they occupy. Rides are often the only open areas for light-loving species and they tend to support different plants and animals from the rest of the wood. They are important in game management for access to release pens, feeding pheasants and standing the guns on shoot days. We sought to determine whether the density and structure of rides differed between woods with and without pheasant releasing. We also sought to examine any differences in the abundance and composition of the ride flora and butterflies.

We compared oak- and ash-dominant woods that contained pheasant release pens and had winter supplementary feeding with woods that had no recent history of game management (within the last 25 years). On the Hampshire and South Wessex Downs, we surveyed 36 game woods and 37 non-game woods and in East Anglia we

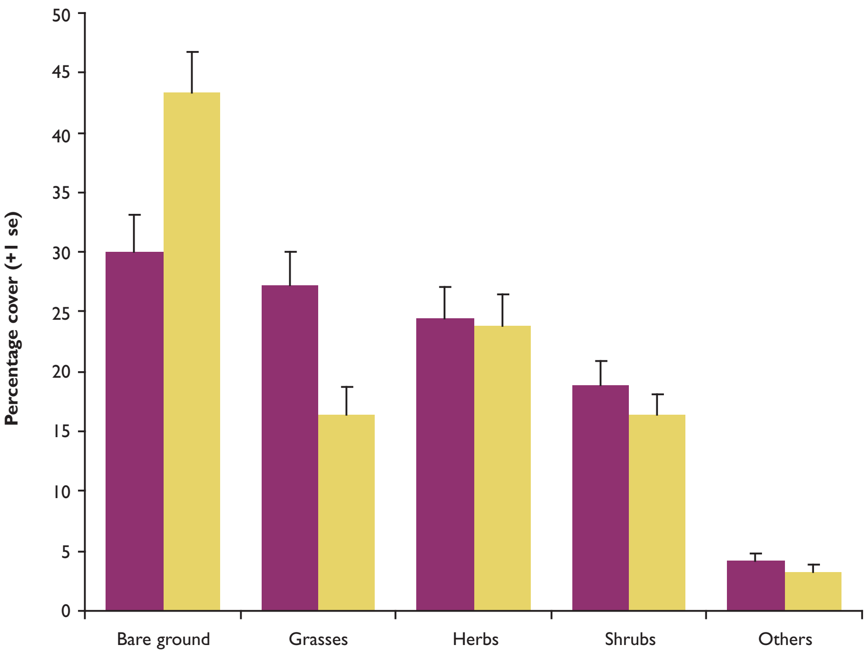
Figure 1

Comparison of bare ground and vegetation cover in rides within game and non-game woods on the Hampshire and South Wessex Downs

Game woods

Non-game woods

The 'others' category comprises bracken, ferns, rushes and sedges.



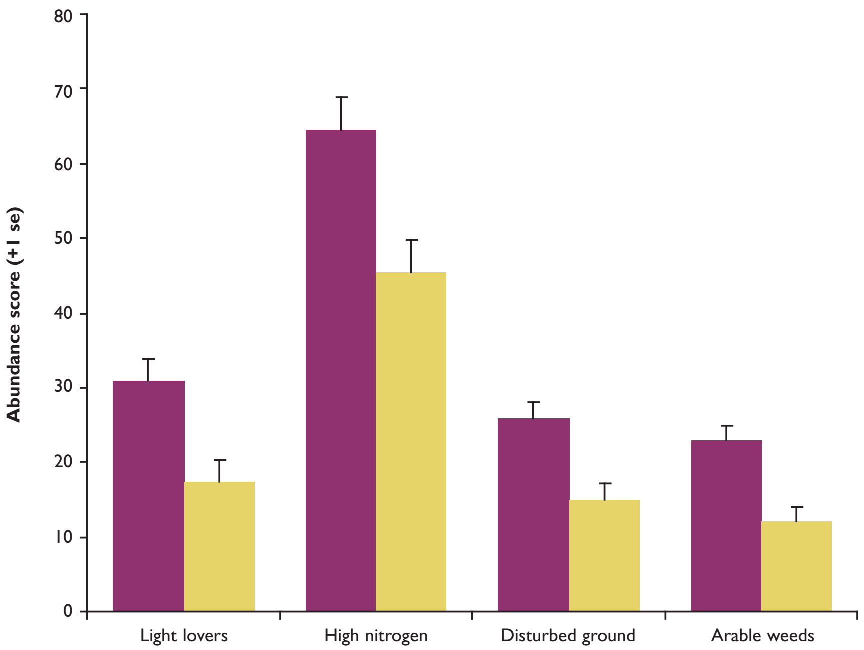


Figure 2

Comparison of herb species abundance in rides within game and non-game woods on the Hampshire and South Wessex Downs

Game woods

Non-game woods

The abundance score is the total number of occurrences of all species within the group in 12 four-square-metre quadrats along the centre of the ride. A few species are common to more than one grouping.

surveyed 34 game and 32 non-game woods. During May and June we measured the length and width of all the rides in each wood (or within a 30-hectare plot for woods larger than this), conducted a butterfly survey of all rides and recorded plant species occurrence in 36 quadrats along the widest ride. In July and August, we surveyed butterflies and recorded the occurrence and structure of shrubs along the widest ride.

We found no statistical difference in the length of ride per hectare of woodland between game and non-game woods (134 ± 19 metres and 104 ± 12 metres respectively). On average, however, rides were wider in game woods than non-game woods (10.5 ± 0.6 metres and 8.8 ± 0.4 metres respectively). Consequently, rides comprised a higher proportion of the woodland area in game woods (12.6 ± 1.5%) than non-game woods (8.4 ± 0.9%). Rides in game woods were more open, with average canopy closure scores on a scale from 0 (open) to 1 (closed) of 0.45 ± 0.03 in game woods and 0.57 ± 0.03 in non-game woods. We found no overall difference in ride erosion scores between game and non-game woods, but disturbance by vehicles was 1.6 times higher in game woods, whereas erosion caused by horse riding and footpaths were 3.0 and 8.9 times higher respectively in non-game woods.

Further analyses of the large set of vegetation data are required, but here we present some preliminary findings based on information from the Hampshire and South Wessex Downs. Comparison of vegetation cover in rides revealed similar herb and shrub cover in game and non-game woods, but rides in game woods had 0.3 times less bare ground and 1.7 times more grass cover than those in non-game woods (see Figure 1). The number of herb species per four-square-metre quadrat was higher in game woods (29 ± 1) than non-game woods (24 ± 1). This was the result of slightly more characteristic woodland species, but also a greater abundance of species preferring high fertility and disturbed soil in game woods (see Figure 2). Abundance ranks of cleavers and docks were similar in game and non-game woods, but nettles and chickweed were more abundant in game woods. In some cases it was apparent that disturbance resulting from ride management had led to a temporary flush of docks and thistles. However, wheat and barley volunteers and a few arable weeds, such as mayweed, regularly featured in rides in game woods, whereas arable weeds were only very occasional in non-game woods.

Bramble and hazel were the two most common shrubs in rides in both game and non-game woods. Rides in non-game woods typically supported a greater number of shrub species (10 ± 0.4) than those in game woods (7 ± 0.4), but shrub abundance was very similar in both sets of woods. We found no differences in butterfly abundance or species richness between game and non-game woods in either spring or summer.

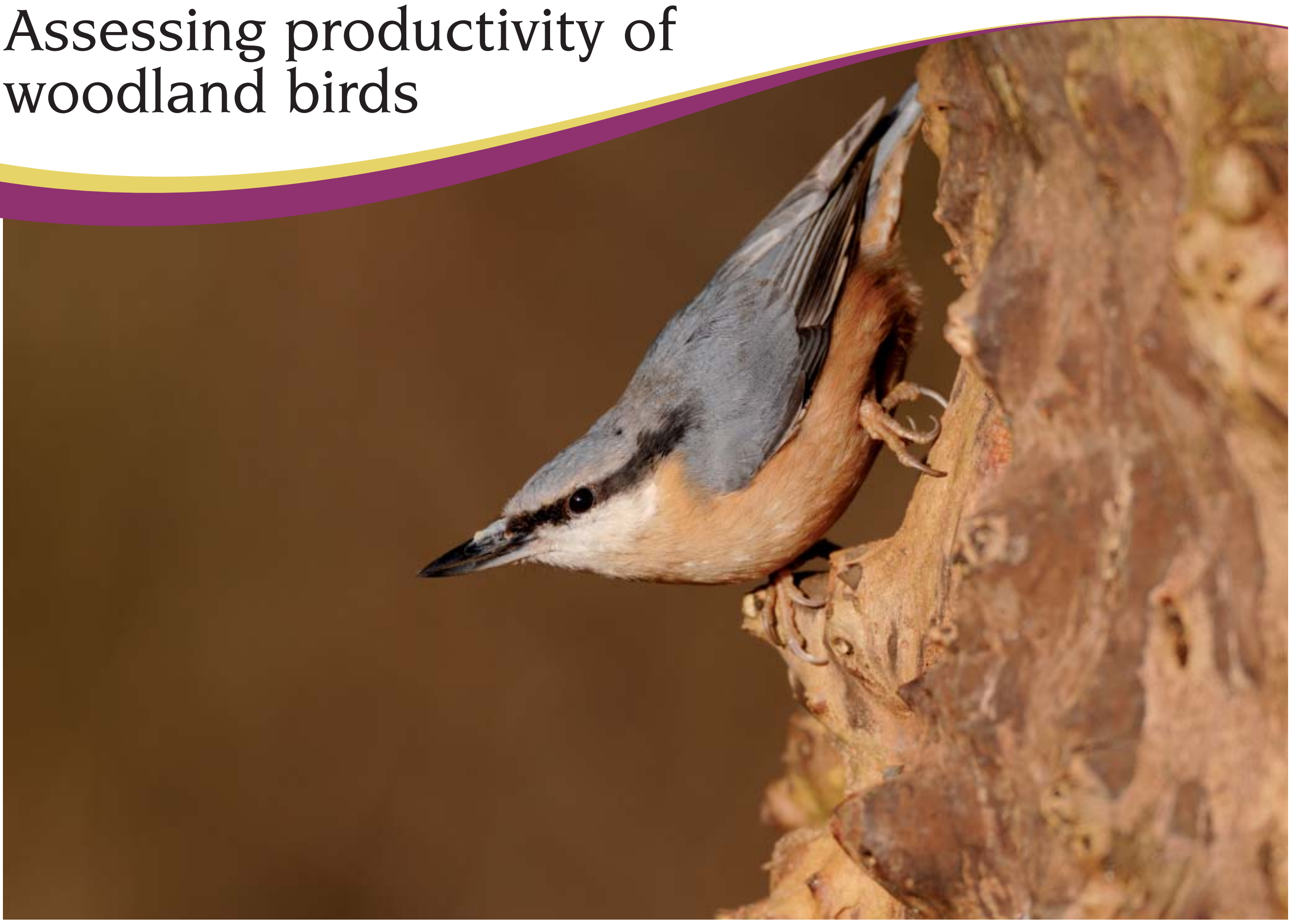
There was large variation in ride structure and species composition within our samples of both game and non-game woods. On average, however, it seems that rides in game woods are kept more open than those in non-game woods, but that driving into woods and feeding pheasants along rides results in the introduction of certain arable weeds. Incorporation of information from East Anglia, where wheat and barley volunteers were less common, and analyses including habitat management effects will provide a more complete picture.

Rides in game woods appear to be kept more open than rides in non-game woods.
© Andrew Hoodless/GWCT

ACKNOWLEDGEMENTS

This study was funded by the Countryside Alliance. We are grateful to all the landowners who granted access to their woods.

Assessing productivity of woodland birds



The nuthatch is one of the species for which we hope to use our new technique for testing productivity. © Laurie Campbell

The grey squirrel was introduced to England from America in the early part of the 20th century. It now occupies most of England, Wales and Ireland and is making inroads into Scotland and, on the continent, in Italy too. Wherever they go grey squirrels displace native red squirrels. Grey squirrels are much larger and live at higher densities than reds. They can kill trees by stripping bark so they are sometimes controlled by foresters.

TABLE 1

19 bird species recorded in all six study woods

Species	Pairs per 15 ha	Br:Pr ratio	2-visit prob	Power analysis
Blackbird	8.7	0.65	0.41	12
Blackcap	10.0	0.52	0.38	17
Bullfinch	1.7	0.50	0.75	64
Blue tit	16.5	0.73	0.64	7
Chiffchaff	8.7	0.54	0.36	<5
Chaffinch	11.8	0.60	0.43	8
Coal tit	3.7	0.88	0.45	8
Dunnock	3.0	0.73	0.35	22
Goldcrest	5.7	0.57	0.68	28
Greater spotted woodpecker	2.5	0.76	0.45	15
Great tit	11.0	0.80	0.47	9
Garden warbler	3.0	0.38	0.21	64
Long-tailed tit	3.5	0.89	0.83	6
Marsh tit	3.0	0.93	0.81	<5
Nuthatch	2.3	1.00	0.61	<5
Robin	20.7	0.53	0.57	11
Song trush	2.2	0.97	0.58	<5
Treecreeper	3.5	0.47	0.60	53
Wren	19.8	0.46	0.61	33

KEY FINDINGS

- It is possible to assess productivity of many woodland bird species by regularly surveying woods for fledged broods and comparing this with spring counts of adults.
- The technique could be used in studies of predation in woodland birds - we plan to undertake a study of the effects of grey squirrels on woodland birds in 2008/09.

Rufus Sage

There are also reports that grey squirrels predate birds, their nests and young. Some woodland bird species are declining and it is unclear why, so grey squirrels could be playing a role. If they are, they could be legally controlled wherever bird conservation demands it.

We are leading research to look at this and, with funding from the European Squirrel Initiative and Barnby Trust secured in 2007, we plan to compare the breeding success of birds in woods that have lots of squirrels, with woods in which squirrels are controlled for forestry or by gamekeepers.

However, there is no proven method for quantifying breeding success of woodland birds. Studies have monitored nests in trees to establish nest outcome but this is time-consuming, expensive, and for species nesting in tree tops, almost impossible to do. For gamebirds and other ground-nesting birds, we assess breeding success using repeat counts of fledged broods. So we thought we should try this with woodland songbirds.

With the British Trust for Ornithology, we selected six 15-hectare woods and mapped bird territories to measure the total number of pairs in spring. We then surveyed the woods four or five times every week from May to August to look for broods.

Table 1 lists 19 bird species that we recorded at all six sites. Br:Pr is the brood-to-pair ratio for each of these. We had high encounter rates with broods of most species (indicated by Br:Pr approaching 1.0) on most days.

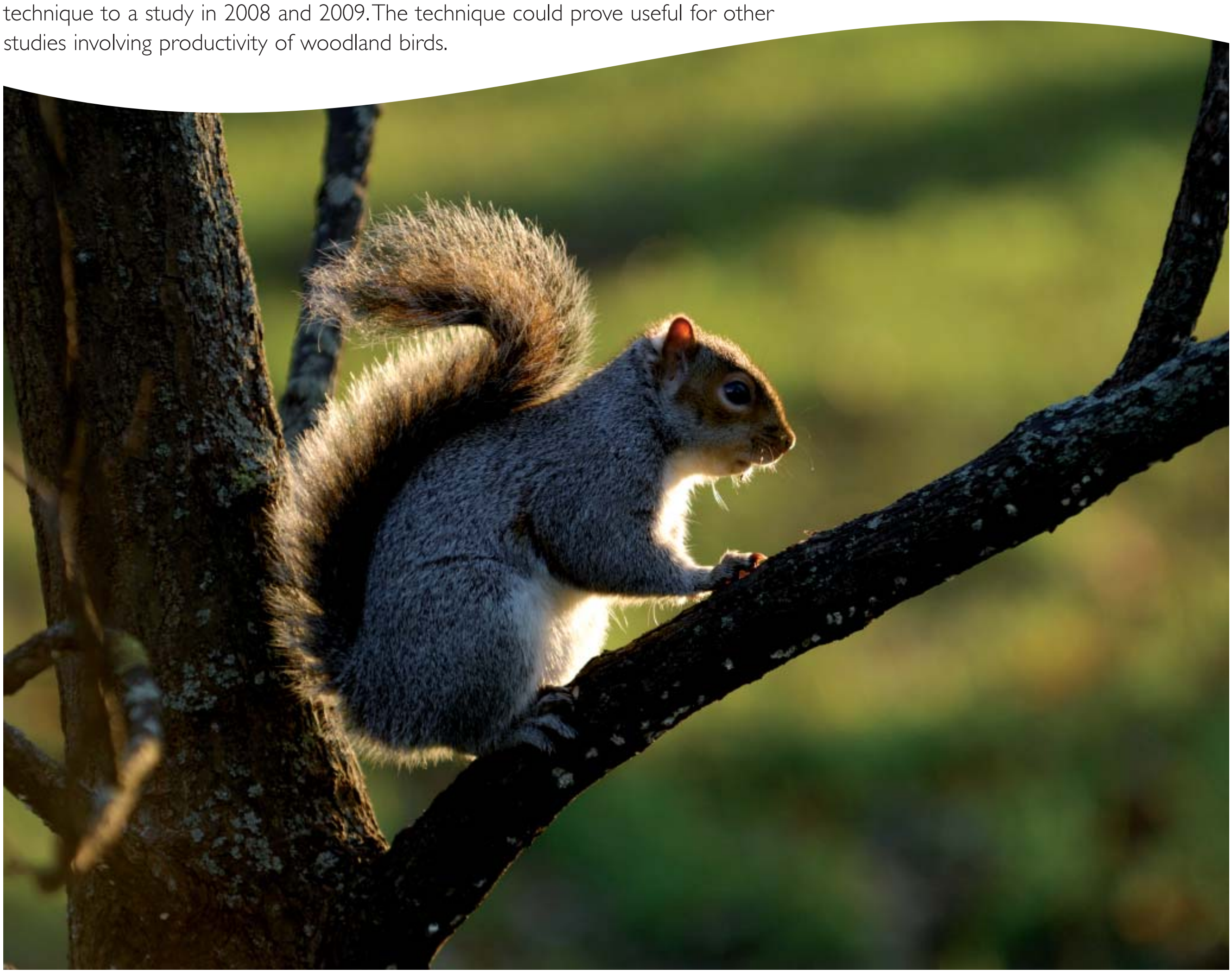
We can sub-sample our data to see how many times we actually need to visit each wood to calculate the Br:Pr ratios. For example, the next column is the probability of seeing any one brood if we surveyed woods just twice a week (2-visit prob). Broods of all but four species would have a >40% chance of being seen on this basis. Garden warbler is the common species for which this method is least likely to work.

Predation theory suggests that predators often take a surplus of a prey population so usually the proportion predated during breeding needs to be substantial if it is to affect adult population size the next spring. So we undertook a 'power analysis' which was designed to indicate how many sites we would need to study to detect a difference in Br:Pr of half of the mean value (the value in the table) for each species.

This means that a squirrel predation study is practical and we plan to apply this technique to a study in 2008 and 2009. The technique could prove useful for other studies involving productivity of woodland birds.

ACKNOWLEDGEMENTS

Funded by European Squirrel Initiative and The Barnby Trust



The grey squirrel could be helping the decline of woodland birds. Our study aims to find out.
© Laurie Campbell


© Neville Kingdon/GWCT

Summary of partridge and biometrics research

KEY ACHIEVEMENTS

- Sussex study reaches 40th year.
- Grey partridge work demonstrates clear routes for species recovery.
- National Gamebag Census continues to provide insight into current and historical trends.

Nicholas Aebischer

Our work on grey partridges goes from strength to strength. The current focus of this work is on restoring the bird to these islands, as set out in the aims of the Grey Partridge Species Action Plan, for which we are lead partner. To this end, we are continuing to urge farmers and land managers who have an interest in grey partridges to join our Partridge Count Scheme (see page 24), which will monitor how the bird recolonises areas and increases in abundance across land managed by participants in the UK. We believe that we can achieve the targets set by the BAP, but not without the help of everyone who is able to manage land sympathetically for this important farmland bird.

Indeed, our demonstration at Royston (see page 22) shows just how management practices can help grey partridges. All the measures that we use there can be replicated elsewhere, and over the coming year we will be encouraging visitors to come, learn and be inspired to achieve similar success on their own land.

Where there are no grey partridges at all, our study looking at methods to re-establish the species finished in 2007. We are now running a programme of training sessions to impart to others information on how this can best be done.

In the grey partridge stronghold, Norfolk, Roger Draycott has been doing an intensive study of habitat features such as hedgerows and their effect on spring pair numbers (see page 28). It confirms that the more linear features there are in a landscape, the better it supports grey partridges.

Although our research has addressed many of the habitat and predation issues that prevent or encourage grey partridge recovery, one area remains poorly understood: what are the factors determining over-winter losses. To understand this better, Francis Buner began a three-year project in 2007 to look at over-winter losses of grey partridges in detail.

Our Sussex study reached its 40th year in 2007. On the study area, fortunes are looking up for the grey partridge (see page 26). As well as monitoring grey partridges on the Sussex Downs, we continue to monitor weeds, invertebrates, pesticides and land use.

Our long-standing National Gamebag Census is the special responsibility of the Biometrics Department. We are very grateful to all those shoots who supply us with their bag records, and emphasize that we hold them in strict confidentiality. Because they include information on predator culls, they add greatly to our work with the Tracking Mammals Partnership, which seeks to monitor trends in UK mammal populations. At the request of Defra, we have also over the last year investigated the potential of the National Gamebag Census as a tool that, through us, would enable the UK government to meet its obligation under EU legislation to monitor the harvests of huntable birds (see page 30).

Within Biometrics, our Geographic Information Systems (GIS) unit, under the leadership of Julie Ewald, is working on a number of data-mapping projects. Two are being done with Areas of Outstanding Natural Beauty (AONBs). The first of these, with the Cranborne Chase and West Wiltshire Downs AONB, related to the importance of game management in the area. The second, in the North Wiltshire Downs AONB, has been mapping rare arable plants. Both finished in 2007. Our GIS unit has also been doing a survey of mountain hares in Scotland, and this is reported in the uplands research section on page 56.

Malcolm Brockless (left) has been our gamekeeper on the Salisbury Plain Experiment, Loddington and now Royston. Dick Potts began our Sussex study in 1968 and has been involved with it ever since. © Neville Kingdon/GWCT

PARTRIDGE AND BIOMETRICS RESEARCH IN 2007

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 26)	*Monitoring game and predator numbers with annual bag records*	*Nicholas Aebischer, Gillian Gooderham, Peter Davey, Vikki Kinrade*	*Core funds*	*1961- on-going*
Sussex study	*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*
Scottish mountain hare survey (see page 56)	*Postal survey of distribution and culling of mountain hares in Scotland*	*Julie Ewald, Vikki Kinrade, Adam Smith*	*SNH*	*2007-2008*
Mapping rare arable flora	*Mapping and spatial modelling of rare arable flora in the North Wessex Downs AONB*	*Julie Ewald, Neville Kingdon*	*NWD AONB*	*2006-2007*
AONB game management questionnaire	*Collating analysis and editing of report by Cranborne Chase and West Wiltshire Downs AONB on game and shoot management*	*Julie Ewald*	*CCWWD AONB*	*2006-2007*
Partridge releasing experiment	*Determination of best release methods as a tool for restoring grey partridges in the UK*	*Nicholas Aebischer, Francis Buner, Des Purdy*	*Westminster Overseas Fellowship, GC USA, Payne-Gallwey Charitable Trust*	*2004-2007*
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*
Trends in bags of huntable birds (see page 30)	*Analysis of huntable and 'pest' bird species from the National Gamebag Census and BASC's Waterbird Shooting Survey*	*Nicholas Aebischer, Peter Davey*	*Defra, Scottish Office*	*2006-2007*

Key to abbreviations:
BASC = British Association for Shooting & Conservation; CCWWD AONB = Cranborne Chase and West Wiltshire Downs Area of Outstanding Natural Beauty; Defra = Department for Evironment, Farming and Rural Affairs; GC USA = Game Conservancy USA; JNCC = Joint Nature Conservation Committee; NWD AONB = North Wessex Downs Area of Outstanding Natural Beauty; SNH = Scottish Natural Heritage.

Grey partridge recovery: fifth anniversary

KEY FINDINGS

- Targets achieved a year early.
- Grey partridge pairs on the demonstration area in 2007 were six times as numerous as when the project started.
- Despite a poor summer, autumn numbers in 2007 were 11 times higher than at the start of the project.
- Numbers on the reference area were less than a quarter of those on the demonstration area in spring and autumn.

Nicholas Aebischer
Malcolm Brockless
Julie Ewald

The Grey Partridge Recovery Project at Royston has now been running for five years. As lead partner for the grey partridge under the UK government's Biodiversity Action Plan, we wanted to lead by example, so we set the project up as a demonstration of the feasibility of restoring numbers of wild grey partridges on farmland.

The demonstration area is in Cambridgeshire, south-west of Royston, on 1,000 hectares (2,500 acres) of arable land on chalk. It is surrounded by a reference area of similar size and topography. Based on the landscape, farming and management, we predicted that we should be able to achieve a spring density of 18.6 grey partridge pairs per 100 hectares.

Management includes habitat creation, year-round predation control and supplementary feeding. Through the use of set-aside, Countryside Stewardship, Entry Level and Higher Level Schemes, partridge nesting cover amounts to 18% of land area, whereas insect-rich brood-rearing habitat (in the form mainly of wildlife mixtures and game-cover crops) covers 10% of land area. Predation control is targeted at foxes, stoats, rats, crows and magpies. We provide supplementary wheat in hoppers from autumn to spring, with at least two hoppers per grey partridge pair.

We count the partridges in March (spring pair counts) and just after harvest (autumn counts). We record the sex of all grey partridge adults and, in the autumn counts, the number of young birds present in each covey. Owing to an exceptionally warm autumn and winter 2006/07, grey partridges started pairing in December, and most had paired by the end of January. The spring pair count was just two pairs short of our predicted density, with 18.4 pairs of grey partridges per 100 hectares on the demonstration area. This represented an increase of 42% on the previous year, and six times as many as at the beginning of the project (see Table 1). On the adjacent reference area, stocks had risen to 4.2 pairs per 100 hectares.

The weather continued to break records as the year progressed, and the spring and summer were the wettest since 1912 and the coolest for 10 years. The expecta-

Figure 1

Distribution of grey partridge coveys at Royston in autumn 2007, showing barren pairs, single males and brood sizes

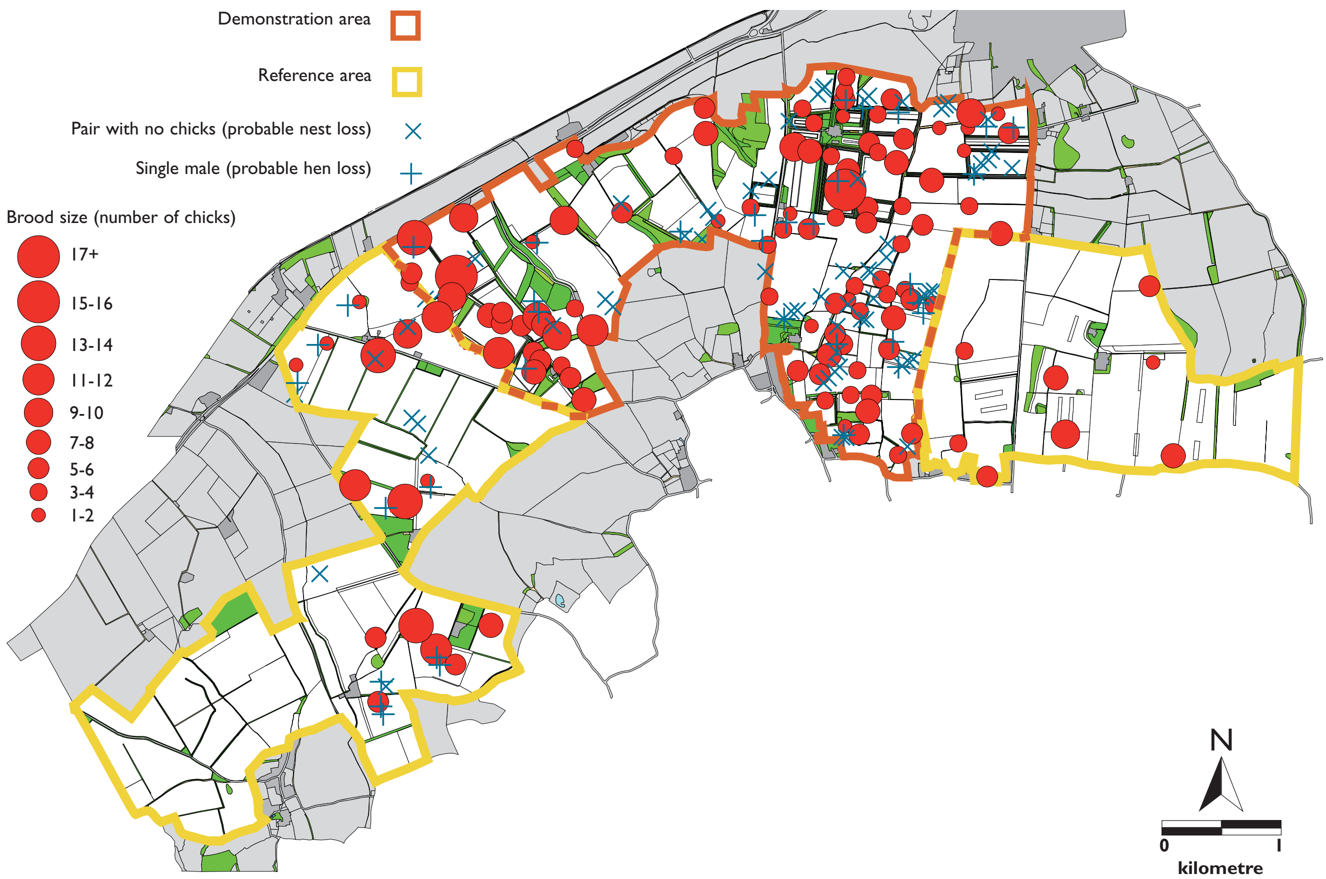


TABLE 1

Grey partridge counts on the recovery project at Royston, 2001-2007

a. Spring pairs per 100 hectares

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

b. Autumn birds per 100 hectares

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

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

tions for chick production were correspondingly low. The 2007 autumn counts showed that grey partridge productivity on the demonstration area was down relative to 2006 (young-to-old ratio of 1.5 versus 2.6). The overall densities of grey partridges in the autumn stood at 83.8 birds per 100 hectares, a 5% drop relative to 2006, but still 11 times higher than when we started (see Table 1). On the reference area, although reproductive success was slightly higher than on the demonstration area (young-to-old ratio of 2.1), overall autumn density fell by 30% relative to the previous year, to 17.9 birds per 100 hectares.

In five years, we have brought the density of grey partridges on the demonstration area to within a whisker of our initial prediction. That is cause for celebration, and we thank all the farmers on the study area for their co-operation. From 2008 onwards, we will capitalise on this success by organising an extensive programme of visits and events at Royston.

A cultivated six-metre margin, grass strip and strip of wild bird mix on the grey partridge demonstration site at Royston.
© Malcolm Brockless/GWCT

Partridge count scheme

We strongly urge our members to count grey partridges on their land. © Francis Buner/GWCT

Opposite: counts are normally conducted from a vehicle. (Neville Kingdon)

KEY FINDINGS

- Overall grey partridge densities were similar to 2006.
- Young-to-old ratios were down, owing to a wet summer.
- Autumn densities were 6% lower than in 2006.

Neville Kingdon
Julie Ewald

Spring counts were difficult in the warm and dry weather which advanced crop growth (particularly winter-sown oilseed rape) making birds difficult to see. The real problem for partridges, however, was the persistent and locally heavy rain across most parts of the country in late spring, followed by a summer, which although generally warm, was very wet.

The counts are summarised in Table 1. The overall spring densities were the same as 2006, with northern England and Scotland higher, whereas densities were down in southern England, East Anglia and the Midlands. Young-to-old ratios and autumn densities of grey partridges for the whole country were down, with the north and the south of Britain both reporting a decrease in density. There was some good news with the first young grey partridges reported in Wales for several years and with overall densities up in the Midlands, but the general impression is that it has not been good for grey partridges across the country. The decline in densities in the autumn overall was down 6% on 2006, with the density of adults in the autumn 13.4 per 100 hectares in 2007 compared with 13.6 in 2006.

Worryingly, the number of members undertaking a count this year was down in both spring and autumn, with the number of spring counts 20% fewer, and the number of autumn counts 26% fewer than in 2006. We urge those registered with our scheme to undertake counts in spite of weather conditions.

We believe that there are many members whose land sustains some grey partridges, but who have not yet joined our scheme. We hope that these people will join and help us to help them turn the fortunes of their grey partridges around. The scheme is designed not just to benefit the established 'Partridge Manors' – the largest contribution towards conserving the grey partridge will be from 'typical' farms that dominate the arable area of the UK. If every farm and shoot with a single grey partridge pair could increase this to two or three, then the country as a whole could easily achieve the Government target of 90,000 pairs by 2010, from the current estimated 65,000 pairs. Please make it a priority and join via our website (www.gct.org.uk/partridge) or contact Neville Kingdon by email (nkingdon@gct.org.uk) or telephone (01425 651066).

TABLE 1

Grey partridge counts

a. Densities of grey partridges pairs in spring 2006-2007, from contributors to our partridge count scheme

	Number of sites		*Spring pair density (pairs per km² (100ha))*		
Region	*2006*	**2007**	*2006*	**2007**	**Comparison**
South	*188*	135	*2.5*	1.6	decrease
Eastern	*270*	218	*6.7*	6.2	decrease
Midlands	*167*	138	*3.6*	3.5	decrease
Wales	*2*	2	*0.0*	0.0	no change
Northern	*191*	169	*4.8*	6.0	increase
Scotland	*163*	127	*3.5*	3.7	increase
Overall	*981*	**789**	*4.5*	**4.5**	**no change**

b. Densities and young-to-old ratios for grey partridges in autumn 2006-2007, from contributors to our partridge count scheme

	Number of sites		*Young-to-old ratio*		*Autumn density (birds per km² (100ha))*		
Region	*2006*	**2007**	*2006*	**2007**	*2006*	**2007**	**Comparison**
South	*159*	96	*1.8*	1.9	*7.5*	6.6	decrease
Eastern	*236*	172	*2.3*	1.8	*33.3*	28.7	decrease
Midlands	*157*	118	*2.1*	1.4	*15.8*	18.2	increase
Wales	*3*	2	-	1.8	*0.0*	9.2	increase
Northern	*184*	154	*2.7*	1.7	*29.6*	28.6	decrease
Scotland	*154*	120	*3.0*	2.1	*20.0*	14.9	decrease
Overall	*893*	**663**	*2.4*	**1.8**	*22.6*	**21.2**	**decrease**

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.

© Francis Buner/GWCT

Turn-around in Sussex

Julie Ewald visiting the Sussex study area, which we have monitored since 1970.
© Francis Buner/GWCT

This year was our 38th year of monitoring the cereal-crop flora, the invertebrate fauna and partridge numbers on the Sussex study area and our 40th year of counting the partridges. In spite of poor weather it was one of the best years we have had for a long time in Sussex. The chick survival rate in 2007 was 40% overall, higher than the 33% needed to maintain numbers. In contrast to 2004, when we counted only 33 pairs of grey partridges across the whole of the 8,000-acre study area, this autumn we found 83 pairs of grey partridges.

After the long-running decline in numbers of grey partridges on our Sussex study area, there has recently been an increase in the numbers of breeding pairs (see Figure 1). There are signs of a slight increase in the supply of chick-food insects since the early 1990s, but the overall picture is one of little long-term change since the early 1970s (see Figure 2). This is remarkable in view of the changes in agriculture. As a result of the slightly improved insect situation, owing partly to fewer insecticides being used, there has been a steady increase in chick survival rate over the whole area (see Figure 3). All of these changes indicate that things are improving for grey partridges in this area of Sussex.

Several farms have also started to increase nesting cover and the quality of the chick-rearing habitat. By 2006 they had already installed 15 kilometres of beetle banks, 13 kilometres of conservation headlands and eight kilometres of 10-20 metre-wide strips of brood-rearing cover. Some of this has attracted funding from the new Environmental Stewardship Scheme (ESS), with the rest funded directly by the farmers themselves. There is evidence that this effort is working, with the average chick survival rate being 47% over the last four years on the area with new management compared with 33% on the area without it. Further improvements are under way and the prospects for grey partridges in Sussex are the best we have seen for four decades.

KEY FINDINGS

- 2007 was one of the best years with chick survival at 40% with a steady increase over the whole area.
- There was a marginal increase in chick-food insect numbers, but little long-term change.
- Recent years have seen an increase in breeding grey partridge pairs.

Julie Ewald
Dick Potts
Steve Moreby

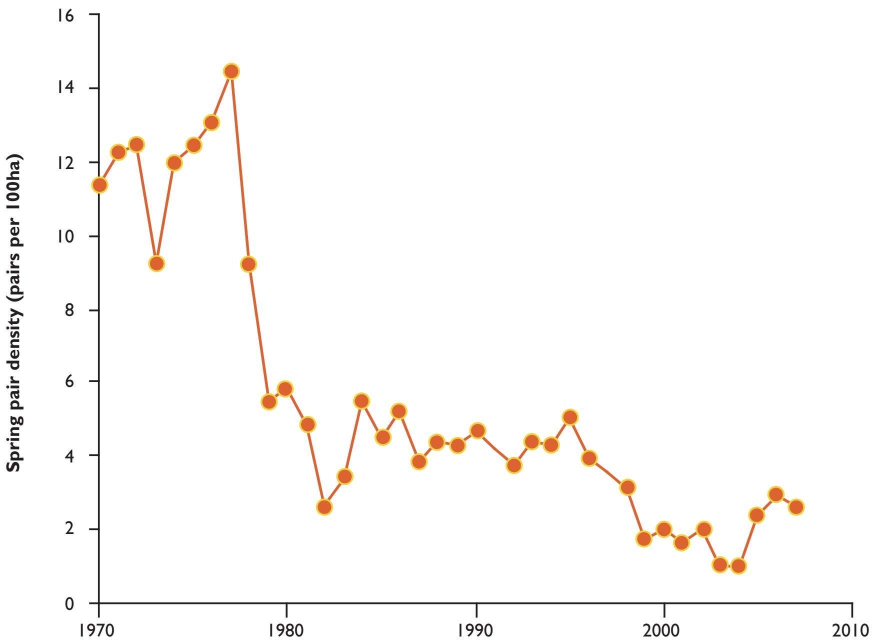


Figure 1

Grey partridge spring pair density on the Sussex study site 1970-2007

In the last three years, the density of pairs of grey partridges on the Sussex study area has been higher than in the preceding six.

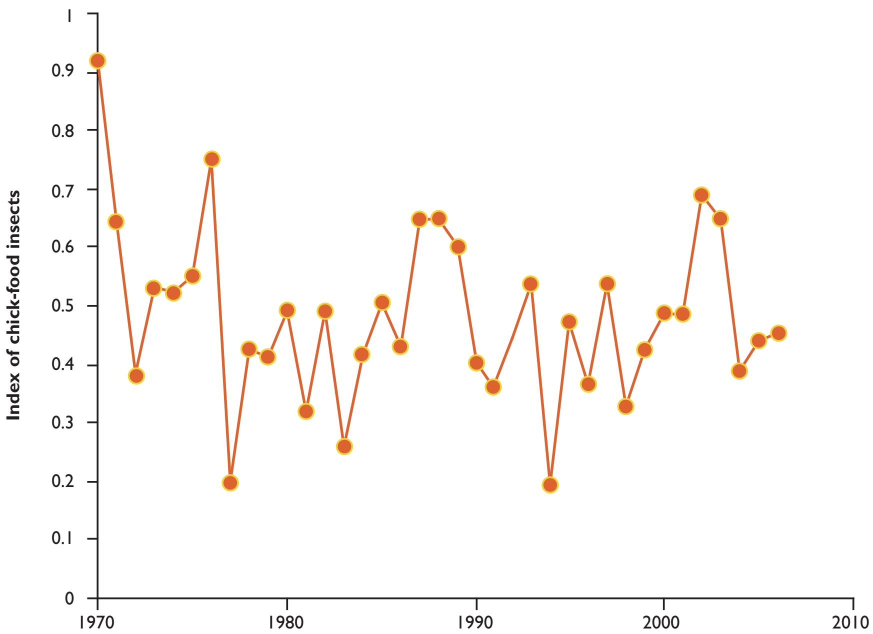


Figure 2

Changes in the average level of chick-food insects across the Sussex study area, 1970-2007

The general picture is of an increase in chick-food insects since the 1990s.

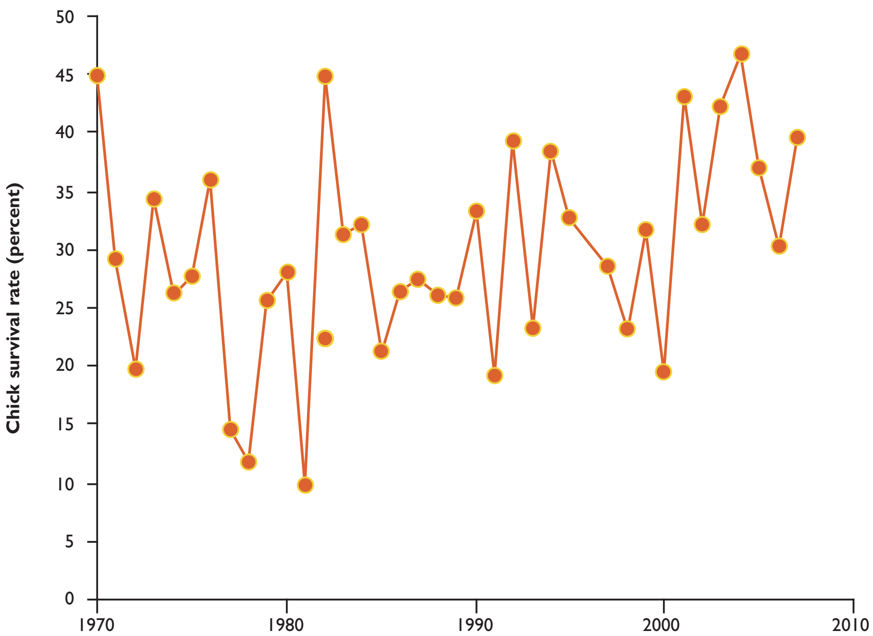


Figure 3

Changes in chick survival rate over the Sussex study area, 1970-2007

Over the last seven years, there has been the beginnings of an increase in the number of chicks that survive through the summer..

Grey partridges and land use in Norfolk

Part of the study area in Norfolk.
© Roger Draycott/GWCT

Figure 1

Grey partridge pairs on one game beat (600 hectares) on a Norfolk partridge estate in 2006

Pairs

Single birds

Norfolk has been a stronghold for grey partridges in Britain. A long history of gamekeeping, light soils and diverse cropping provide favourable conditions for them. In common with the rest of Britain, numbers have declined in recent decades, although many farms and estates are now working to restore them on their land. On one famous shooting estate in north Norfolk, partridge numbers on a study area of 4,000 hectares comprising five different game beats have been monitored for many years. Each spring breeding pairs are located and marked on maps (see Figure 1). In autumn, after harvest, the locations of all coveys are recorded along with the sex and age of the birds. Crop type and the locations of hedges, game covers, grass margins and beetle banks are also recorded. We were interested to find out how cropping patterns and permanent habitat features influenced the distribution and productivity of partridges on this estate. To do this we used a Geographic Information System to analyse spatial patterns in the distribution of partridge pairs and coveys in relation to crop type and proximity to linear habitat features using data collected between 2000 and 2006.

Spring pairs were positively correlated with the proportion of permanent boundary features in the landscape (see Figure 2). In other words, partridges preferred to set up breeding territories in smaller fields alongside hedges with grass margins or along beetle banks. As well as providing potential nesting cover, these areas provide escape cover from raptors, especially sparrowhawks. These are also the areas where feed hoppers are located, which is likely to influence the distribution of partridge territories. Crop type was not particularly important in influencing where pairs set up their territories, although there was a tendency for them to avoid spring-sown crops, presumably because they offer less cover at count time than autumn-sown ones. Farmyards and gardens were also positively correlated with spring pairs, probably because of the availability of cover and food. There was a negative correlation between the amount of woodland cover and partridge density, which is not surprising as partridges are known to favour open habitats.

Based on autumn counts, the productivity of partridges is measured by the chick survival rate (CSR) and the brood production rate (BPR). Higher BPRs were associated with fields of combinable peas. Anecdotally, dried peas have often been cited as being good for partridges. They are not harvested until quite late, allowing broods to get away, and they are usually rich in insects, particularly the large pea aphid. Densities of partridges on pea stubbles are likely also to be influenced by the quantity of highly nutritious spilt peas left after harvest. No other combinable crops were positively correlated with CSR or BPR. However, a number of 'crop types' were negatively correlated with CSR or BPR including fields under organic conversion, set-aside/fallow land, grassland and woodland. Fields under organic conversion are subject to a cutting regime through the partridge breeding season, hence it is possible that nests and broods may be lost in this crop. The effect of organic cropping after the organic conversion will be analysed in future years. Partridges probably did not perform well in the fallow or set-aside fields because these fields tend to be sprayed off in the summer, hence reducing cover and insect availability in these fields.

KEY FINDINGS

- Densities of grey partridges were highest in small fields and those with tussocky grass margins.
- Partridge breeding pair densities were negatively associated with woodland.
- Of all crop types, productivity appeared highest in dried (combinable) peas.

Roger Draycott
James Palmer

ACKNOWLEDGEMENTS

We are grateful to The Chadacre Agricultural Trust for part funding this project.

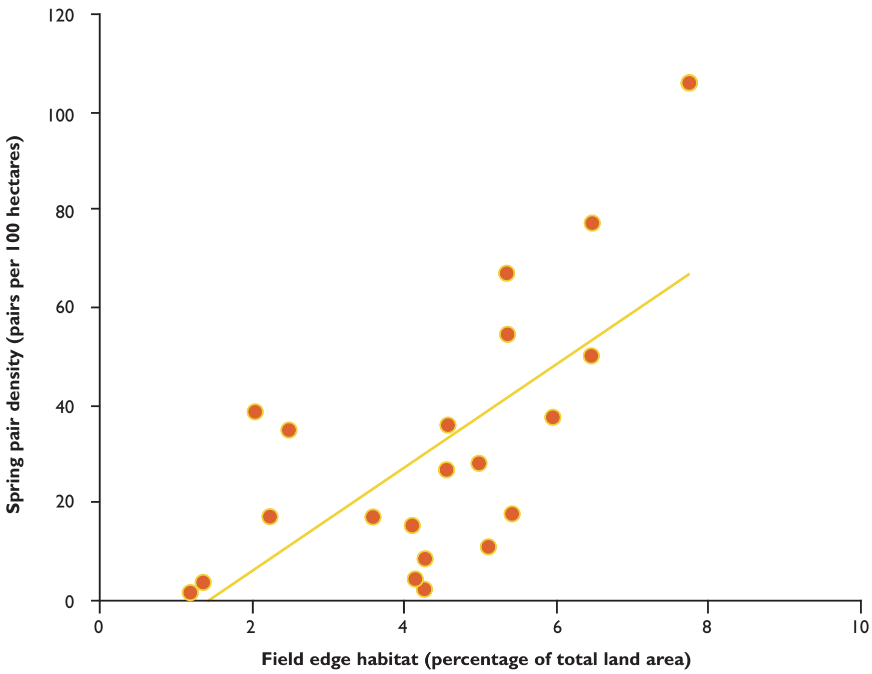


Figure 2

The relationship between grey partridge pair density and the proportion of linear features (hedgerows, grass margins and beetle banks) in the landscape

Each point on the graph represents average data from areas of high, medium and low partridge density in each year between 2000 and 2006 on one partridge beat.

National gamebag census: game species trends

KEY FINDINGS

- Releases of pheasants and red-legged partridges have increased four-fold over the last 15 years, whereas releases of grey partridges have remained static. The numbers of redlegs shot continue to increase in line with releasing, unlike the number of pheasants shot.
- Red grouse bags continue to show signs of decline over the last 15 years, whereas woodcock bags are roughly stable and hare bags have increased.

Peter Davey
Nicholas Aebischer

Through the National Gamebag Census (NGC), we monitor the bag sizes of a large range of game and predator species. These records provide an index of population change that can be compared with standard surveys of abundance conducted by the British Trust for Ornithology (BTO) and the Royal Society for the Protection of Birds (RSPB). We mail questionnaires to some 650 NGC contributors at the end of each season. Participation is voluntary and we are grateful to all the owners and keepers who send in their returns. For each species, analysis is based on sites that have returned bag records for two or more years. The analysis summarises the year-to-year change within sites as an index of change relative to the start year, which receives a value of one.

Grey partridge (see Figure 1)

Grey partridge bags have continued to decline over the last 10 years and have fallen by a third, on average, since 1990. This matches the national trend in grey partridge breeding numbers, which the BTO estimates at -40% from 1995 to 2004. 15 years of set-aside policy seem to have had no effect on bags at the national level, although voluntary restrictions on shooting may have masked any effect. We take the decline of this game species very seriously, and urge estates not to shoot grey partridges if they have fewer than 20 birds per 100 hectares (250 acres) in the autumn. Particular care is needed with driven redleg shooting not to shoot wild greys at the same time (see our leaflet *Conserving the grey partridge*, available on-line at www.gct.org.uk). Likewise, releasing of greys for shooting should be done only when there is no risk to wild stocks. In fact, numbers released have been roughly constant over the last 15 years, unlike for pheasants or redlegs.

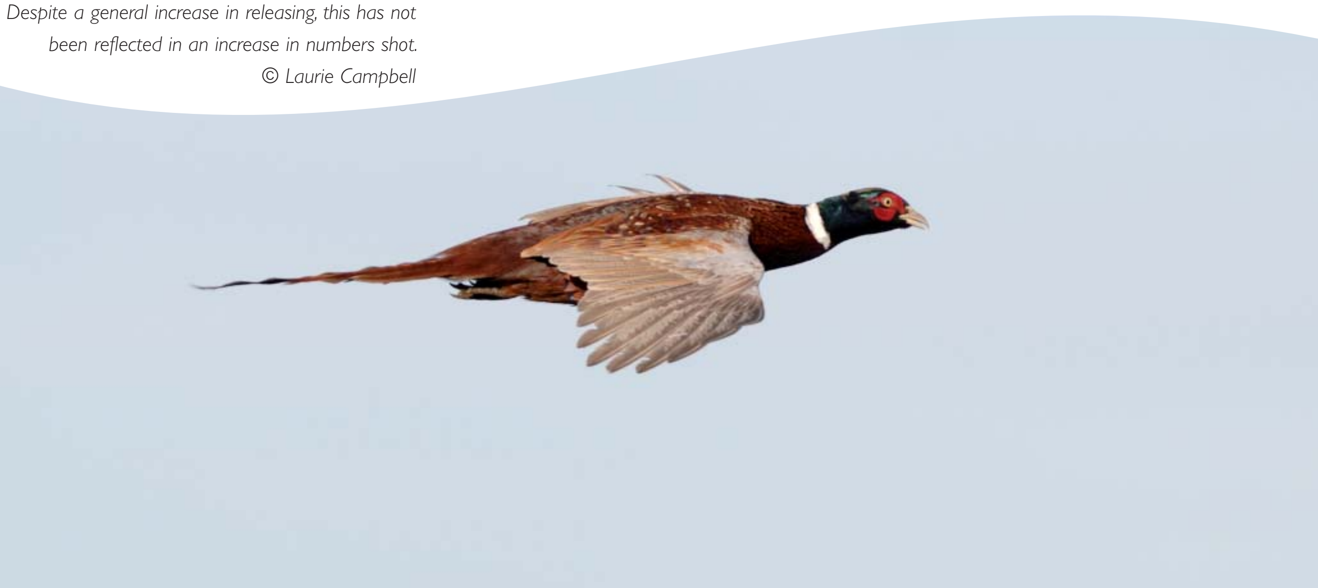
Red-legged partridge (see Figure 2)

From practically none in the 1960s, the bulk of redlegs shot now derive from released stock. Since 1990 the numbers released per unit area have increased four-fold. The increase in releasing has fed through to the bag, which has also quadrupled over the last 15 years.

Pheasant (see Figure 3)

Pheasant releasing began some 10 years earlier than for redlegs. The number released per unit area has increased since the 1960s, although the rate of increase slowed from over 5% per year before 1990 to roughly 3% per year thereafter. The period of rapid increase in releasing is reflected in the bag until 1990, but since then the bag has more or less stabilised.

Despite a general increase in releasing, this has not been reflected in an increase in numbers shot.
© Laurie Campbell



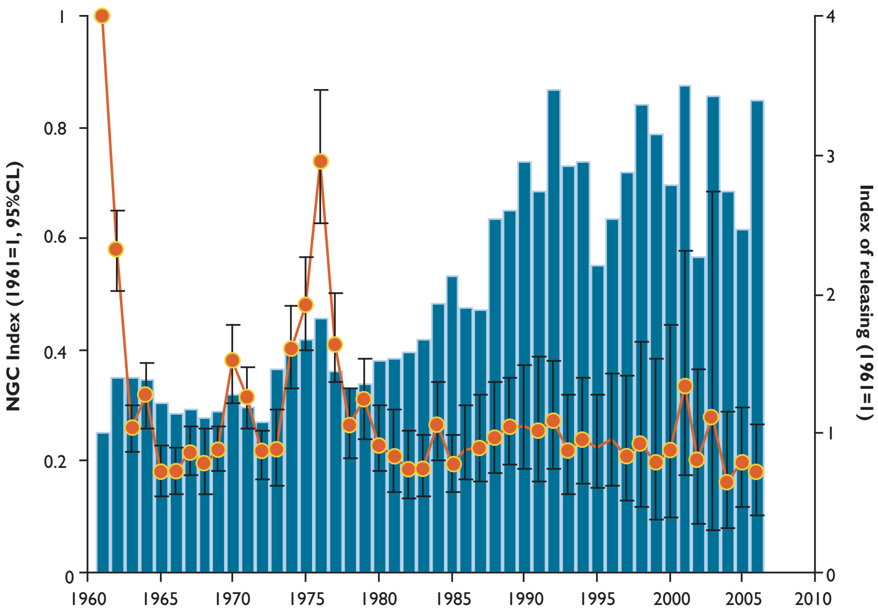


Figure 1

Grey partridge bags (dots) and releasing (columns) 1961-2006

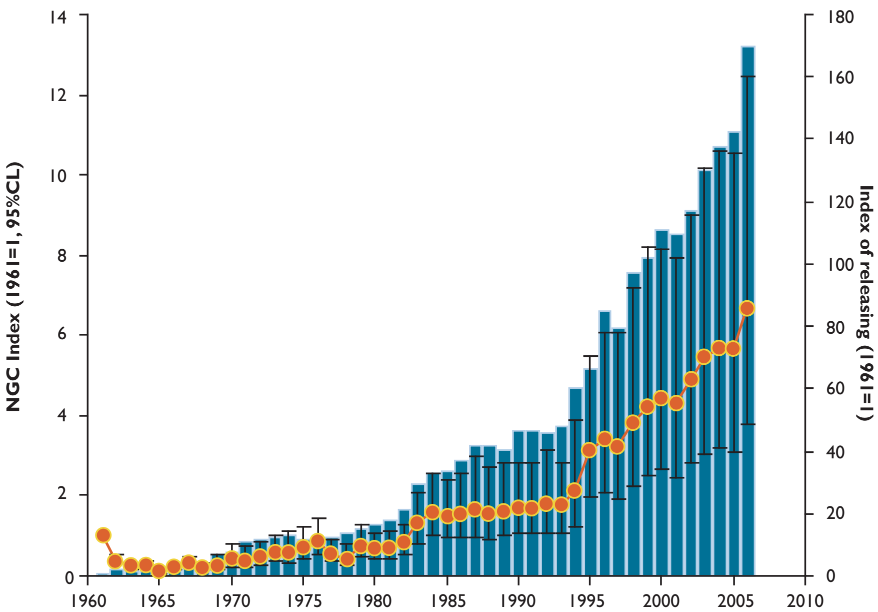


Figure 2

Red-legged partridge bags (dots) and releasing (columns) 1961-2006

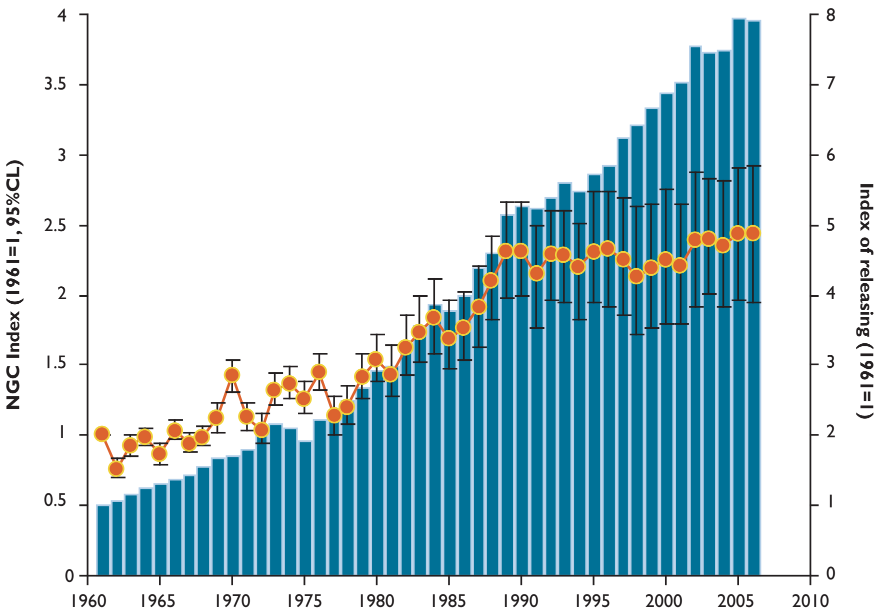


Figure 3

Pheasant bags (dots) and releasing (columns) 1961-2006

Away from grouse moors, red grouse stocks are sparse. © Laurie Campbell

Red grouse (see Figure 4)
We consider grouse bags from England (upper series) and Scotland (lower series) separately. Until 1992, bags on English moors had been holding up well. From that time, the cycle peaks (1997, 2004) and the cycle troughs (1993, 1999, 2005) have been getting gradually lower, with the 2005 value the lowest average bag in the series. In Scotland, following a decline in the 1970s and early 1990s, there appears to have been some improvement from 1997, although the past three seasons have been disappointing. Away from grouse moors, grouse stocks are sparse. We hope that the new status of red grouse as a Biodiversity Action Plan species will bring about concerted action for recovery.

Woodcock (see Figure 5)
The large increase in numbers shot observed in the 1970s appears to have stabilised. Woodcock shot in winter in the UK come primarily from Scandinavia, the Baltic states and Russia, so variation may be linked to reproductive success overseas or the extent of migration. A joint Franco-Russian monitoring scheme suggests that those eastern breeding populations are stable, whereas those in lowland Britain appear to have declined by 74% between 1968 and 1999 (BTO Common Birds Census, small sample sizes). To establish how many woodcock breed in Britain, we launched a national survey in 2003 jointly with BTO (see article on page 14). The survey estimated the number of males across the UK at 78,350, with a 35% chance of woodcock being present in one-kilometre squares containing at least 10 hectares of woodland.

Brown hare (see Figure 6)
The number of brown hares shot each year per unit area declined steadily from 1961 to a low point in the mid-1980s, at an average rate of -6% per year. Since then, there has been a reversal as bags have increased slowly at +2% per year. Last year we showed how this rise coincided with the introduction of set-aside and agri-environment schemes. Loddington and Royston have certainly demonstrated that game-friendly set-aside management and Entry Level Stewardship combined with predator control leads to outstanding recovery (see page 77). Appropriate farming practices are outlined in our leaflet *Conserving the brown hare*, available on-line at www.gct.org.uk.

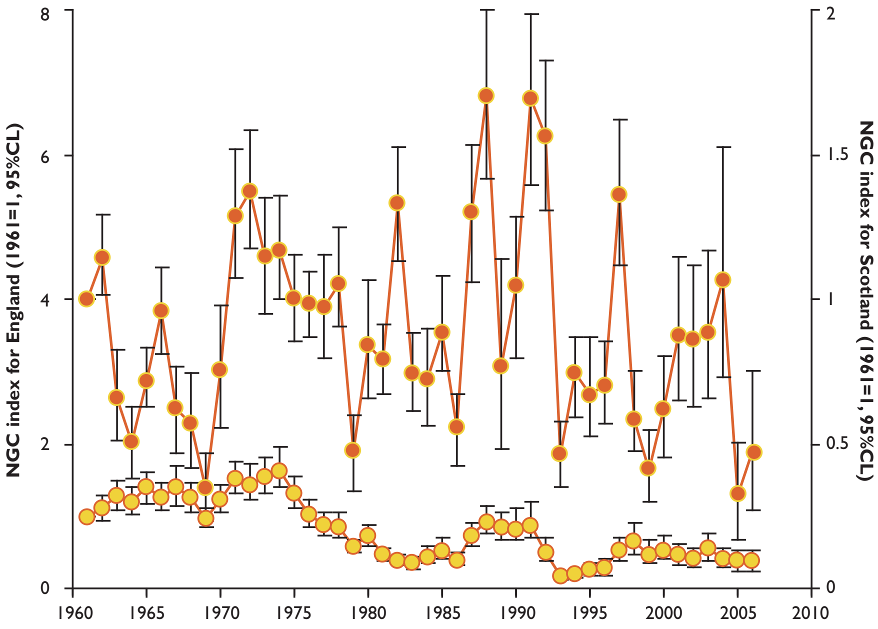


Figure 4

Red grouse bags in England (upper series, left axis) and Scotland (lower series, right axis), 1961-2006

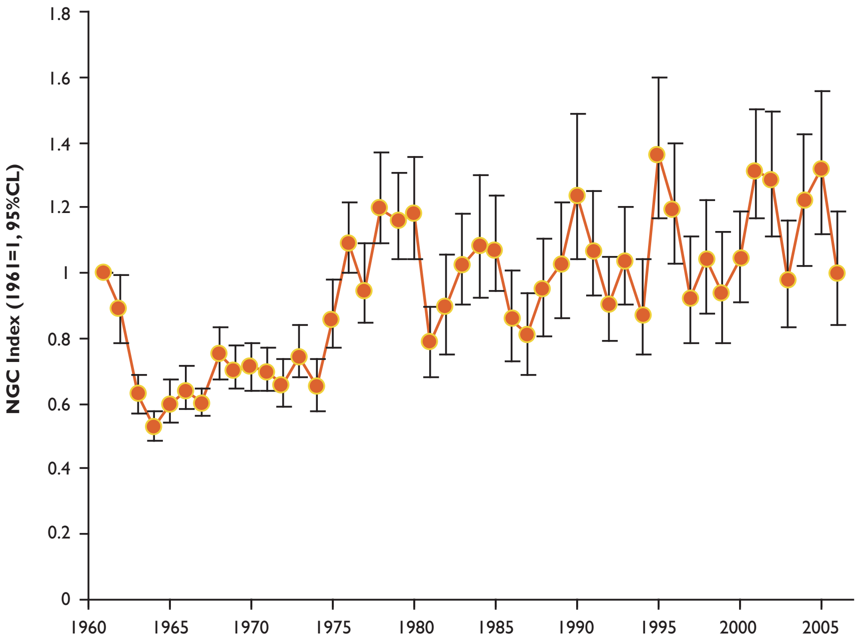


Figure 5

Woodcock bags 1961-2006

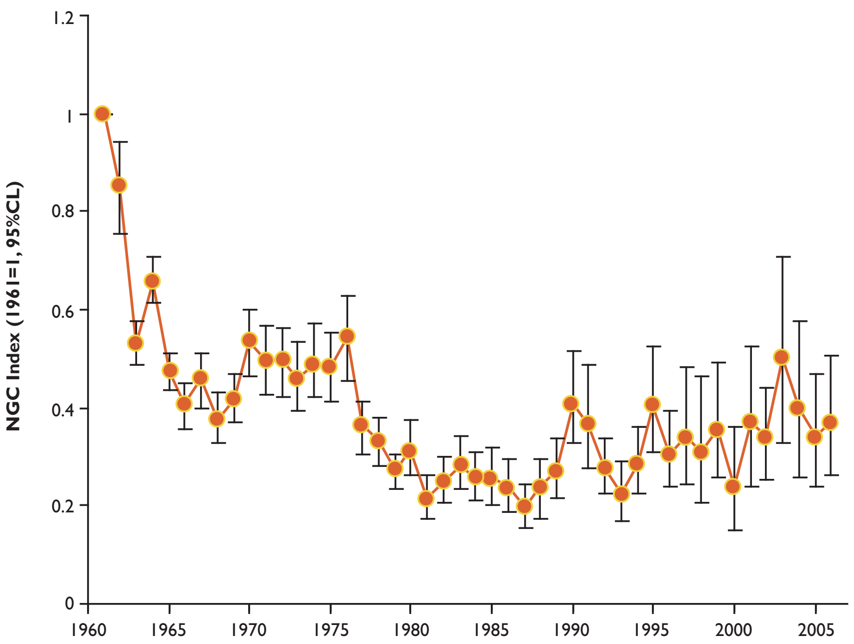


Figure 6

Brown hare bags 1961-2006

Summary of uplands research

KEY ACHIEVEMENTS

- We tested a new medicated grit which withstands weathering.
- We completed a study of red grouse populations in the presence of shooting.
- It was the penultimate year in which we collected Otterburn data.

Dave Baines

We continued our long-term monitoring of red grouse, black grouse and capercaillie - conducting spring and summer counts (see page 36). The red grouse is the core species that we study and our research continued on the development of strongylosis control techniques, a disease caused by worms which can result in cyclic crashes of red grouse numbers. A new medicated grit to control the strongyle worms in grouse, which withstands weathering better than previous medicated grit formulations, has been tested and looks set to be a success (see page 46).

Another disease affecting red grouse is louping ill virus, transmitted by ticks. Our research continued to study ticks and how other hosts (such as deer, mountain hares and sheep) affect this parasite in relation to red grouse. Other research on red grouse has included the effect of shooting on red grouse populations (see page 44) and the role of parasites, predators and habitat on red grouse abundance.

Management for red grouse also affects other species and our Upland Predation Experiment at Otterburn has been looking at how reducing predators affect ground-nesting birds. This flagship project is now nearing completion (see page 40). We have also monitored the abundance of waders and other ground-nesting birds at Langholm in the presence and absence of gamekeepers (see page 52).

Waders are also the subject of other research, namely that of snipe nesting on moorland (see page 48).

The black grouse continues to be an important element of our studies as we are joint lead partner for its Biodiversity Action Plan. As well as running the North Pennines black grouse recovery project, we have also looked at the effect of sheep grazing on the insects eaten by black grouse chicks (see page 50).

The mountain hare is considered by many to be an important quarry species in its own right. This year we conducted a survey to estimate mountain hare numbers and we report on our results on page 56.

UPLANDS RESEARCH IN 2007

Project title	Description	Staff	Funding source	Date
Strongylosis research (see page 46)	*Development of strongylosis control techniques*	*David Newborn, David Baines, Mike Richardson*	*Core funds*	*2006-2011*
Grouse monitoring (see page 36)	*Annual long-term counts and parasite monitoring*	*Dave Newborn, David Baines, Mike Richardson, Adam Smith, David Howarth*	*Core funds, Gunnerside Estate*	*1980- on-going*
Black grouse research (see page 50)	*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 Anderton*	*MoD, NE, RSPB, Northumbrian Water, North Pennines AONB*	*1996-2011*
Black grouse translocation	*Translocating males to achieve range expansion*	*Philip Warren, Kim Anderton*	*SITA Trust*	*2007-2009*
Upland predation experiment (see page 40)	*Effect of grouse moor management on other bird species*	*David Baines, Kathy Fletcher, Rob Foster, Craig Jones, Philip Chapman*	*Uplands Appeal, Core funds*	*1998-2008*
Otterburn Demonstration Moor	*Predator and habitat management for conservation benefits*	*David Baines, Craig Jones, Paul Bell, Rob Foster*	*Landmarc/Defence Estates*	*2007-2014*
Tick control	*Tick control in a multi-host system*	*Adam Smith, David Howarth*	*Scottish Trustees, Various Trusts*	*2000-2008*
Woodland grouse - Scotland	*Ecology and management of woodland grouse*	*David Baines, Allan Macleod*	*SNH, LIFE, Dulverton Trust*	*1991-2009*
Langholm research (see page 52)	*Monitoring of raptors, grouse, voles, pipits, waders and foxes on Langholm Moor*	*David Baines, Mike Richardson*	*SNH, Core funds*	*2003-2007*
Grouse ecology in the Angus Glens	*Roles of parasites, predators and habitat in determining grouse abundance in the Angus Glens*	*David Baines, Laura Taylor, Adam Smith*	*Various*	*2006-2009*
PhD: Red grouse (see page 44)	*Grouse population dynamics in relation to shooting*	*Nils Bunnefeld Supervisors: David Baines, Prof EJ Milner Gulland/Imperial College*	*John Stanley Trust Studentship*	*2005-2007*
PhD: Grouse management and conservation	*Quantifying the impacts of grouse management on the conservation of wildlife in the North Pennines*	*Julie Black Supervisors: Nick Sotherton, Prof E.J Milner Gulland, Dr Susan Mourato/ Imperial College*	*ESRC/CASE Studentship*	*2005-2007*

Key to abbreviations:
AONB = Area of Outstanding Natural Beauty; ESRC = Economic and Social Research Council; LIFE = European Union Financial Instrument for the Environment; MoD = Ministry of Defence; NE = Natural England; RSPB = Royal Society for the Protection of Birds; SNH = Scottish Natural Heritage.

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Uplands monitoring in 2007

KEY FINDINGS

- In England red grouse had a successful breeding season. In Scotland, there was only a slight improvement on 2006.
- Black grouse had the lowest breeding success since 1996.
- For capercaillie, 2007 was the worst year in the last five.

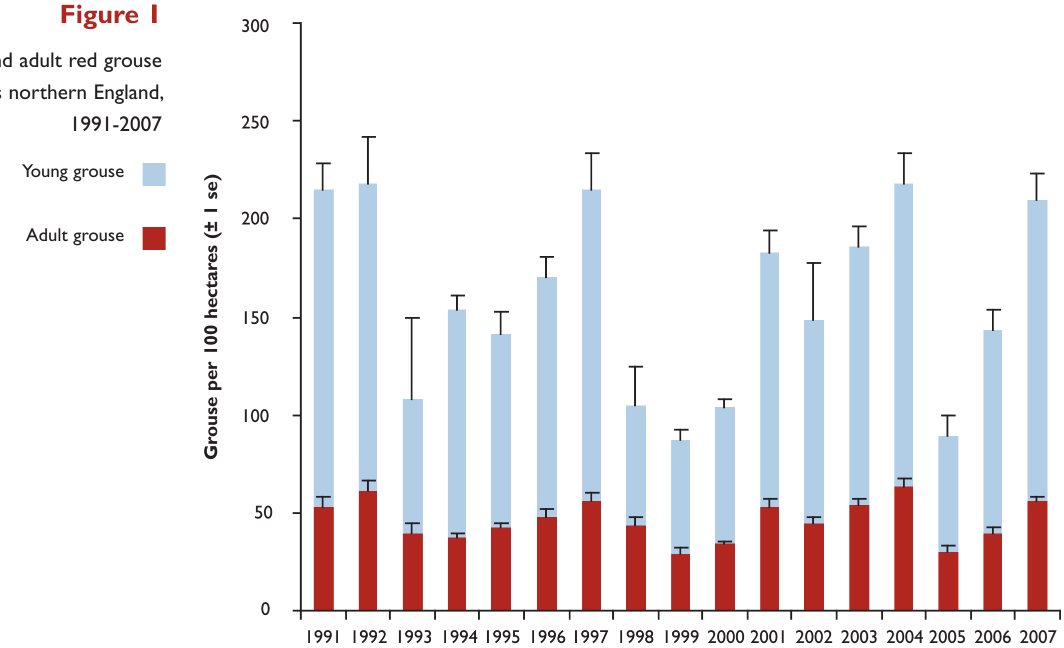
David Baines
Allan Macleod
David Newborn
Phil Warren
Adam Smith

If the 2007 performance is anything to go by, prospects for red grouse on our English moors in 2008 look excellent. © Laurie Campbell

Red grouse (northern England)
As part of our monitoring programme, we counted red grouse at 25 sites in 2007. Strongylosis caused a population crash in 2005, but the last two years have seen strong recovery from just over 140 per 100 hectares in 2006 to just over 200 in 2007 (see Figure 1). With a predominantly young breeding stock with low parasite burdens, the heavy rain in June and July had little impact on chick survival, with hens rearing an average of 6.5 chicks over the 14 Pennine sites. Post-breeding parasite levels remained

Figure 1

Average density of young and adult red grouse in July from 25 sites across northern England, 1991-2007



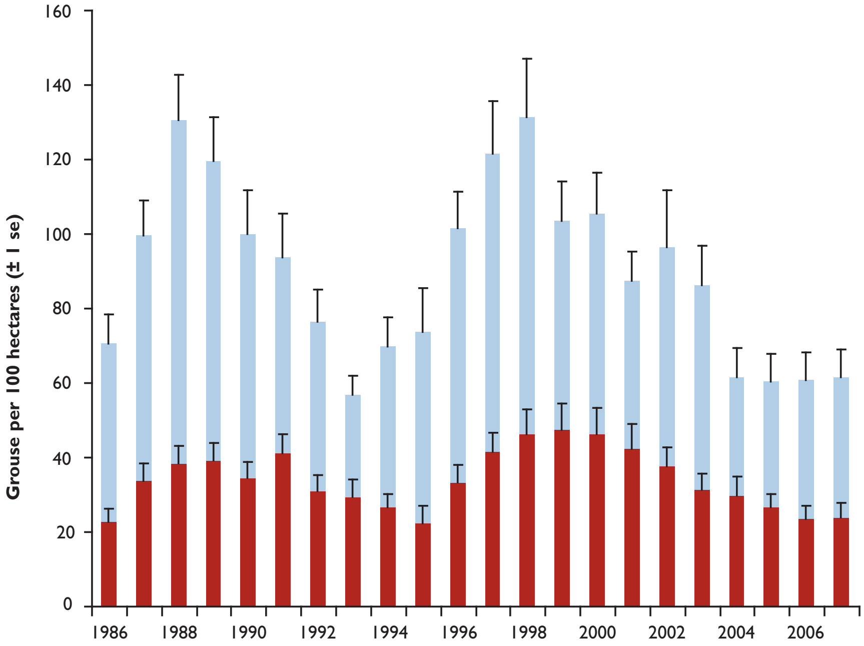


Figure 2

Average density of young and adult red grouse in July/August from 24 sites across Highland Scotland, 1986-2007

Young grouse

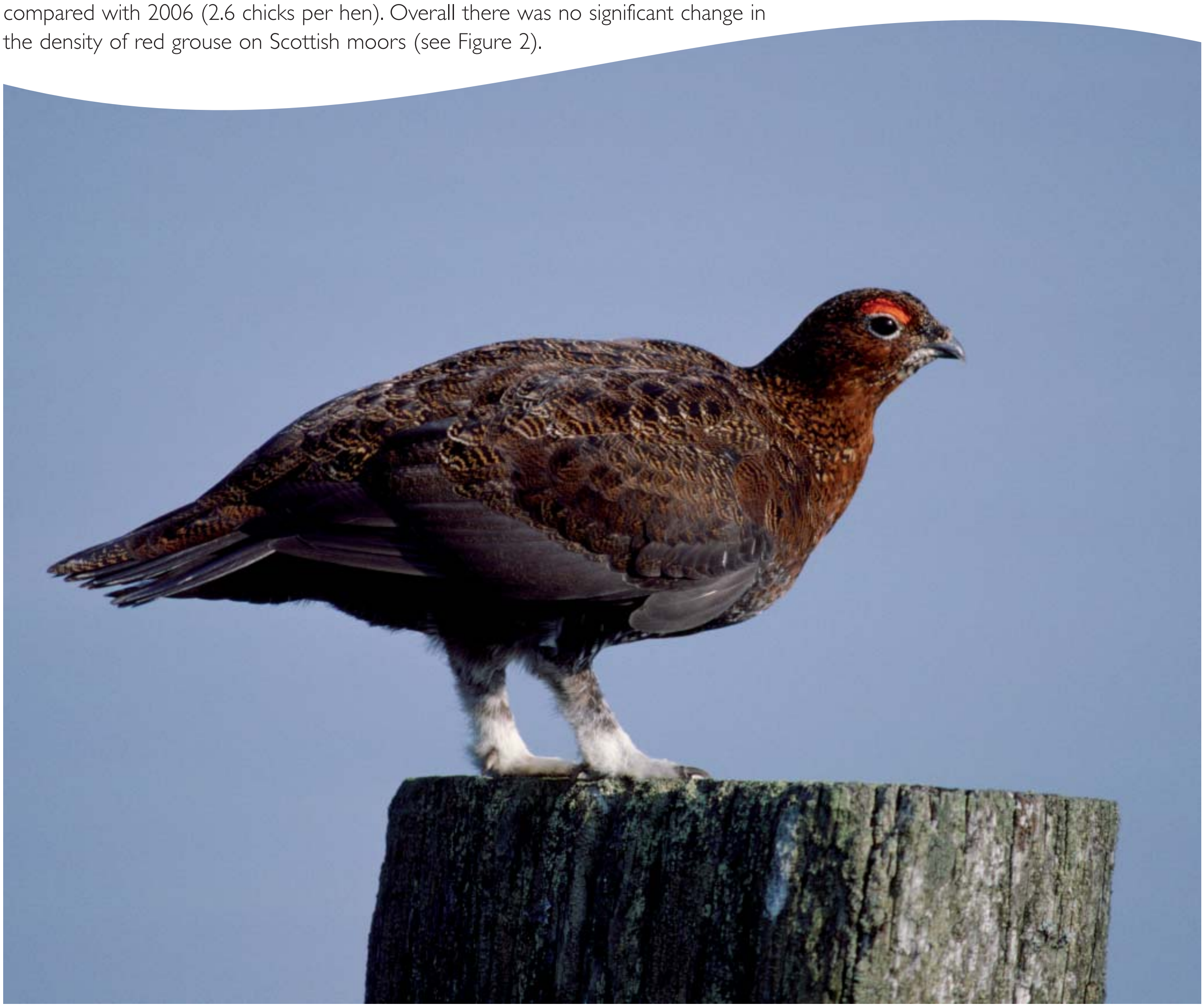
Adult grouse

low on most moors (mean of 1,247 worms per adult grouse), hence the prospects for 2008 currently look excellent.

Red grouse (Scotland)

We counted grouse on 24 sites in Scotland. There was no difference in spring red grouse densities compared with 2006, with an average of 12.7 pairs per 100 hectares in 2007. Despite the wet summer, for many areas summer counts were marked by a slight improvement in breeding success in 2007 (average 3.2 chicks per hen) compared with 2006 (2.6 chicks per hen). Overall there was no significant change in the density of red grouse on Scottish moors (see Figure 2).

In Scotland there was a slight improvement in breeding success compared with the previous year. © Laurie Campbell



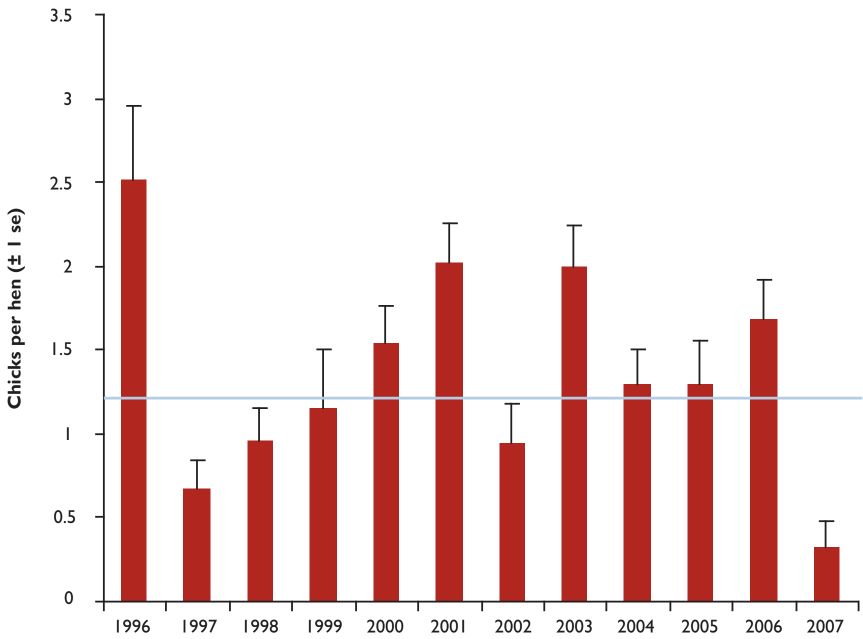
Black grouse

In the spring of 2007, we surveyed leks in the North Pennines as part of our black grouse recovery project. The results showed an 18% increase in numbers since 2006. We estimate the population to be close to 1,200 males, exceeding our 2010 Biodiversity Action Plan (BAP) target of 1,000 males. We are also making progress towards our other 2006 BAP target of expanding the range from 43 to 48 occupied 10x10 kilometre squares. We recorded black grouse displaying in the spring on the southern fringe of their range in the Yorkshire Dales in 10x10 kilometre squares where they had been absent in the 2006 survey.

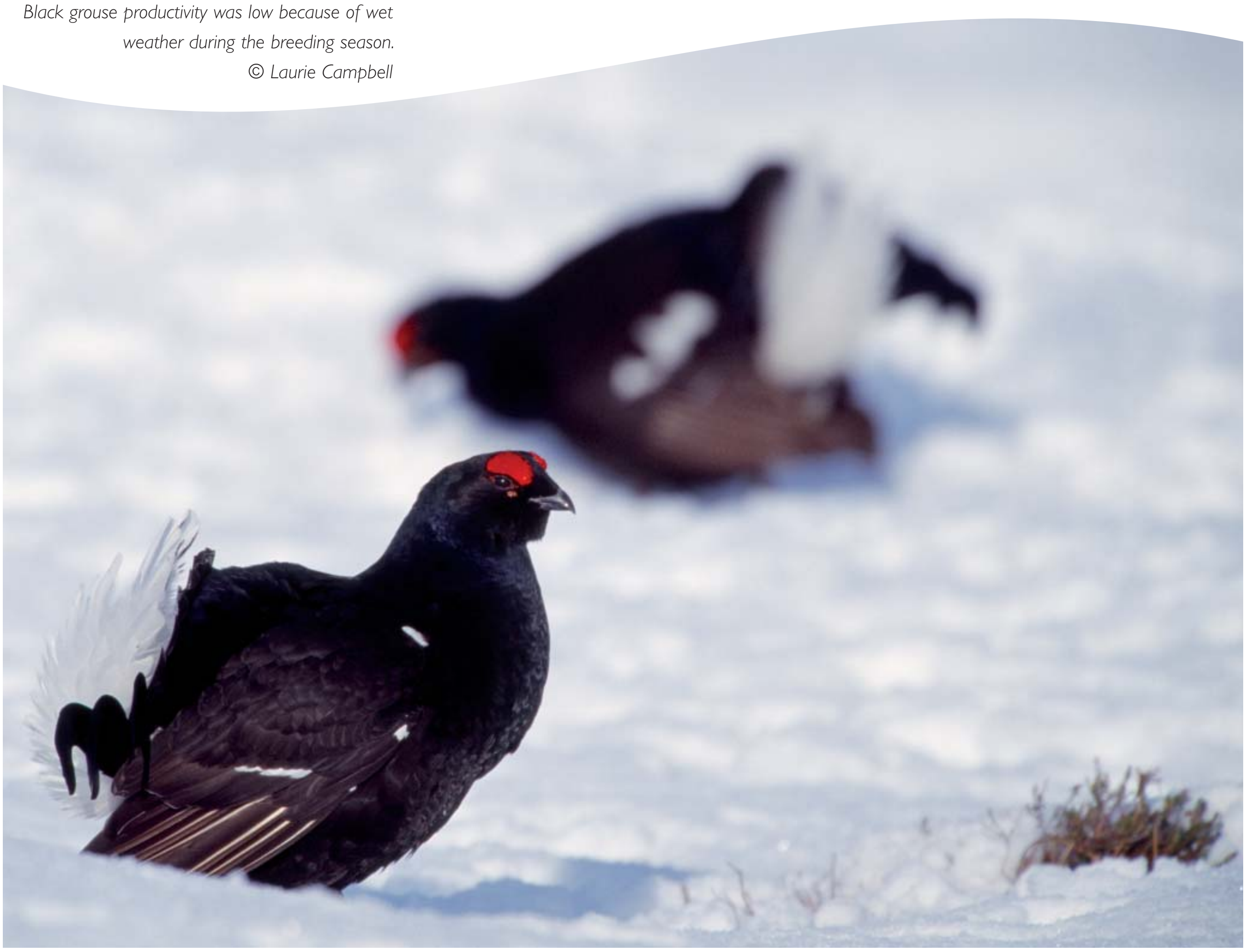
Figure 3

Black grouse breeding success in northern England between 1996 and 2007

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



Black grouse productivity was low because of wet weather during the breeding season.
© Laurie Campbell



Capercaillie had the worst breeding season for five years. © Laurie Campbell

On our long-term study sites, we found a total of 80 greyhens, but only 23% had broods, at an average of 0.3 chicks per hen. This breeding success is the lowest since 1996 (see Figure 3) and was caused by prolonged wet weather in June coinciding with the peak hatch. This is a setback, as productivity was lower than the 1.2 chicks per hen required to maintain population stability.

Capercaillie

Capercaillie also did badly in 2007. Our brood survey indicated that only 15% of hens managed to rear chicks at an average of 0.3 chicks per hen. This was the worst breeding season for five years and the second poorest in the last 17 years. Poor productivity was associated with bad weather in June when the chicks were hatching. This productivity is far below the 0.6 chicks per hen needed to maintain a stable population (see Figure 4). However, recruitment from the relatively large numbers of young in 2006 appears to have been good and the number of adult capercaillie found during the counts was up on 2006 by more than 20 birds.

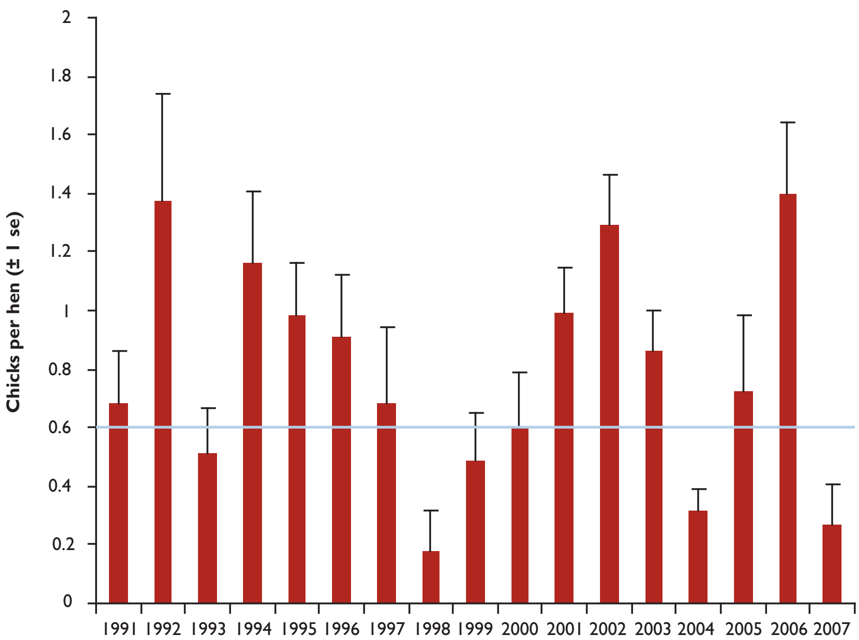


Figure 4

Capercaillie breeding success between 1991 and 2007* sampled from 10-20 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 2007, capercaillie breeding success was derived from a different subset of forest areas each year.*

Predation control and moorland birds

Golden plover have shown a marked response to predator control. © Laurie Campbell

KEY FINDINGS

- The Upland Predation Experiment has completed the final year of collecting breeding success data and has one more spring of breeding abundance data to be collected. The analysis of all the data are in progress from which firm conclusions will be drawn.
- Gamekeepers continue to reduce abundance of foxes and crows on the long-term keepered site and on the new keepered site. Fox and crow abundance have increased to pre-keepering levels where we have stopped controlling them.
- Waders and meadow pipits show a tendency for greater breeding success on sites with predator removal, but the trend in numbers of breeding pairs is not yet clear.
- Black grouse and grey partridges also show a tendency for better breeding success in the presence of predator removal, but the low numbers of these species means that analysis may not be conclusive.

Kathy Fletcher

2007 was the seventh year of the Upland Predation Experiment based at Otterburn in Northumberland. This project, funded by the Uplands Appeal, aims to test whether predator removal by moorland gamekeepers (ie. killing foxes, crows, stoats and weasels) improves numbers or breeding success of moorland birds other than red grouse. Species of conservation concern in the UK, such as golden plover, curlew, lapwing, skylark and black grouse, are of particular interest. The project consists of four plots, each about 12 square kilometres (1,200 hectares), on which bird numbers and breeding success have been monitored since 2000. There are two long-term plots which have remained under the same regime for the duration of the project; Ray Demesne has a full-time keeper, and Emblehope acts as an unkeepered comparison (see Figure 1). 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.

Predator indices from 2007 on Ray Demesne continue to indicate low numbers of all the main predators compared with the long-term unkeepered plot. In this third spring since keepering started on Bellshiel, the indices for foxes were 78% lower (from foxes seen per hour during spring lamping) and crows 87% lower (from carrion crows seen per hour on counts from March to August), compared with the average during unkeepered years. The stopping of predator control on Otterburn was linked to an increase in foxes to pre-keepering levels, and to an increase in crows, but this is 25% lower than in 2000 before keepering started. Although stoats and weasels are also culled on the predator removal plots, the abundance indices show no consistent trends. The abundance of large raptors (peregrine, hen harrier, goshawk and buzzard) is similar across all plots.

On Ray Demesne in the years with predator control, 53% of the 247 nesting attempts by curlew, golden plover and lapwing were successful compared with 28% of the 39 nesting attempts in 2000 without predator control (see Figure 4). On the unkeepered Emblehope plot (see Figure 5), only 12 (21%) out of 56 nesting attempts by waders were successful over the same period. In 2007 only two (6%) out of 31

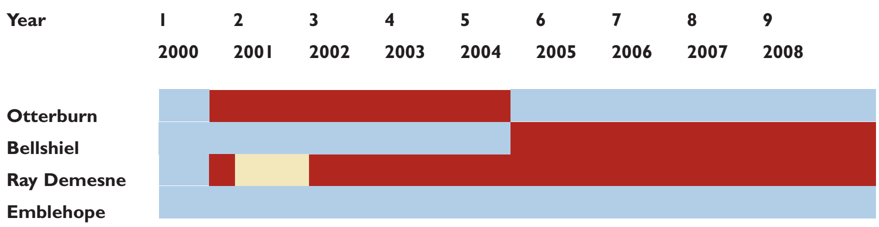
Figure 1

Diagram of the experimental design of the Upland Predation Experiment

Keepered

Unkeepered

Break in keepering and data collection in 2001 owing to Foot & Mouth Disease



Keepered period

TABLE 1

Spring pair counts in the Upland Predation Experiment, 2000-2007

a. Otterburn plot (keepered autumn 2000-2004, unkeepered since)

	Curlew	Golden plover	Lapwing	Red grouse
2000	17	5	3	26
2001	No data collected owing to Foot and Mouth Disease			
2002	14	11	6	40
2003	9	11	8	81
2004	11	10	6	143
2005	10	13	8	111
2006	16	11	3	69
2007	17	10	4	50

b. Bellshiel plot (unkeepered 2000-2004, keepered since)

	Curlew	Golden plover	Lapwing	Red grouse
2000	14	4	7	13
2001	No data collected owing to Foot and Mouth Disease			
2002	10	2	4	18
2003	7	0	1	14
2004	4	1	2	9
2005	3	0	0	14
2006	3	3	2	23
2007	3	1	10	30

c. Ray Demesne plot (keepered autumn 2000-2007)

	Curlew	Golden plover	Lapwing	Red grouse
2000	21	6	12	50
2001	No data collected owing to Foot and Mouth Disease			
2002	18	9	14	55
2003	22	8	18	92
2004	18	7	19	159
2005	17	7	17	165
2006	18	8	11	107
2007	20	8	8	77

d. Emblehope plot (unkeepered 2000-2007)

	Curlew	Golden plover	Lapwing	Red grouse
2000	4	7	2	26
2001	No data collected owing to Foot and Mouth Disease			
2002	4	7	1	22
2003	3	4	1	16
2004	3	3	1	19
2005	3	4	0	16
2006	2	2	0	18
2007	2	3	1	10

Controlling egg thieves like crows provides a better chance for upland waders like the curlew.
© Laurie Campbell

nesting attempts by waders were successful on the Otterburn plot, compared with 61 (71%) out of 86 attempts in the years when the plot was keepered (see Figure 2). The opposite trend occurred on Bellshiel (see Figure 3) with five (63%) out of the eight wader nesting attempts were successful in 2007 compared with only four (8%) out of

Figure 2

Otterburn plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2007 (no data for 2001 owing to Foot & Mouth Disease)

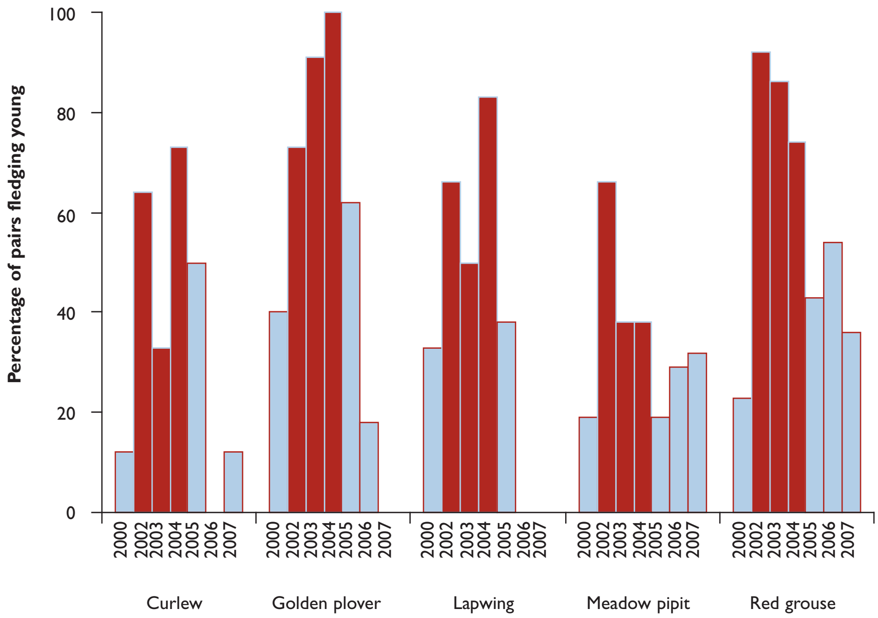
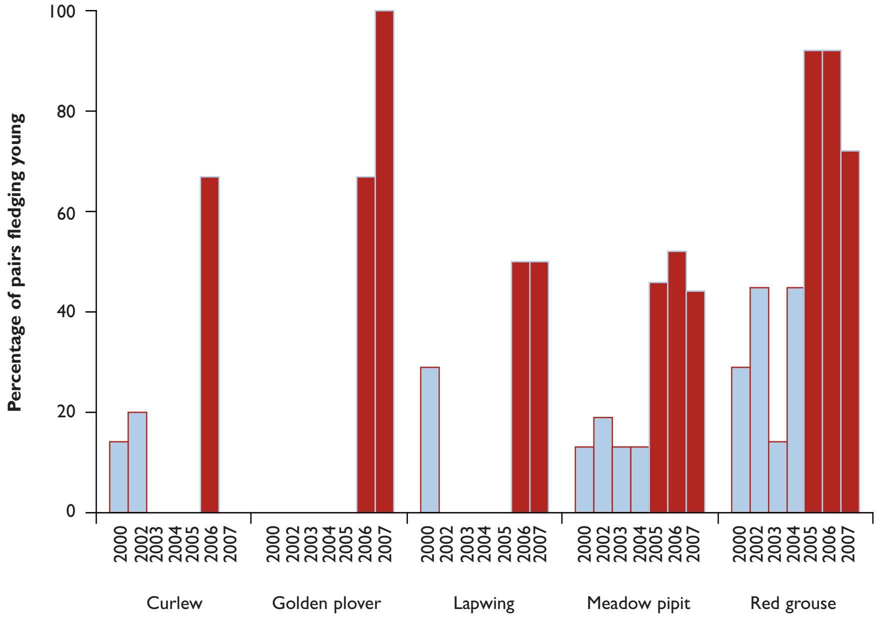


Figure 3

Bellshiel plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2007 (no data for 2001 owing to Foot & Mouth Disease)



The meadow pipit is one of the ground-nesting moorland species we monitor. © Laurie Campbell

the 51 attempts during the unkeepered phase. Compared with numbers of breeding pairs in the baseline year, golden plovers on Otterburn and lapwings on Ray Demesne may have increased slightly, but curlews declined on all plots during the first half of the experiment (see Table 1). On Otterburn since 2006, numbers of curlew have been stable. Meadow pipits seem to breed better with predator control, but the small number of nests that we find each year (on average 60 nests across the four plots) means that this trend will become clear only with more data (see Figure 2). Meadow pipit abundance shows no trend in relation to predator control, with numbers generally increasing regardless of treatment.

For all gamebird species, breeding success in 2007 was poor because of weather. Over the whole project, black grouse hens had on average 0.7 young per hen (18 hens) without predator control, but 3.9 young per hen (15 hens) with predator control. On Otterburn, grey partridges produced 4.9 young per pair (24 pairs) without predator control and 6.9 young per pair (43 pairs) with predator control. We have more data for red grouse and over the duration of the project on average 84% of hens had broods on Ray Demesne in years with predator control compared with the unkeepered plot, Emblehope, which had an average of 44% of hens with broods over the same time period.

Our findings suggest that predator removal may improve the breeding success of some species of ground-nesting birds in addition to red grouse. By the nature of the study, the numbers of pairs of most species are small and therefore demonstrating effect on breeding numbers is difficult. The figures and conclusions in this report are provisional. A final analysis of the project will be completed in 2008.

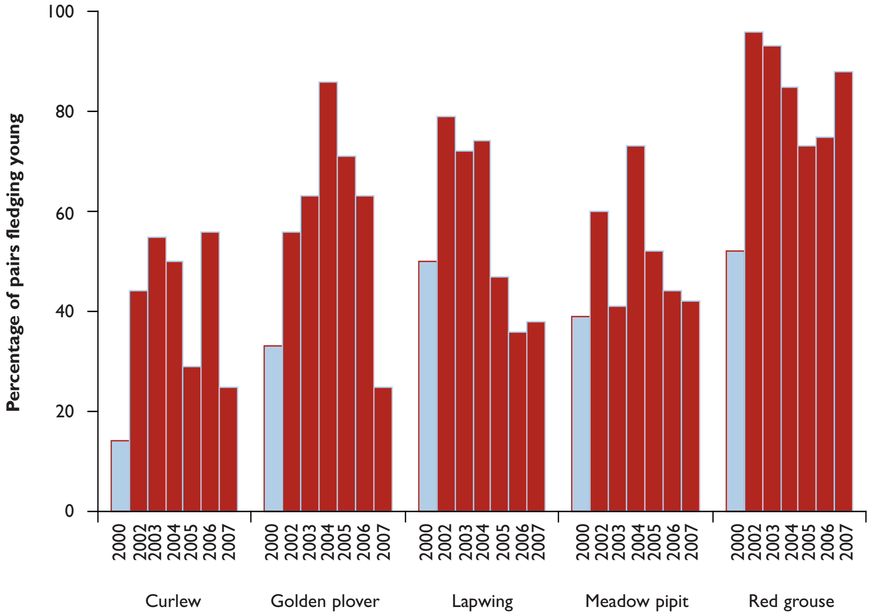


Figure 4

Ray Demesne plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2007 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered

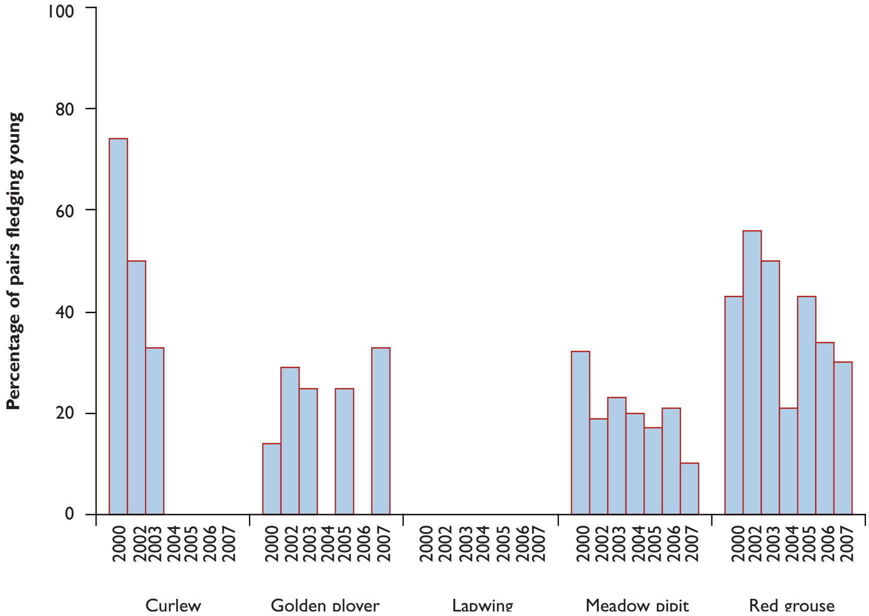


Figure 5

Emblehope plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2007 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered

Lapwings have done better where there is a keeper.
© Helen Foster/GWCT

Red grouse populations and shooting

© Nils Bunnefeld/GWCT

KEY FINDINGS

- At low shooting bags, proportionally fewer young grouse were shot than expected from the July counts.
- More old males were shot than expected from July counts when the bag was high.
- More old males were shot at the start of the shooting season.

Nils Bunnefeld

This study on red grouse compared age and sex ratios in the bag with those in the population before shooting. We collected data on shooting selectivity in 2005 and 2006 between mid-August and the end of September on nine moors in northern England. All data were from driven grouse shooting days where beaters drive grouse in the direction of a line of guns. A day of grouse shooting usually consists of four to five separate shooting locations (drives). We attended 45 drives and determined the total number of grouse shot, broken down by age and sex, for each drive. We calculated the length and the area of each drive and noted the number of beaters involved.

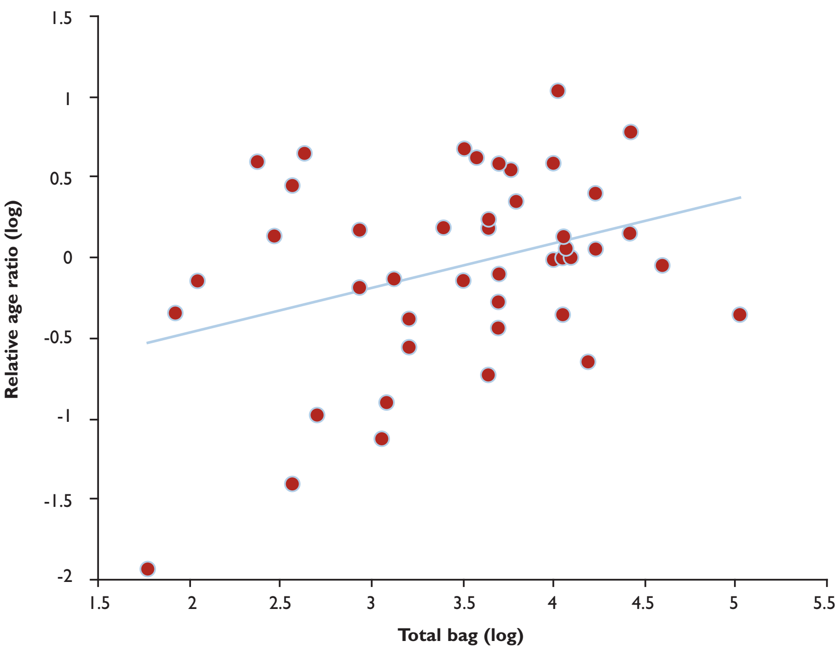
To compare the age and sex ratios of shot birds with the age and sex ratio of the population before shooting, we counted grouse in July 2005 and 2006 in the same areas where we collected shooting data. For all 45 drives we visited during the shooting season we knew the age structure, but we only had available the sex-ratio of the old birds for 33 drives. The counts were part of our long-term data collection to determine the ratio of old birds to young of the year and the sex ratio of the old birds.

We considered the relative 'young-to-old ratio' and relative 'sex-ratio' between the counts and the bag in relation to variations in the number of beaters per square

Figure 1

The young-to-old ratio of the bag divided by the young-to-old ratio of the July count (log-transformed) for different bag sizes

A log (bag/count) ratio above 0 for young/old means that a higher proportion of young birds were shot than occurred in the population before shooting.



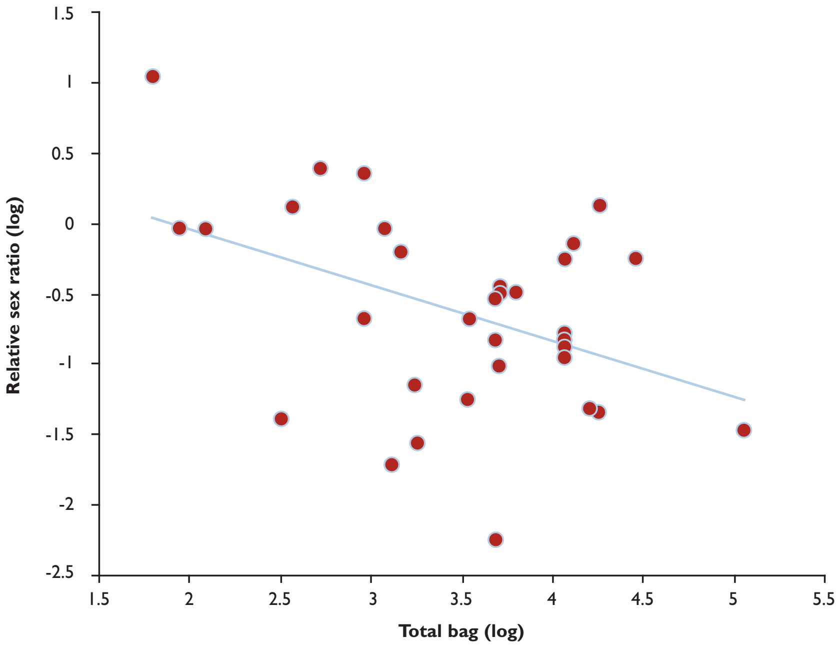


Figure 2

The female-to-male ratio of the bag divided by the female-to-male July count (log-transformed) for different bag sizes

A log (bag/count) ratio above 0 for females/males means that a higher proportion of females were shot than occurred in the population before shooting. The regression line was predicted from a mixed effect model.

kilometre (100 hectares), the length of the drive, the total number of grouse shot and whether the data came from the first, second or the third/fourth time the same area was driven in a season.

Although hunters cannot consciously select for a specific sex or age class during the shooting process, fewer young than old grouse were shot at low bag sizes, on average, than would be expected from the population composition before shooting (see Figure 1). The susceptibility of old males to shooting increased with bag size (see Figure 2). It was high early in the season, but decreased with the number of times an area was shot (see Figure 3).

The susceptibility of old birds to shooting might be driven by territoriality. Aggressive behaviour, which plays an important role for establishment of territories, increases with density and therefore old birds, especially males, might be more inclined to return to their territory and are therefore less likely to fly over the line of hunters in driven grouse shooting. However, single males that fly over the line of butts might be easier targets than females with family groups.

Our results have important implications for understanding red grouse population dynamics since recent research has found that parasites alone do not explain cycles in red grouse. Shooting and parasites might interact at high density such that old highly parasitized grouse remain in the population after shooting.

The study stresses that the assumption made in many studies that harvest records reflect the age and sex ratio of the population, and therefore reflect productivity, can be misleading.

Nils Bunnefeld with a sample of shot grouse.
© Nils Bunnefeld/GWCT

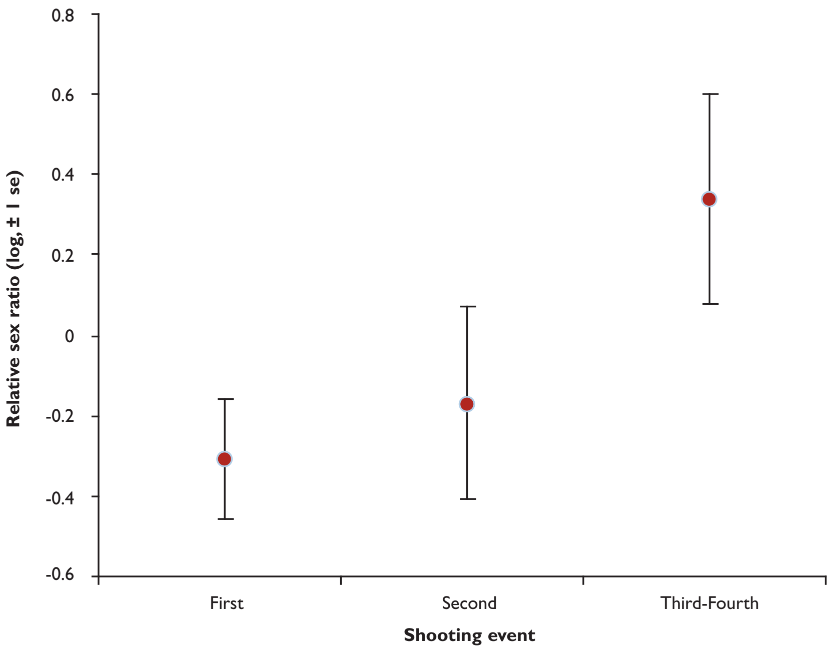


Figure 3

Predicted values from the mixed effects models for the female-to-male ratio of the bag divided by the July count (log-transformed) for different shooting events

A log (bag/count) ratio above 0 for females/males means that a higher proportion of females were shot than occurred in the population before shooting.

Development of improved medicated grit

The new medicated grit has better resistance to weather. © Laurie Campbell

KEY FINDINGS

- We now have a medicated grit that withstands weathering.
- Grit boxes are used by grouse, but the degree of use differs between moors.
- After one or more months of making grit available, 40% of grouse caecal pats from medicated plots contained effectively no worm eggs, compared with only 2% from non-medicated plots.
- The more grouse used medicated grit, the higher the percentage of worm-free caecal pats.
- Grouse breeding success was 19% higher on medicated plots than on non-medicated plots.

David Newborn

In 2007 we tested an improved medicated grit with a more persistent coating. Weathering trials of this new grit have shown that 70% of the drug is still present after nine months of exposure on the hill. This raises the concern that the drug could pass into the human food chain if access to it is not withdrawn before the shooting season.

To address this, the new grit is designed to be used only in grit boxes with two compartments: one containing medicated grit, the other non-medicated. A flip or slide lid regulates access to each compartment and hence determines the duration of exposure of the grouse to the drug. The initial questions we wanted to answer from this study were

1. Do grouse regularly visit grit boxes?
2. Is the drug released from the grit after being eaten by grouse?
3. Does grouse productivity improve with medication?

In March 2007, we selected two plots of 25 hectares on each of three Pennine moors, allocating medicated grit to boxes in one plot and non-medicated to the other. We spaced all boxes 100 metres apart so that there were 25 boxes per plot. Each box was a shallow tray (with each of the two compartments measuring 30 x 30 cm and 7.5 cm deep), and contained one kilogramme of grit. We collected fresh caecal pats from grouse from each plot each month from February to May to assess worm infection. At the same time, we recorded then removed evidence (feathers/faeces) of grouse activity.

Grit box use:

The index of box use by grouse differed between sites and was highest on the moor where grouse densities were also highest (see Table 1).

TABLE 1

Monthly percentage of grit boxes being used by red grouse containing either medicated or non-medicated grit

Moor	Treatment	March	April	May	Mean
Moor 1	Non-medicated	28	44	52	41
	Medicated	56	56	56	56
Moor 2	Non-medicated	85	80	80	82
	Medicated	80	75	71	75
Moor 3	Non-medicated	40	76	-	58
	Medicated	24	9	-	17

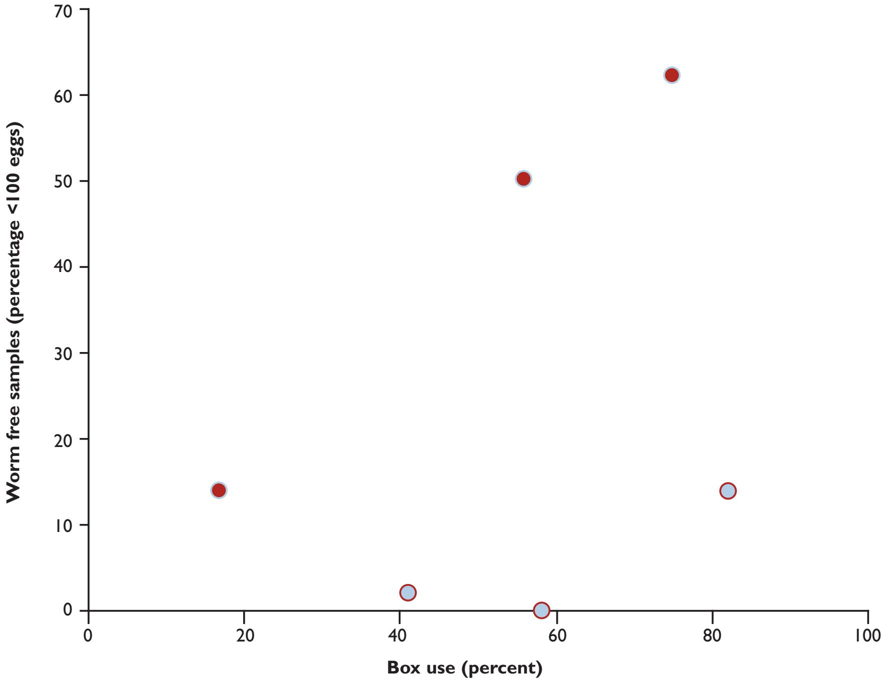


Figure 1

Grouse caecal pats containing fewer than 100 eggs (effectively worm free) on medicated and non-medicated plots

Medicated grit

Non-medicated grit

The percentage of grouse caecal pats that contained fewer than 100 eggs (effectively worm free) increased with box use by grouse on medicated plots but not on plots with non-medicated quartz grit. Each data point is a mean.

Worm burdens:
In February, before treatment, there were similar levels of worm eggs on all plots. By the end of March (after one month exposure) monthly egg counts were 66% to 92% lower on the medicated plots and 90% to 99% lower by the end of April (two months exposure). By the end of May, we found an average of only 100 worm eggs per sample on the medicated plots compared with over 12,000 eggs per sample on the non-medicated plots (see Figure 1).

Grouse counts:
On all three moors, breeding success was higher on the medicated plots, with an average of 8.5 young per hen (36 hens) compared with 6.1 on non-medicated sites (40 hens), a difference of 19%.

Strongylosis in England
Following the grouse population crash in 2005, red grouse populations are increasing. With increasing numbers of grouse, and the very mild autumn in 2007, there has been a considerable increase in the worm numbers, in particular in the young birds (see Figure 2). Parasite burdens in these young birds have increased more than 10 times from 2006 to 2007. However, worm burdens in adult birds have remained fairly static. Correct application of medicated grit should help to keep parasite burdens down in 2008.

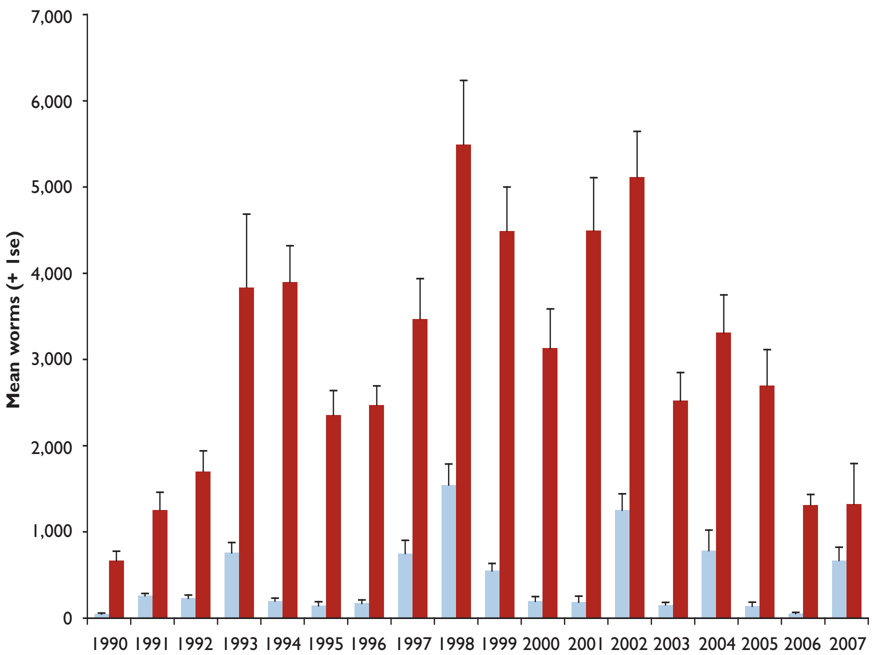


Figure 2

Mean worm burdens in adult and young red grouse on eight moors in the North of England, 1990–2007

Young grouse

Adult grouse

Snipe habitat use on moorland

KEY FINDINGS

- Snipe breeding on moorland was associated with marsh, acid flush and unimproved acid grassland.
- Feeding locations were close to ditches or pools and characterised by damp soil.
- Snipe diet during April-June consisted mainly of earthworms and cranefly larvae.

Andrew Hoodless

Moorland is increasingly important for breeding snipe. © Laurie Campbell

Breeding snipe have declined in lowland Britain since the late 1940s as a result of agricultural intensification, such that they are now patchily distributed. Snipe are more widespread and numerous in northern Britain and Ireland and are regular breeders on moorland and rough pastures in upland areas. However, despite the increasing importance of these habitats, snipe ecology on moorland is poorly understood. Using data collected during the Upland Predation Experiment (see page 40), we examined use of different habitats, the characteristics of feeding areas and snipe diet.

Average snipe density across our four study areas was 2.28 birds per 100 hectares (approximately 1.14 pairs per 100 hectares). There was a large difference in density between habitats, with densities ranging from 0.97 bird per 100 hectares on improved grass to 5.44 birds per 100 hectares on marsh. Snipe densities on marsh were 3.4 times higher than on heath and heath-grass mix habitats (see Figure 1). Densities on acid grass were 2.7 times higher than on improved grassland.

Comparison of 186 locations where snipe were disturbed during the day with 119 random points revealed no difference in vegetation height or density, but the sward was more tussocky at snipe flush sites. Taking into account differences between habitats, snipe locations were closer to wet ditches or pools than random points (averages 12 metres and 40 metres respectively) and the soil was wetter (average difference of one point on a five-point scale). Further comparison of habitat measures

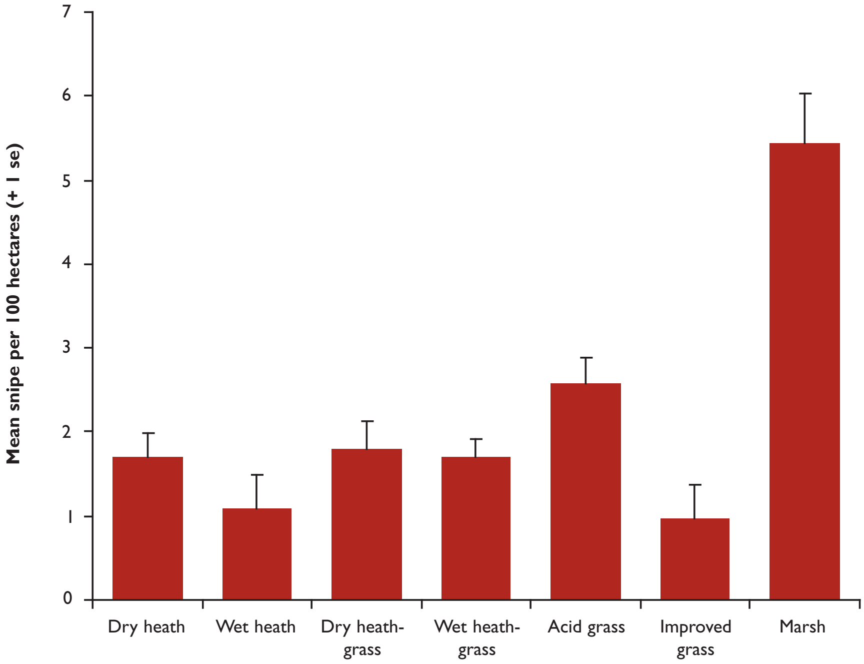


Figure 1

Mean breeding snipe densities on different habitats across four moors in Northumberland

at snipe locations with evidence of recent feeding and locations where birds were presumed to be resting (no probe holes), showed that birds fed close to ditches or pools and used areas with wetter soil.

Microscopic examination of faeces revealed that earthworms, cranefly larvae and midge larvae were numerically the most important food items of adult snipe, but they also ate a wide range of surface-active and other aquatic invertebrates. Earthworms and cranefly larvae accounted for 85% of estimated dry weight ingested. Comparison with a study of snipe diet on lowland wet grassland indicates that cranefly larvae are taken more frequently and more aquatic groups (dragonfly nymphs, midge larvae, aquatic beetles, freshwater snails and mussels) are eaten on moorland. Diet changed between late April, mid-May and early June, with more surface-active and aquatic prey taken in late April and more cranefly larvae taken in mid-May and early June (see Figure 2). Earthworms were the most important food throughout.

The availability of feeding areas on moorland may limit breeding density, with only low densities likely on extensive areas of dry heath, but high densities likely in areas with a mosaic of habitats including patches of marshy grassland and acid flush (damp areas dominated by rushes and *Sphagnum* moss). Rough grassland is likely to provide the most earthworms, but the soft soil near ditches and flushes makes earthworms and cranefly larvae more accessible. Ditches and flushes also support a much higher abundance of insects than heather-dominated moorland and are frequently visited by other birds such as meadow pipits and red grouse when rearing broods.

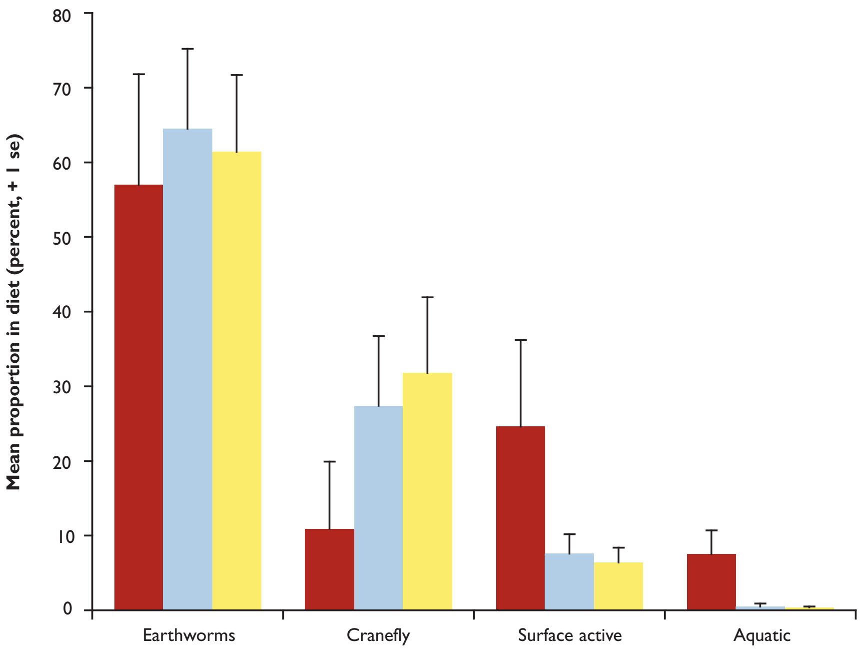


Figure 2

Comparison of mean proportions of estimated dry weight of prey ingested between late April, mid-May and early June

Sheep grazing, invertebrates and black grouse

Heavy grazing by sheep reduces the number of invertebrates eaten by black grouse chicks. © *Laurie Campbell*

With the RSPB, we are lead partners responsible for restoring black grouse numbers in the UK as part of the Government's Biodiversity Action Plan. In northern England, through our combination of research and subsequent management, black grouse numbers have increased from about 800 displaying males in 1998 to an estimated 1,200 males in 2007. Thus we have achieved our first major target of stabilising numbers ahead of our target date. How was this achieved? Our research has shown that black grouse respond well to habitat improvement along the moorland margin. In the North Pennines, we found that improved breeding success increased numbers of black grouse following reductions in sheep grazing, particularly in the autumn and winter. The key to this has been agri-environment payments (notably Countryside Stewardship Schemes), which pay farmers to restore heather on the moor edges through livestock reductions.

Grazing restrictions not only provide better cover from predators and more diverse herbs which adult black grouse eat but also, we suspect, more insects needed by growing black grouse chicks. By inspecting chick droppings from the North Pennines, we found that sawfly larvae comprised two-thirds of all invertebrates eaten by chicks, with moth caterpillars, beetles and spiders comprising most of the remainder.

To ascertain how reduced sheep grazing affected invertebrates important to black grouse chicks we sampled invertebrates at 10 sites in the North Pennines over two years. At each site, we selected two plots: one where sheep were either permanently or seasonally excluded, the second where sheep grazing continued at locally typical densities and duration. Eight of the 10 plots where sheep grazing was restricted were in Government-funded agri-environment schemes to promote recovery of ericaceous vegetation.

KEY FINDINGS

- More invertebrates were found in plots with restricted grazing.
- Numbers of sawfly larvae did not differ between grazing regimes.
- Invertebrate abundance responded quickly to grazing regime change.
- Breeding black grouse densities were higher where grazing was restricted.

Dave Baines

TABLE 1

Mean number of invertebrates (95% CL) caught by sweep-netting and by vacuum sampling in exclosures where sheep grazing was reduced, or in grazed areas without change

Group	Method	Exclosure	Grazed
Beetles	Sweep	2.0 (0.3-4.2)	0.6 (0.4-0.7)
	Vac	4.9 (2.6-7.2)	3.1 (1.9-4.3)
Plant bugs	Sweep	**59.8 (22.2-97.4)**	**26.8 (16.6-37.0)**
	Vac	**43.2 (21.7-64.6)**	**22.8 (18.0-27.6)**
Flies	Sweep	**15.0 (12.8-17.1)**	**23.6 (19.4-27.7)**
	Vac	**6.5 (5.0-8.0)**	**11.3 (8.0-14.6)**
Spiders & harvestmen	Sweep	**2.6 (0.3-4.8)**	**1.1 (0.7-1.6)**
	Vac	**10.2 (7.3-13.1)**	**6.9 (5.8-8.1)**
Hymenoptera adults	Sweep	4.3 (2.5-6.2)	3.6 (2.9-4.3)
(sawflies, wasps, bees, ants)	Vac	2.5 (1.8-3.2)	3.1 (1.5-4.7)
Sawfly larvae	Sweep	1.4 (0.9-1.9)	1.1 (0.5-1.8)
	Vac	0.4 (0.2-0.6)	0.3 (0.2-0.4)
Moth caterpillars	Sweep	0.24 (0.07-0.4)	0.15 (0.06-0.23)
	Vac	**0.18 (0.09-0.27)**	**0.04 (0.01-0.09)**
Total	Sweep	88.0 (49.6-126.4)	58.2 (46.8-58.2)
	Vac	**90.3 (64.5-116.1)**	**67.6 (57.3-77.9)**

Significant relationships are given in bold

Reduced sheep grazing was associated with, on average, 34% more invertebrates when sampled by sweep nets, and 23% more when sampled by a vacuum method. Plant bugs, spiders, harvestmen and moth caterpillars were significantly more numerous where grazing had been restricted, but flies were fewer. Notably, the abundance of sawfly larvae did not differ between grazing treatments (see Table 1), but moth caterpillars, beetles and spiders all preferred by chicks increased. Differences in invertebrate abundance between paired plots in relation to grazing did not increase over time since entry into the reduced grazing scheme, indicating that invertebrate abundance responded quickly to grazing changes.

Breeding densities of female black grouse were on average 41% higher where grazing had been restricted. However, differences in breeding hen densities between grazing treatments declined with time after the first three years of grazing reduction. Densities of black grouse were not related to the abundance of sawfly larvae, the primary invertebrate food of their chicks in this region. Instead, differences in vegetation structure were a better predictor of differences in hen densities, with decreased hen densities being associated with structurally less diverse vegetation.

Breeding densities of hen black grouse were higher where grazing was restricted. © Laurie Campbell

Abundance of ground-nesting birds at Langholm

Hen harriers are a contentious subject when it comes to grouse moors. © Laurie Campbell

The relationship between hen harriers and red grouse is highly contentious. Predation by harriers can limit grouse productivity, reduce shooting bags and ultimately can lead to the loss of grouse shooting and management. This was clearly shown to be the case on Langholm Moor during the Joint Raptor Study (1992-1997). In addition, there has been a lot of speculation about changes in the number of other moorland birds at Langholm Moor in relation to hen harriers.

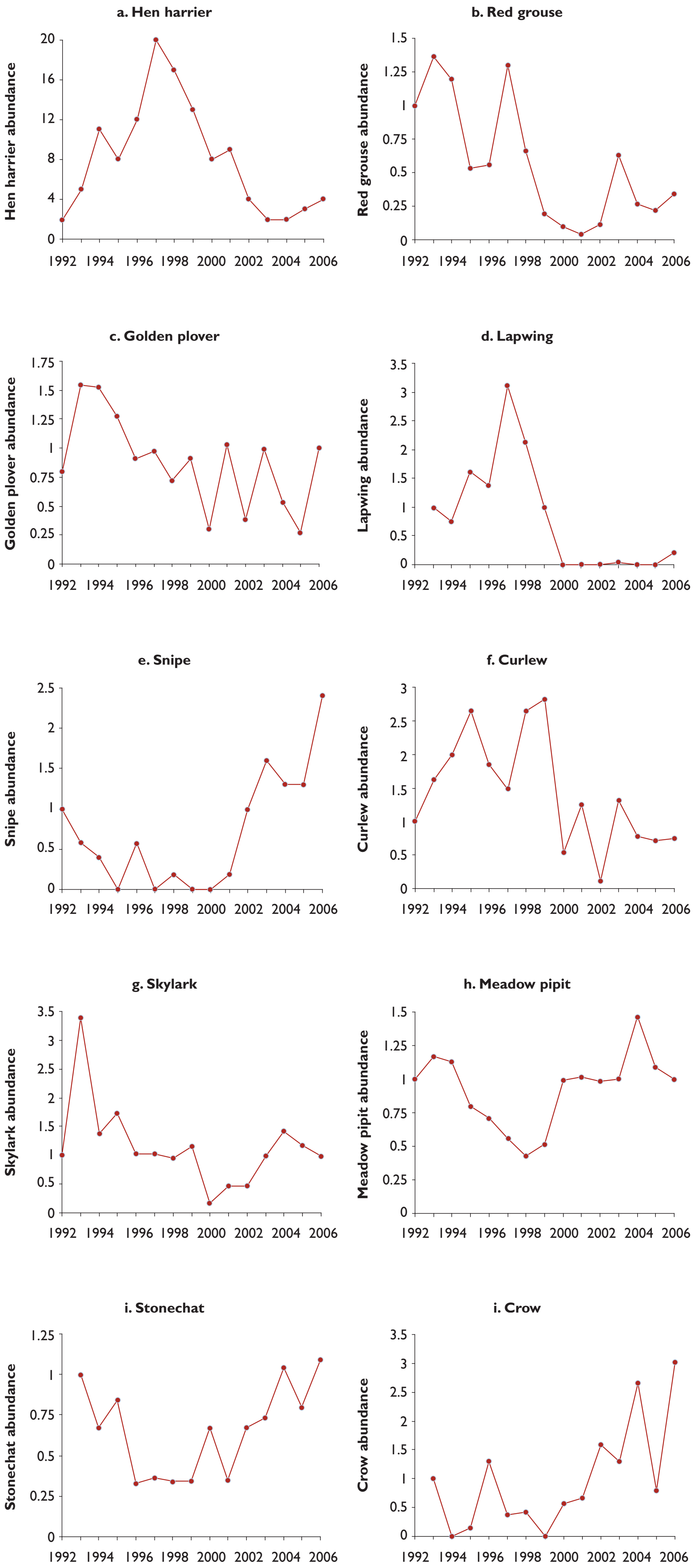
With recent support from Scottish Natural Heritage, we have been counting numbers of breeding ground-nesting birds within 15 sample 1x1 kilometre squares at Langholm. To do this, we have adopted a standard transect technique used by the British Trust for Ornithology's Breeding Bird Survey. We recorded all birds seen from two parallel one kilometre transects situated 500 metres apart within the grid square. We wanted to find out whether bird abundance changed during two periods of the study. First, between 1992 and 1997 when numbers of breeding hen harriers increased from two breeding females in 1992 to 20 in 1997 and, second, after grouse management ceased in 1999.

In all, we observed 50 bird species, but there were only sufficient data for analysis of 10. Of these, estimates of numbers of golden plover, skylark and meadow pipit differed between observers, whereas estimates of red grouse abundance differed

Figure 1

Trends in abundance of 10 birds species at Langholm Moor, 1992-2006

Data for hen harriers are the number of breeding females.



KEY FINDINGS

- Several species of ground-nesting birds including waders, red grouse and hen harriers declined following the cessation of game keepering.
- Cessation of predator control by gamekeepers was associated with more carrion crows and probably more foxes.
- Moorland passerines, chiefly meadow pipits and skylarks were fewer when there were more hen harriers. These observations together with studies of prey brought to harrier chicks suggested that harriers may negatively impact upon their preferred prey.

David Baines

TABLE 1

Differences in bird species abundance (mean birds per kilometre) when gamekeepers were present (1992-1999) and absent (2000-2006)

Species	Gamekeeper present	Gamekeeper absent
Hen harrier	11	5*
Red grouse	0.74	0.28**
Golden plover	0.38	0.21*
Lapwing	0.38	0.01*
Snipe	0.06	0.18*
Curlew	1.77	0.71*
Skylark	5.40	2.30**
Meadow pipit	17.2	19.8
Stonechat	0.22	0.31
Carrion crow†	0.10	0.44*

*Notes: Hen harriers = breeding females on the whole moor (n=15 years). *P<0.05, **P<0.01, ***P<0.001. † 2001 was used as the year that keepering stopped as carrion crow exhibited a one-year lag in recovering after being systematically trapped before 2000.*

There were significantly more skylarks when the area was keepered than when it was not.

© Laurie Campbell

As hen harrier numbers increased, stonechat numbers dropped and they rose again when hen harrier numbers fell. © Laurie Campbell

between dates of survey, with more birds being seen earlier in the season. Numbers of golden plover, lapwing, curlew and red grouse declined over time, whereas those of carrion crow and snipe increased (see Figure 1 on page 53). Hen harrier numbers increased then declined. Lapwing abundance was higher during the first, period but lower during the second. Moorland passerines (skylark, meadow pipit and stonechat) tended to be lower when harrier numbers were highest. Watches at harrier nests even suggest that predation by harriers on pipits may be important.

Numbers of golden plover, curlew, red grouse, skylark and hen harrier were all two to three times higher during the first half of the study when the moor was managed for grouse, than during the second half when management had ceased (see Table 1). Lapwings were virtually lost from our count areas after grouse management stopped. In contrast, numbers of carrion crows increased four-fold when gamekeeping, including crow control, stopped. This increase in predators like crows, as well as probably foxes, could have contributed to the declines in other bird populations, although other factors such as reduced habitat quality and variation in counts between different observers over time cannot be entirely ruled out.

ACKNOWLEDGEMENTS

Our thanks to our project partners, Buccleuch Estates, the RSPB and Scottish Natural Heritage.

Distribution of mountain hares in Scotland

Tracks left by mountain hares in snow.
© Laurie Campbell

KEY FINDINGS

- The area surveyed for mountain hares was 71,098 square kilometres (at the 10x10 kilometre level), equivalent to 90% of the total area of Scotland.
- Mountain hares were present on 34,359 square kilometres (48%) of this area and absent from 36,739 square kilometres (52%).
- Mountain hares were found more frequently on estates with driven grouse shooting (found on 64% of area) than on moors with walked-up grouse shooting (9%) and estates with no grouse shooting interest (0%).
- There was no evidence that culling reduced the distribution of mountain hares in Scotland.

Vikki Kinrade
Julie Ewald
Adam Smith

In 2007, together with the Macaulay Institute, we were commissioned by Scottish Natural Heritage to investigate the current Scottish distribution of mountain hares (a Biodiversity Action Plan species designated in 2007), assess the numbers taken for sport and pest control, and look for patterns of change relative to an earlier survey in 1995/96. We conducted a postal survey of estate owners, managers and gamekeepers who were our members, contributed to our National Gamebag Census, or who were members of the Scottish Gamekeepers Association, asking them whether mountain hares were present on their estates and numbers culled (if any) in 2006/07. We received additional mountain hare data from other organisations and members of the public.

The total area surveyed was 71,098 square kilometres (based on 10 x 10 kilometre squares), equivalent to 90% of the total area of Scotland. Of this area, mountain hares were present on 34,359 square kilometres (48%) and absent from 36,739 square kilometres (52%, see Figure 1). The extent of mountain hare distribution within estates was compared to the management of those estates. On average, mountain hares were found over 64% of the area of driven grouse moors, compared with 9% of walked-up grouse estates and 0% of estates with no grouse interest. It is known that mountain hares are associated with heather moorland managed for red grouse, and predator control for grouse is likely to benefit mountain hares too.

We compared the 2006/07 mountain hare distribution to that recorded in the 1995/96 survey which covered 20,936 square kilometres. Mountain hares were consistently present in 59% and consistently absent in 21% of the area in common between the two surveys. Of the remaining area, mountain hares were present on 10% in 1995/96 but not 2006/07, and present on 9% in 2006/07 but not in 1995/96. This suggests that there has been no net gain or loss in distribution in areas surveyed in both 1995/96 and 2006/07. However, it is not possible to assess whether mountain hare distribution has changed outside this area. In addition, it is not possible to comment on changes in mountain hare abundance during this time.

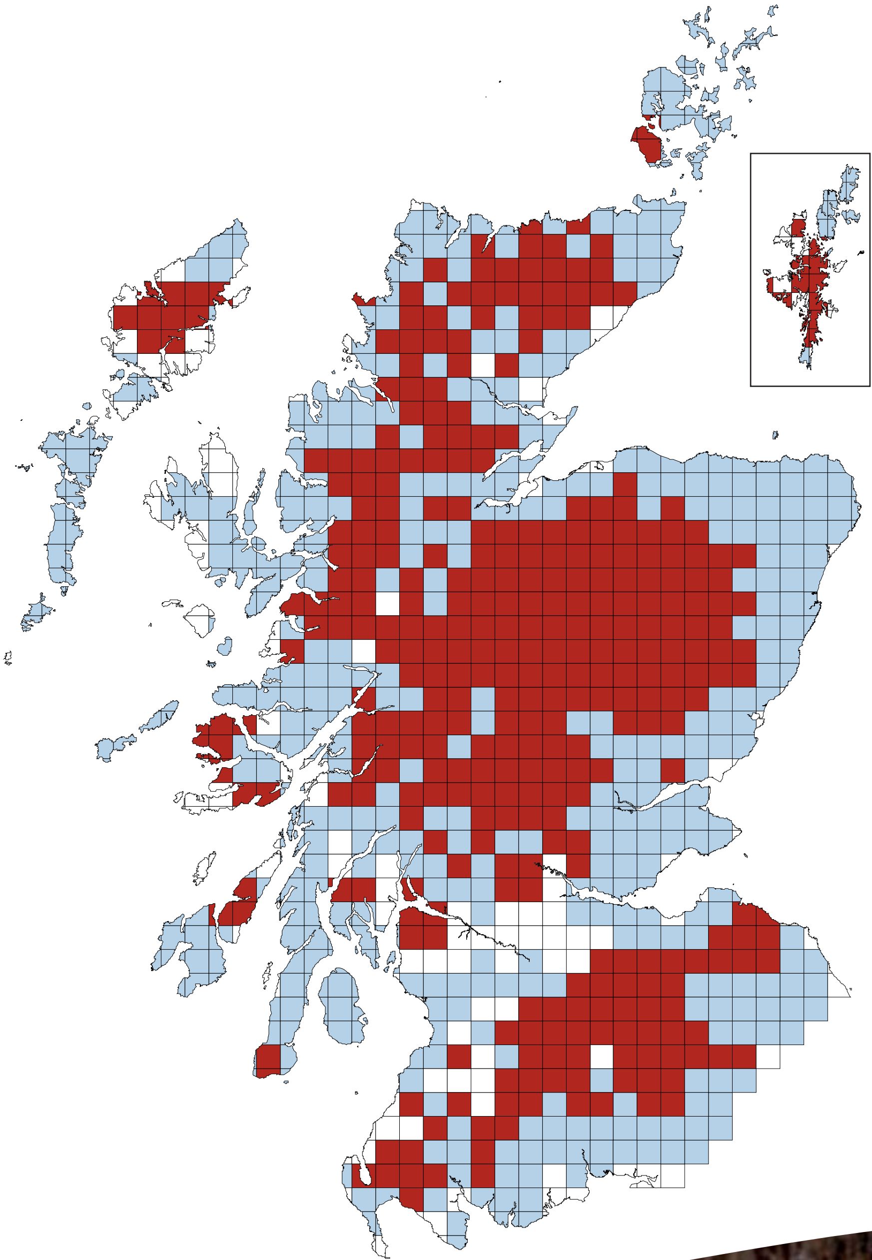
The main reason for culling mountain hares may have changed over the last 11 years. In 1995/96 the majority (60%) of mountain hares culled were culled for sporting purposes. Now only 40% are culled for sport, with the majority (50%) culled for the purpose of tick control, and only 10% culled to protect trees and crops.

The total number of mountain hares reported culled in 2006/07 was 32% more than in 1995/96 over the same area. There was no evidence that this culling is reducing the distribution of mountain hares in Scotland.

We believe that this survey could and should be repeated periodically to check mountain hare distribution. Additionally, measures of abundance are needed to track population changes.

Figure 1

Mountain hare distribution, 2006-2007



Mountain hares present

Mountain hares absent

Not surveyed

Each square is 10x10 kilometres.

ACKNOWLEDGEMENTS

Many thanks to the members of the Trust, the National Gamebag Census and the Scottish Gamekeepers Association as well as the public who supplied mountain hare information. Funding was provided by Scottish Natural Heritage.

We hope to repeat our mountain hare survey periodically. © Laurie Campbell

Summary of farmland research

KEY ACHIEVEMENTS

- We produced the final report for the Sustainable Arable Farming For an Improved Environment (SAFFIE) project.
- We conducted a review of the importance of arthropod pests and their natural enemies in relation to recent farming practice changes in the UK.
- We completed a project on assessing the environmental impact of crop production practice beyond the GM crop farm-scale evaluations.

John Holland

We completed the final report for the five-year SAFFIE project and we present findings from the experiment (see page 60) in which we tested the effects of a combination of different field margins and skylark patches on invertebrates.

In conjunction with ADAS, we conducted a review for Home-Grown Cereals Authority (HGCA) examining how the recent changes in farming practice and especially the new Environmental Stewardship (ES) scheme will affect important pests and their natural enemies in arable crops. We found that insecticides and molluscicides will remain the mainstay of pest control in the future. Of the ES options, well managed hedgerows provide the best habitat for natural enemies of crop pests (see Table 1). Although many of the ES options have the potential to support crop pests, there is little evidence that increased damage occurs as a consequence of pests utilising these habitats.

It is a sad fact that there is no biodiversity risk assessment in place before new agricultural practices are introduced. Over the last two years we have been part of a consortium which: a) produced a framework to test such an approach; b) evaluated the methodology used in the GM farm-scale evaluation trials to see if this was the most economic; and c) appraised whether the current UK wildlife monitoring schemes

TABLE 1

Extent to which natural enemies are supported within Environmental Stewardship habitats

ES option	Extent to which natural enemies supported within habitat
Hedgerow management	***(spiders, beetles, predatory flies, predatory bugs, parasitic wasps)
Protection/creation of uncultivated ground flora	**(spiders, beetles, predatory flies, predatory bugs, parasitic wasps)
Wild bird seed mixture	*(spiders, beetles, predatory flies, predatory bugs, parasitic wasps)
Flower rich habitats	***(predatory flies, predatory bugs, parasitic wasps)
Over-wintered stubbles	*(spiders, beetles)
Beetle banks	***(spiders, beetles)
Fallow plots	unknown
Reduced or no herbicide inputs	*(spiders, beetles, predatory flies)
Undersown spring cereals	**(beetles)
Uncropped, cultivated margins	**(spiders, beetles)
Non-inversion tillage	**(spiders, beetles, predatory flies, parasitic wasps)

**** High abundance, ** Medium abundance, * Some encouragement.*

would be suitable for assessing any changes after a new practice was adopted.

We started the farmland biodiversity project, which aims to determine whether management of uncropped land for biodiversity on conventional arable farms can achieve significant and measurable increases in biodiversity, which are at least equivalent to those attained on organic farms with a primarily arable cropping system. More specifically, we are investigating how the management of uncropped land, its proportion and distribution across the farm effects the abundance and diversity wildlife. On the uncropped land managed by the project for wildlife, we have established areas of insect-rich cover, wild bird seed, flower-rich grass and natural regeneration either in strips or blocks, covering 1.5 or six hectares of the 100 hectare study area. We have assessed plants, invertebrates, mammals and birds on these farms and on those in which the uncropped land was managed by the farm. The dry spring delayed drilling and on some farms there was poor establishment of the annual insect rich cover. A perennial brood rearing cover may prove more reliable and manageable; therefore, this autumn we established a trial comparing nine different grass and wildflower mixtures.

We are also involved in the largest government-funded project on biomass crops, and are collaborating with Rothamsted Research on the ecology of the two principal biomass crops, *Miscanthus* and short rotation coppice, and we will report on this work in 2008.

FARMLAND RESEARCH IN 2007

Project title	Description	Staff	Funding source	Date
Sawfly ecology	*Investigate the ecology of over-wintering sawflies*	*Steve Moreby, Tom Birkett, Steve Bedford*	*Core funds*	*2000-2008*
SAFFIE project (see page 60)	*To enhance farmland biodiversity by integrating novel habitat management approaches in crop and non-crop margins*	*John Holland, Barbara Smith, Sue Southway, Tom Birkett, Mark Gibson, Louise Bailey*	*Defra, SEERAD, NE, BPC, CPA, HGCA, RSPB, Safeway Stores plc, Sainsbury's Supermarkets Ltd, Syngenta Ltd, The National Trust*	*2002-2007*
Re-bugging the system	*To investigate large-scale habitat manipulation for biocontrol*	*John Holland, Imperial College, Rothamsted Research, University of Kent Steve Moreby, Sue Southway, Tom Birkett, Barbara Smith*	*RELU*	*2005-2009*
Farmland biodiversity	*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, Charlotte Harris*	*Defra, BASF plc, Bayer CropScience Ltd, Cotswold Seeds Ltd, Dow AgroSciences Ltd, DuPont (UK) Ltd, HGCA, PGRO, Syngenta Ltd, TAG*	*2006-2010*
Perennial brood rearing habitat	*To develop perennial brood rearing habitat for grey partridges*	*Barbara Smith*	*Core funds*	*2007-2010*
Arable arthropods review	*Importance of arthropod pests and their natural enemies in relation to recent farming practice changes in the UK*	*John Holland, Steve Moreby*	*HGCA*	*2007-2007*
Quarry restoration	*Measuring the success of quarry restoration*	*Barbara Smith, John Simper*		*2006-2009*
Birds in Miscanthus	*Study of birds in winter and summer* Miscanthus *plantations*	*Rufus Sage, Mark Cunningham*	*Defra*	*2006-2008*
PhD: Invertebrate aerial dispersal	*To examine the dispersal of beneficial invertebrates within arable farmland*	*Heather Oaten Supervisors: John Holland, Barbara Smith Dr M Thomas/Imperial College, London*	*RELU*	*2005-2007*
PhD: Bumblebee nesting ecology	*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*	*2005-2008*
PhD: The population genetics of sawflies	*The impact of population dynamics on genetics and the implications for habitat management*	*Angela Gillies 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	*Molecular analysis of intraguild 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; BPC = British Potato Council; CASE = Co-operative Awards in Science & Engineering; CPA = Crops Protection Association; Defra = Department of the Environment, Farming and Rural Affairs; HGCA = Home-Grown Cereals Authority; NERC = Natural Environment Research Council; PGRO = Processors and Growers Research Organisation; NE = Natural England; RELU = Rural Economy & Land Use; RSPB = Royal Society for the Protection of Birds; SEERAD = Scottish Executive Environment and Rural Affairs Department; TAG = The Arable Group.

Restoring biodiversity in winter wheat

The skylark was the only species in the study whose food items were significantly affected by the presence of wild flower margins or skylark plots.
© Laurie Campbell

KEY FINDINGS

- In general, invertebrate abundance declined with distance from the crop edge into the crop; in standard fields, the abundance of skylark food invertebrates was 72% lower at 32 metres than at one metre from the crop edge.
- Skylark food invertebrates were 31% lower at the crop edge in fields with a wild flower margin than in ones without. These results underline the importance of establishing conservation headlands or insect-rich cover along standard field margins.
- Wildflower margins and skylark plots did not affect the abundance of grey partridge chick-food invertebrates, so these measures will not enhance grey partridge chick survival.
- When no skylark plots were present, putting in a wild flower margin led to 23% more skylark food items (compared with standard fields). However, when skylark plots were present, putting in a wild flower margin led to 9% fewer skylark food items.

Barbara Smith

In 2007 we completed the final phase of the five-year Sustainable Arable Farming for an Improved Environment (SAFFIE) project, in which we collaborated with others to find ways of increasing biodiversity in winter wheat. In this experiment we tested two management options separately and in combination: skylark plots (now adopted as Entry Level Stewardship option: EF8) and six-metre-wide wild flower margins (EF4). We knew that the wildflower margins supported high numbers of invertebrates but our main aim was to determine whether these spilled over into the adjacent crop and skylark plots, providing a boost in food resources for birds that prefer to forage in more open vegetation.

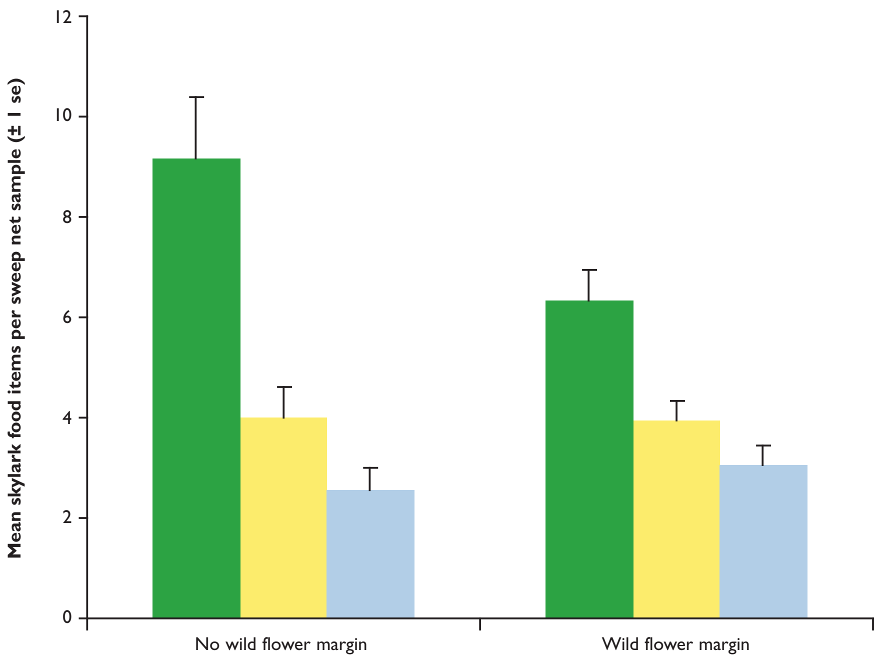


Figure 1

Mean skylark food items per sweep net (back transformed data) sampled at one metre, 16 metres and 32 metres from the crop edge

One metre
16 metres
32 metres

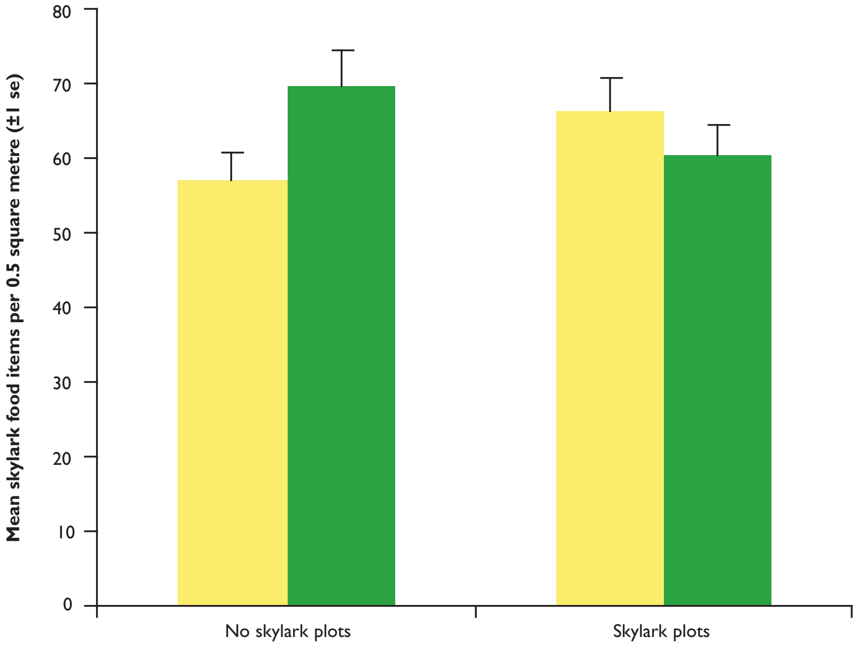


Figure 2

Mean skylark food items per 0.5 square metre (back transformed data) in fields with and without skylark plots and wild flower margins

No wild flower margin

Wild flower margin

[1]*CFI =(0.00614*plant bugs & hoppers) + (0.0832*(leaf beetles&weevils) + (0.000368*aphids) + (0.1199*caterpillars) + (0.1411*ground & click beetles). Potts, GR, Aebischer, NJ (1995) Population-dynamics of the grey partridge* Perdix perdix *1793-1993 – monitoring, modeling and management.* Ibis, *137, s29-s37 Suppl.*

[2]*SFI = Sum of snails + plant bugs + hoppers + sawflies + beetles + weevils + flies. Calculated using evidence from skylark faecal samples collected during the SAFFIE project.*

On each of 15 farms there were four treatments in conventional wheat fields: a) no skylark plots; b) skylark plots only; c) wild flower margins only; and d) skylark plots and wild flower margins. Over three years, we sampled the four fields on each farm in both first- and second-year wheat. Using pitfall traps, a suction sampler and sweep net, we collected invertebrates on transects at one metre, 16 metres and 32 metres from the crop edge. We also collected mid-field samples. Here we present the results, averaged across year, for the grey partridge chick-food index (CFI)[1], specifically calibrated for suction samples, and skylark food-items (SFI)[2], sampled by both suction sampler and sweep net. The CFI measures invertebrate food in terms of grey partridge chick survival; 0.7 is considered a good score.

In general, there were more invertebrates at the crop edge than in the crop. In standard fields there were 71% fewer skylark food items (sampled by sweep net) at 32 metres than at one metre from the crop edge; in fields with wild flower margins there were 51% fewer at 32 metres than at one metre (see Figure 1). Although not statistically significant, grey partridge invertebrate food and skylark food items (sampled by suction sampler) were also higher in abundance at the crop edge. There were 31% fewer skylark food items at the crop edge in fields with wild flower margins than at the edge of standard fields; we suggest that either the insects moved into the margins where there was more food or the insects were eaten by predators residing in the margins. These results emphasise how, in standard fields, the crop edge is important for invertebrates and the birds that feed on them. For this reason we have long recommended selectively sprayed conservation headlands to provide some weed cover for invertebrates in standard fields.

Mid-field, there was an unexpected effect of combining wild flower margins with skylark plots. In fields without skylark plots, wild flower margins led to a 23% increase in SFI (see Figure 2). Conversely, in fields with skylark plots, the presence of wild flower margins led to a 9% decrease. It is possible that this was due to higher predation by birds, as skylark densities were between 1.3 and 2.8 times higher on fields with skylark plots and wild flower margins than in fields without these habitats. However, this pattern was not replicated for grey partridge chick food items or skylark food items sampled by sweep net.

Overall, the abundance of invertebrates in wheat was low; the CFI was frequently lower than 0.5, which indicates poor partridge chick survival. There is some evidence that skylarks, which avoid the edges of fields, may have benefited from skylark plots by gaining access to food, but we have found no robust evidence to suggest that wild flower margins or skylark plots boosted overall abundance of invertebrate bird-food. Indeed, combining these options reduced the abundance of skylark food in the middle of fields. Conventional herbicide regimes were in place, thereby limiting weed cover and the insects associated with weeds. The utility of measures such as skylark plots and wild flower margins can be maximised only if more selective herbicide regimes are introduced.

ACKNOWLEDGEMENTS

Our research partners in the SAFFIE project (LK0926) were: ADAS, Royal Society for the Protection of Birds (RSPB), British Trust for Ornithology (BTO), Central Science Laboratory (CSL) and Centre for Agri-environmental Research (CAER, University of Reading). The project was sponsored by government departments, levy boards, wildlife and farming organisations, food retailers and the farming and crop protection industry's Voluntary Initiative, through the Sustainable Arable LINK programme. See www.saffie.info for more details.

Farmland birds in Scotland

The number of breeding yellowhammers seems to increase where farms provide food over the winter.
© Laurie Campbell

KEY FINDINGS

- Monitoring of new agri-environment scheme entrants in Scotland revealed an increase in breeding birds of 29% over five years (54% for songbirds).
- Farms providing over-winter food supplies showed an average increase in breeding yellowhammer numbers of 51%, compared with 28% on control farms.

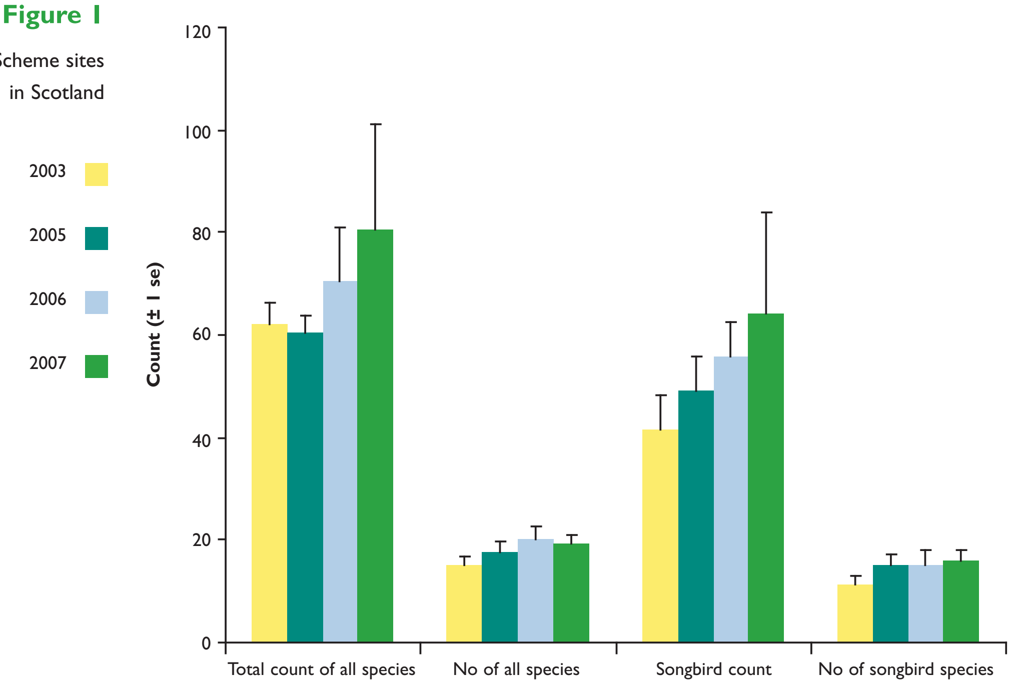
Dave Parish

We have two principal studies in Scotland that focus on farmland songbirds, both of which are looking at aspects of Scotland's main agri-environment scheme, the Rural Stewardship Scheme (RSS). For five years we have monitored songbird numbers at four sites in East Lothian, starting just after the farmers signed up to the RSS, and for three years we have investigated the impact of winter food availability – including that provided by the unharvested crop (very similar to game crops) prescription in the RSS – on the number of breeding yellowhammers in eastern Scotland.

When our surveys began in East Lothian in 2003 on our RSS monitoring sites, prescriptions had not been put in place so the number of birds seen were representative of numbers on typical conventional farms. With the exception of 2004, annual monitoring since then has recorded the change in breeding bird numbers as the prescriptions became established and matured. These prescriptions included grass margins, unharvested crops and changes to hedgerow management. Early morning visits to the farms in the spring and summer revealed good numbers of typical farmland species such as skylark, yellowhammer and whitethroat. Overall, we saw 47 species (35 songbird species and 12 species of waders, gamebirds, pigeons, raptors and waterfowl). Most importantly these surveys revealed a steady increase in bird numbers: up to 2007 the total number of birds seen, and the number of songbirds

Figure 1

Bird counts on Rural Stewardship Scheme sites in Scotland



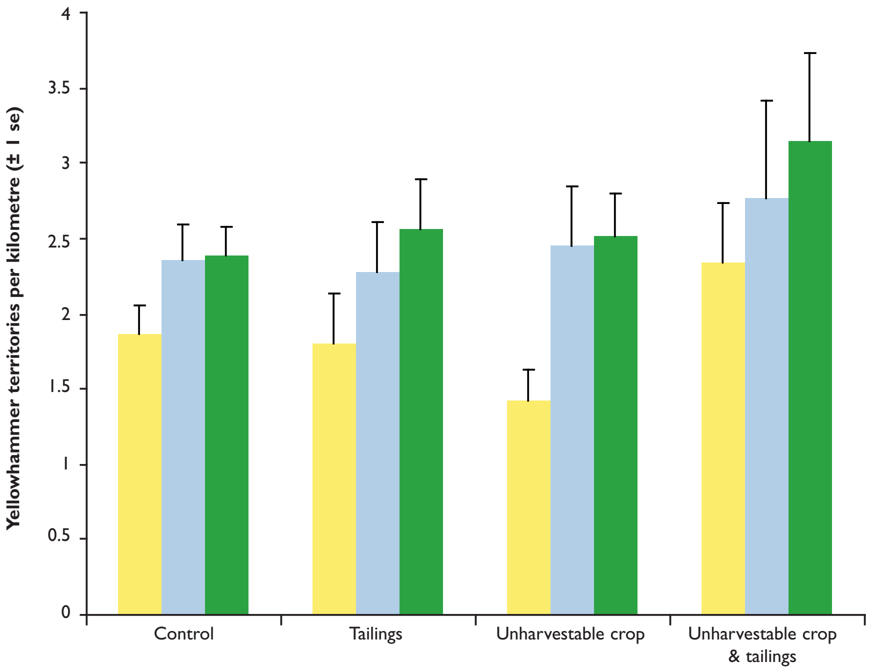


Figure 2

The impact of winter food on yellowhammer breeding numbers

2005

2006

2007

seen, increased significantly by 29% and 54% respectively, equivalent to average annual increases of 7% and 11% (see Figure 1). At the end of 2008 we hope to compare bird trends on the study farms with bird trends on farms across Scotland as recorded by the British Trust for Ornithology's Breeding Bird Survey.

Our experiment looking at the impact of winter food on the number of breeding yellowhammers is now in its third year and progressing well. We have taken 32 farms in eastern Scotland from Aberdeenshire to the Lothians and altered the availability of grain during the winter. None of them provided any meaningful winter feeding prior to the experiment: eight farms now provide a two-hectare crop of wheat that is left through the winter, eight put down grain-rich tailings from mid-January to mid-April, eight provide both forms of feeding and eight farms have been left unchanged. This design gives us farms providing food primarily in the first half of the winter (wheat crop only), farms with food available later in the winter and early spring (tailings only), farms with food available throughout (both methods of food provision) and farms with no additional food provided.

On average, the number of breeding yellowhammers has increased from 2005 to 2007 in all four treatment groups, probably reflecting the mild winters over the last few years (see Figure 2). The farms without any additional food have shown an average increase of 28% compared with 51% across all fed sites, although this difference is not significant. This is a complex picture that we hope will be clarified after the final year counts in 2008.

Scotland's main agri-environment scheme is the Rural Stewardship Scheme (RSS). © Laurie Campbell

Summary of the Allerton Project

KEY ACHIEVEMENTS

- Long term monitoring data added to.
- Farm profitability increased despite weather and animal diseases.
- Soil and water projects reporting important results.

Alastair Leake

The extremes of weather experienced on the farm in 2007 are a reminder to us of the extent that both our food supply and the wildlife which inhabits our farmland are subject to sometimes dramatic changes in patterns. During the wettest summer in living memory, it looked as if harvest would never come, but it did, and although yields were down, unprecedented world shortages saw commodity prices reach new heights.

Meanwhile, under the shadow of bovine TB, Foot & Mouth disease outbreaks and Blue Tongue, coupled with high feed costs and low returns, the livestock sector would be forgiven for giving up, ploughing up the grass and growing arable crops. Yet management of the farming and the countryside is a long-term occupation and isn't suited to knee-jerk reactions to a single season's results. The same is true of our game and songbird work. This began in 1992 with a baseline study, followed by a period from 1993 until 2001 of full keepering, then from 2002 until 2006 with no control of predators. Now we are into the next phase whereby we withdrew the 160 or so feeding hoppers on the farm. To complement the farm scale results that this will produce, we are filming feed hoppers on an adjacent farm. Earlier observations indicate that many other species benefit from this source of food. Our 'Wetting Up' project (see page 74) is showing that bunded ditches are proving beneficial for farmland birds. If this measure were to be widely adopted it could help protect us

LODDINGTON RESEARCH IN 2007

Project title	Description	Staff	Funding source	Date
Effect of game management at Loddington	*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 (see page 70)	*Annual monitoring of game species, songbirds, invertebrates and habitat*	*John Szczur, Alastair Leake, Steve Moreby, Sue Southway, Barbara Smith, Chris Stoate*	*Allerton Project funds*	*1992- on-going*
Grey partridge recovery project (see page 22)	*Restoration of grey partridge numbers: a demonstration project*	*Nick Sotherton, Malcolm Brockless, Tom Birkett, Julie Ewald, Roger Draycott, Nicholas Aebischer*	*GC USA, Research Funding Appeal, Core funds*	*2001- on-going*
SOWAP project	*Demonstrate use of conservation tillage to protect and enhance soil resources, water quality and biodiversity*	*Alastair Leake, Chris Stoate*	*EU Life, Syngenta*	*2003-2007*
Songbird ecology	*Ecology of songbirds at Loddington, including species-specific studies and influence of habitat on nesting success*	*Chris Stoate, John Szczur, Patrick White*	*Allerton Project funds*	*1992- on-going*
PARIS: Phosphorus from agriculture: riverine impact study	*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*	*2005-2008*
Wetting up farmland for biodiversity	*Assessment of bird conservation potential of small wet features on farmland*	*Chris Stoate, John Szczur*	*Defra*	*2004-2008*
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*
Herbicides for conservation headlands	*Evaluating dose rate and timing on weed populations in conservation headlands*	*Alastair Leake, Phil Jarvis*	*Bayer CropScience Ltd*	*2004- on-going*
Soil and waste management	*Training for farmers in the understanding of Soil Management Plans and the EU Waste Directive*	*Alastair Leake, Phil Jarvis*	*Course fees, Defra, Environment Agency*	*2005- on-going*
Wildlife seed mix agronomy using organic methods	*Developing management practices for organic farmers growing wildlife seed mixes*	*Alastair Leake*	*NE*	*2004-2007*
Environmentally sensitive slug control in arable crops	*Testing the efficacy of a new slug control active ingredient which is host specific and does not affect non-target species*	*Alastair Leake, Alex Butler*	*Omex Agriculture*	*2006-2008*
PhD: Birds and bees	*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	*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*	*2005-2008*
PhD: Game as food	*Wild food networks and sustainable rural developement in England*	*Graham Riminton 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; LIFE = European Union Financial Instrument for the Environment; NE = Natural England.

against the flooding caused by the 2007 summer's downpours by holding back water during times of flood, but making it available for wildlife during extended dry periods.

We are privileged to be able to take such an important and long-term view of how we conduct our farming and our research. This is not made easy sometimes by other rapid changes in circumstances. The total removal of the requirement of the EU Commission that farmers put land into set-aside is a particular challenge to us. This is because our variations to the system (ie. withdrawing predator control, then ceasing winter feeding) have been done against a permanent and consistent level of set-aside retention and management. We have needed to do this and remain credible with our most important audience – farmers and landowners. The loss of set-aside at this point in our research presents some challenges to us and, indeed, for any plans to establish a viable shoot again in the future.

The farming year at Loddington

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 & 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

Phacelia growing on set-aside at Loddington.
© Sophia Gallia/Natterjack Publications

2007 has been particularly demanding for both the arable and livestock sectors, with the weather and an outbreak of Foot & Mouth disease dominating a somewhat turbulent year. Summer came in April with high temperatures and much sunshine; during the entire month just 7mm of rain fell, the soil dried out and cracked open in

TABLE 1

Arable gross margins (£/hectare) at Loddington 1994-2007

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*	2007†
Winter wheat	773	1,007	981	551	668	723	572	603	518	836	536	591	837	772
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
Spring oilseed rape	433	-	-	-	-	-	-	-	-	-	-	-	-	-
Winter beans	450	626	574	616	507	553	573	331	452	491§	415§	541§	409§	694§
Winter oats	-	-	-	-	-	-	-	-	462	759	545	516	692	634
Linseed	473	535	-	497	-	477	-	-	-	-	-	-	-	-
Set-aside	301	331	335	326	296	317	205	204	251	247	217	194	213	194

* revised figures § spring beans †estimated figures

a way we normally only see in mid-summer. But the deficit was more than made up with 121mm in May, a further 120mm in June and, to top it off, 124mm in August, a total of 365mm falling in the three summer months, which is more than half the 30-

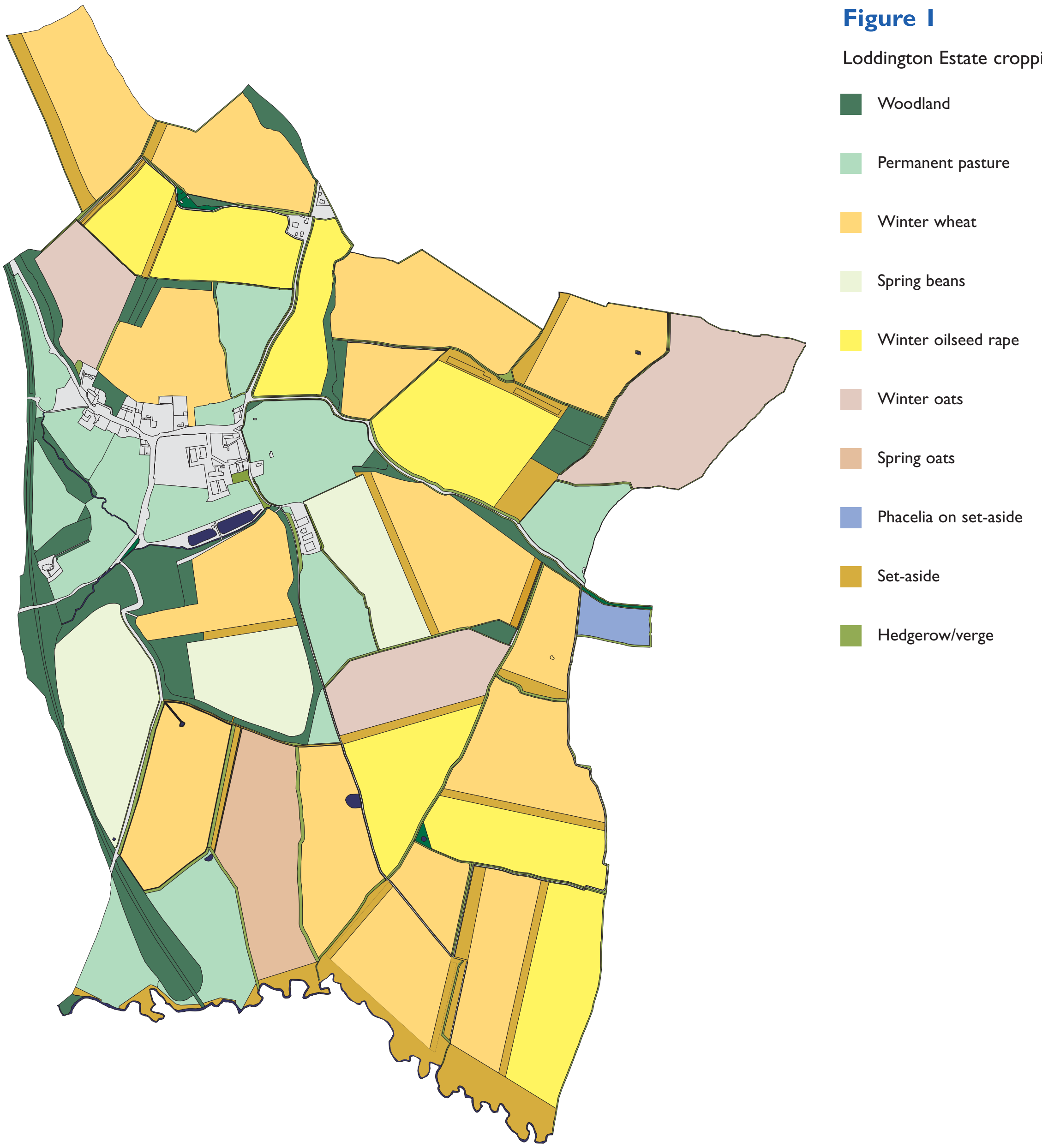


Figure 1

Loddington Estate cropping 2006/07

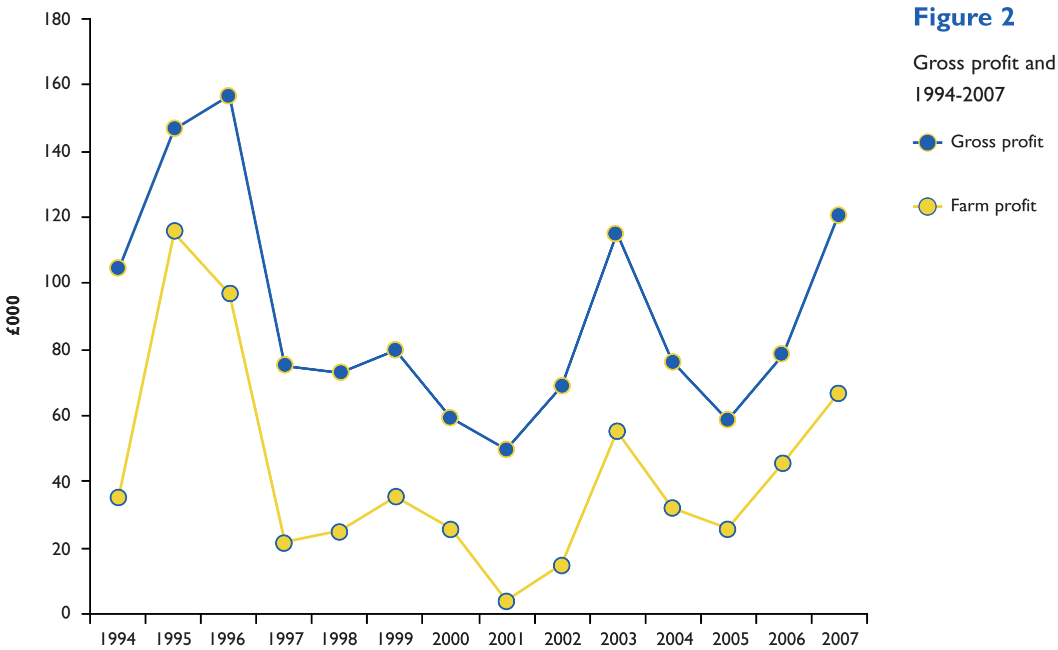


Figure 2

Gross profit and farm profit at Loddington 1994-2007

Figure 3

Crop yields at Loddington in 2006 and 2007

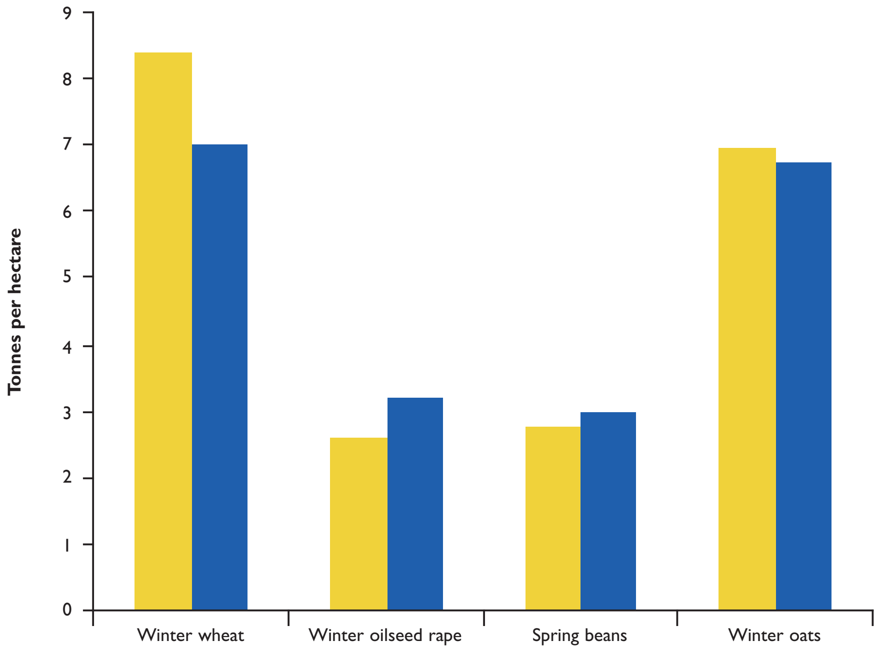


TABLE 2

Farm conservation costs at Loddington 2007 (£ total)

Set-aside (wild bird cover)[1]	
(i) Farm operations	1,003
(ii) Seed	1,122
(iii) Sprays and fertiliser	211
Total set-aside costs	**2,336**
Conservation headlands[2]	
(i) Extra cost of sprays	0
(ii) Farm operations	85
(iii) Estimated yield loss	1,009
Total conservation headland costs	**1,094**
Grain for pheasants	40
Grass strips	300
Stewardship (CSS & ELS)	10,271
Woodland	1,500
Total conservation costs	**15,541**
Stewardship income (CSS & ELS)	(14,500)
Total profit foregone	
- conservation	**1,427**
- research and education	**5,561**
	6,988

[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

Wildlife crops are grown in strips at Loddington.
© Sophia Gallia/Natterjack Publications

Winter wheat is the primary crop at Loddington.
© Alastair Leake/GWCT

year annual average of 650mm. Being high up in the catchment, any flooding that took place was transitory and localised, but other low-lying areas that received our flood waters were not so lucky.

When September came with just 41mm of rain, the combine harvesters were able to edge their way across the landscape. Both yield and quality suffered the ravages of the weather but things improved with a good market and a firming price. In response to steeply rising cereal prices and very tight global supply, the European Commission cut the rate of compulsory set-aside to zero for the 2008 harvest year, potentially freeing up 18 million hectares of land within the EU which could be brought back into production. This poses particular difficulties for the farm at Loddington where the set-aside has been deliberately spread across the landscape and managed to provide good habitat for game and other wildlife. Rotational set-aside and land which farmers withdrew from production over and above their mandatory amount (so-called 'eligible land not in agricultural production') are both relatively easy to release and crop. Set-aside land that supports options taken out through the Entry Level Stewardship Scheme will have to remain in place as part of the farmers' five-year contract, and land in difficult corners, wet hollows and strips around fields or adjacent to water courses will be more difficult to justify taking out. The set-aside land at Loddington is mostly made up of wide field margin strips or mid-field strips, often 20 metres wide, thereby representing a potentially large element of our profit foregone if not cropped that amounts to an estimated £25,000 for 2008 at current market prices.

Game at Loddington

KEY FINDINGS

- Stopping predator control has greatly reduced numbers of pheasants, red-legged partridges and hares.
- We have now started a period without winter feeding and are monitoring the contribution of this practice to autumn and spring numbers of gamebirds.
- This research will inform development of a new shoot at Loddington.

Chris Stoate
John Szczur

In the five years since predator control stopped, autumn numbers of gamebirds have fallen and, consequently, there has been no shooting at Loddington over this period. Autumn hare numbers also dropped (see Figure 1). The changes in hare numbers at Loddington are described in an article on page 77. This phase of the project has demonstrated how important predator control is to the management of wild game, supporting the experimental approach that we took on Salisbury Plain in the 1980s.

Spring numbers of pheasants have declined since we stopped predator control, but not as much as autumn numbers. In fact, for three years, spring numbers were at least as high as autumn numbers. This must have been due to immigration from neighbouring areas where birds are released, which might in part be because of the habitat, but also because of the food we have provided through the winter. Feeding through the winter was probably the key to maintaining pheasants at Loddington in the absence of predator control.

Winter feeding is a widely adopted game management practice. To understand its impact on both game and non-game species, in 2006/7 we reduced feeding from 140 hoppers to just 10, and in 2007/8 we stopped altogether.

By spring 2007, numbers of pheasants were down to 96, lower than the 114 present in the previous autumn and the first sign of a response to the considerably reduced feeding. By autumn 2007, red-legged partridges were down to just 11 birds, compared with 140 in 2001. At 92 birds, autumn pheasant numbers were just 17% of the number present when predator control finished (see Figure 2). However, our casual observations are that pheasants and red-legged partridges move onto the farm from adjacent areas through the early part of the winter, probably in response to disturbance associated with shoots in those areas. Whether these birds stay at Loddington through to spring 2008 in the absence of winter feeding remains to be seen. The late winter period is a time of food shortage and our current phase without winter feeding will help us to determine to what extent habitat and food contributed to the maintenance of spring numbers in the past.

We have now stopped winter feeding of pheasants at Loddington. © Laurie Campbell

The number of hares at Loddington has plummeted in recent years. © Laurie Campbell

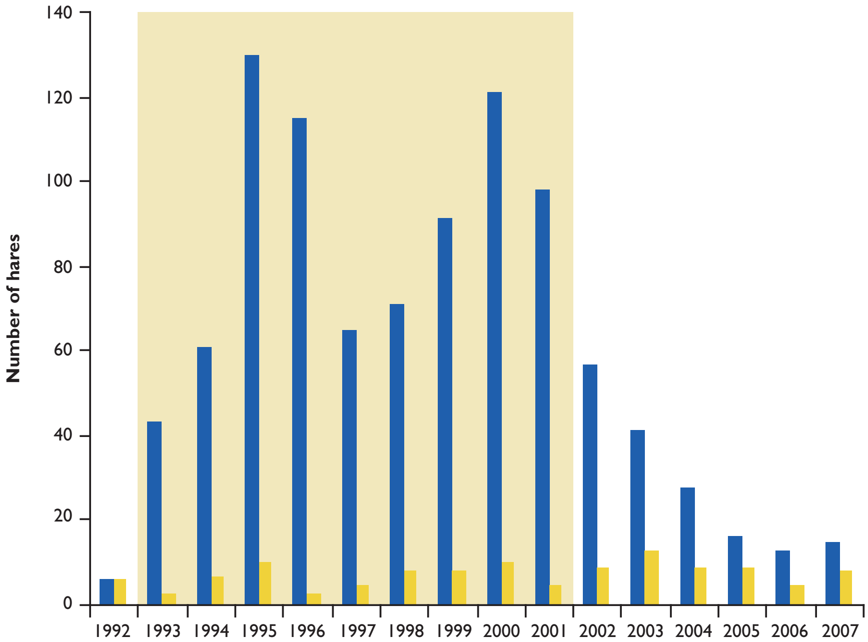


Figure 1

Number of hares at Loddington and a similarly-sized farm nearby as a comparison

Loddington

Comparison farm

Keepered period

It is not just gamebirds that use hopper feeders and we are filming hoppers on a neighbouring farm to understand better their use by songbirds and pests.

Ultimately, we are keen to restore both winter feeding and predator control at Loddington so that a viable shoot can be developed on the farm.

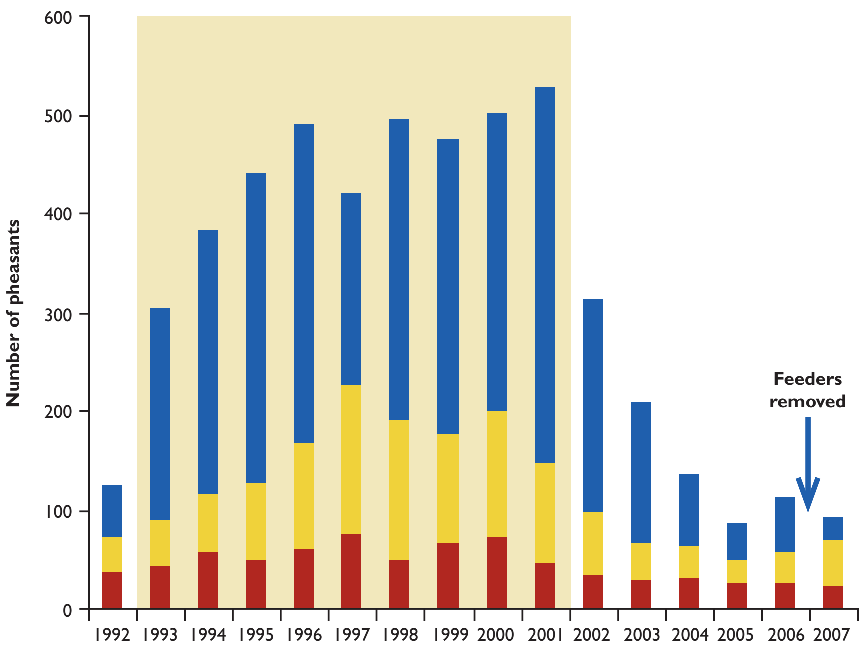


Figure 2

Pheasants in autumn at Loddington

Young

Hens

Cocks

Keepered period

Songbirds at Loddington

Dunnock make considerable use of hoppers put out for game. © Laurie Campbell

KEY FINDINGS

- For five out of six study species, nest survival was lower without predator control than it was with it.
- Breeding numbers show a decline in the first year following reduced winter feeding but longer-term monitoring is required to put this into perspective.

Chris Stoate
Patrick White
John Szczur

There are currently two aspects to our research on songbirds at Loddington. One is a detailed statistical analysis of songbird nest survival and the relative effects of predator control, adjacent habitat and weather in the periods with and without predator control. The other aspect of our work is continued monitoring of songbird numbers in response to our changing management. 2007 was the first year in which we reduced winter feeding to assess the effect of this widely adopted game management practice on both game and non-game species.

We expect that two main aspects of game and wildlife management at Loddington – predator control and habitat management – will have an effect on songbird breeding success. Our most recent investigation has focused on farm scale effects of predator control at Loddington, and comparison sites at Owston and Horninghold. Loddington was subjected to continuous and intensive predator control between 1993 and 2001 inclusive, whereas these nearby farms were not.

Our previous analysis showed that there was an initial increase in nest survival probability when we first introduced predator control in 1993. Our most recent analysis of the data for subsequent years reveals that, for all species except white-throat, nest survival probability was significantly higher during years with keepering than years without (see Figure 1). In an earlier analysis, we obtained similar results when we compared nest survival between keepered and non-keepered sites for the period up to 2001. Together, these findings provide strong evidence for an effect of predator control on songbird nest survival. However, our on-going work is testing this more formally by treating the other farms as control sites. We will also explore the influence of adjacent habitat, using the high-resolution GIS data available for Loddington. For example, does the provision of field boundary habitat influence the susceptibility of hedgerow nests to predation when predators are not controlled?

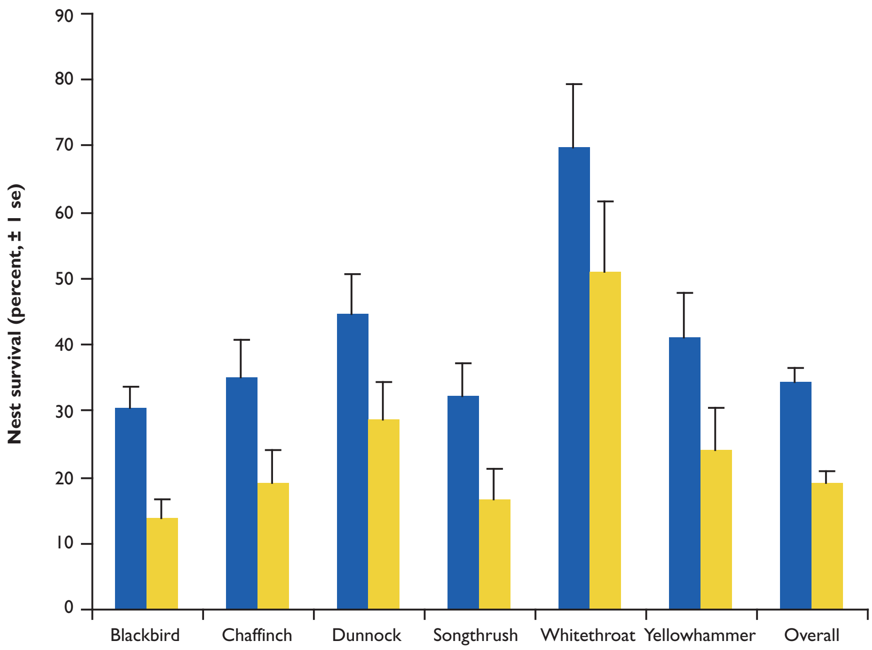
As with nest survival, we can expect breeding numbers of various songbirds to be affected by our changing management in different ways. Songbird territory mapping

Figure 1

Nest survival of songbirds at Loddington

Keepered period

Unkeepered period



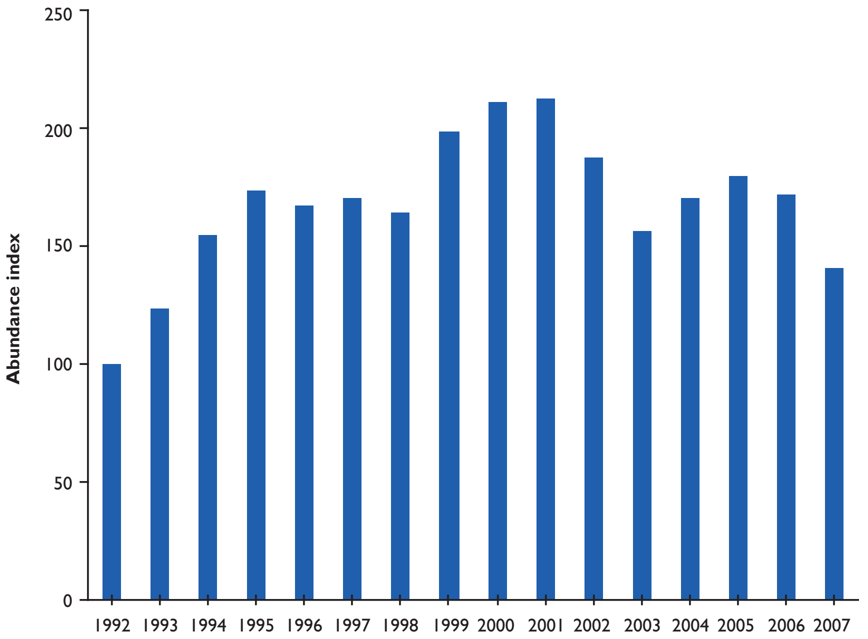


Figure 2

Abundance index of songbirds at Loddington 1992-2007 (where 1992 as reference year = 100)

revealed that numbers of some species declined during the period without predator control (see *Review of 2006* page 54). However, annual transect data suggest that most of this decline took place in the first two years after our keeper left, when winter feeding was also relaxed. When winter feeding was fully restored, overall abundance stabilised. Some of the species to decline in the absence of predator control, such as blackbird and dunnock, are known to make considerable use of hopper feeders put out for game. We are now in a period without winter feeding to determine to what extent, if at all, these species decline further. In the 2006/7 winter, we reduced the number of hoppers from 140 to just 10 and, although winter songbird numbers did not drop dramatically, our annual transect data suggest a decline in songbird abundance the following spring (see Figure 2). In 2007/8, we have withdrawn winter feeding completely and we will continue to monitor the response.

Our analysis of nest survival in relation to predator control, together with our monitoring of changes in overall bird numbers in response to our changing management, will improve our understanding of the influence of game management on songbird conservation.

Nest survival of chaffinches was significantly better when a keeper was present. © Laurie Campbell

Wetting up farmland for wildlife

KEY FINDINGS

- Small wet features such as bunded ditches produce more insect food, and are used more by birds, than relatively dry control plots.
- Areas of bare mud created more insects. Over-hanging hedges reduced insect numbers.
- These wetland features may also help to reduce soil run-off and diffuse pollution. If that can be built into the design, they become significantly more cost-effective.

Chris Stoate
John Szczur

Right: Insect emergence traps made and run by Ponds Conservation. © Chris Stoate/GWCT

Below and opposite: Blackbirds and robins were the most frequent visitors of bunded ditches. © Laurie Campbell

The draining of farmland and resulting loss of ponds and boggy areas is thought to have contributed to the decline of songbirds such as song thrush and tree sparrow. Damp ground and pond edges offer foraging habitats that are used during the breeding season when they are gathering insects for their young. Of course, standing water is also used for drinking and bathing. From work done in Portugal, we know that availability of water can determine numbers of gamebirds in dry environments, and the drier summer conditions predicted under some climate change scenarios could well influence our game and songbirds here in Britain.

We carried out our wetting up farmland for biodiversity project at Loddington and neighbouring farms in 2005 and 2006 and tested the suitability of different wet habitats for birds and their invertebrate food. The main feature was a 'bunded ditch' with an earth dam across the ditch to allow water to back up behind it. The plan was to retain water on the farm for longer into the summer than would otherwise be the case. We created 16 bunded ditches on arable land and 16 in pasture. We also assessed a smaller number of 'paired ponds' in which we diverted water from a bunded ditch into a pair of field corner ponds separated by a grass strip. With colleagues from the RSPB, Ponds Conservation and Reading University, we assessed the abundance of terrestrial and aquatic invertebrates and the use of these features by songbirds. We surveyed invertebrates using sweep netting and pitfall traps, and for the aquatic invertebrates, emergence traps on the surface of the water or exposed mud. We collected insect samples every other week during the spring and summer. To monitor visits by birds, every week we watched from hides for 45 minutes.

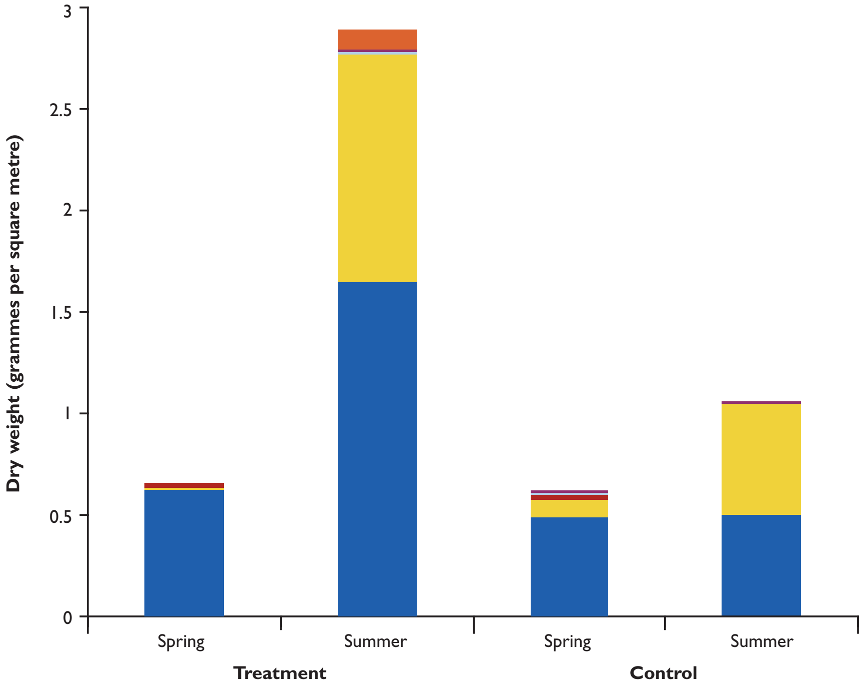


Figure 1

Dry weight of insects per square metre in bunded and control ditches in spring and summer

- True flies (Nematocera)
- True flies (Brachycera)
- Stoneflies (Plecoptera)
- Mayflies (Ephemeroptera)
- Caddis flies (Trichoptera)
- Dragonflies (Odonata)

Both bunded ditches and paired ponds were successful in retaining water into the summer more than control plots (without bunds) within the same field boundary. We assessed aquatic invertebrates only in bunded ditches. We found an average of 1,400 insects (mainly flies) per square metre in bunded ditches, compared with 900 per square metre in the control sections (see Figure 1). The proportion of bare mud was the main influence on insect biomass, and therefore food for birds. As bunded sections of ditch tended to be wider than control sections, bunded ditches produced about four times the insect biomass overall. The extent of hedge overhang had a negative effect on insect biomass, so ditches with cut-back hedges and exposed mud seem to be best in terms of providing insect food for birds.

For both bunded ditches and paired ponds, birds made significantly greater use of the bunded or pond sections of ditch than control sections. This was the case for both years, and the difference in use was greatest in spring and summer when birds were recorded more than twice as frequently in the bunded sections (see Figure 2). Greatest use by birds was associated with high aquatic insect biomass and area of bare mud.

Birds benefit from the new features through additional sources of insect food. However, the numbers of birds involved were relatively low, and larger features than we created may have greater benefits. Bunded ditches and paired ponds also help to counteract the effects of erosion on water courses by allowing sedimentation of coarse material. It is such multifunctional benefits that need to be explored further to develop the most cost-effective design to adopt more widely.

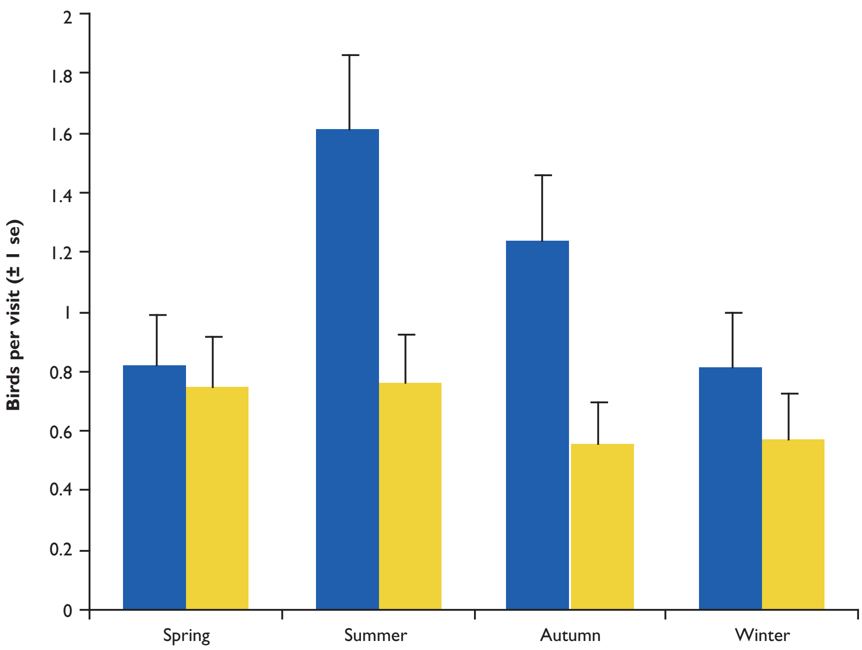


Figure 2

Relative use of bunded and control ditches by birds, based on weekly watches of 16 ditches

- Bunded
- Control

ACKNOWLEDGEMENTS

This project was funded by Defra.

Summary of predation research

KEY ACHIEVEMENTS

- Breakaway fox snare progresses to extensive field trial.
- DOC traps approved by Defra and begin field testing for refinements.
- River Dore water vole reintroduction wins new funding for second phase.

Jonathan Reynolds

We are constantly being challenged to establish the adequacy of existing predation control practices: do they work, are they humane, are they target specific, are they efficient, do they meet expected standards? At the same time, we try to identify ways in which those practices can be improved. Because many existing practices are tested by experience over decades, any novelty we propose has to be a real and demonstrable improvement.

To prove adequacy, we have to use the machinery of science. It's slow and therefore expensive. At the same time, we must be expert practitioners ourselves, familiar with the techniques in the field. And beyond that, we have to appreciate what it takes to create commercially-viable products for a limited market. All these elements are present in our development of a 'breakaway' fox snare (see *Review of 2005*, page 63), which in 2007 began a year-long trial among professional gamekeepers.

Demonstration and training are our other roles. Our demonstration project on mink control on the River Dore in Herefordshire (see *Review of 2006*, page 86) continues to develop and to provide invaluable teaching material. A second phase (2007-2009), in which we will quadruple the size of the mink-free area, is now underway, funded by the SITA Trust. Mink control workshops are in continual demand. The mink issue reminds everyone that the problems with predators are not confined to game management. Brown hares (see page 77) and grey partridge (see page 22) are both game species and BAP species. In 2007 we changed our name to reflect this absence of clear distinctions, and the RSPB published a report acknowledging that predation losses are an issue that they must address for ground-nesting birds. Predator control is steadily becoming a well understood and rationalised management process.

PREDATION RESEARCH IN 2007

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	*Demonstration project combining mink control with restoration of water voles on the River Dore, Herefordshire*	*Jonathan Reynolds, Ben Rodgers*	*Defra, Environment Agency, Core funds*	*2006-2008*
River Monnow project	*Extension of mink control to the entire upper Monnow catchment, Herefordshire*	*Jonathan Reynolds, Ben Rodgers, Owain Rodgers*	*SITA Trust, Ellerman Foundation, Core funds*	*2007-2009*
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*

Key to abbreviations: Defra = Department for the Environment, Farming and Rural Affairs.

Gamekeeping and hare numbers

Since 1985, a sequence of three studies by us has considered the impacts of predator control on small game species including grey partridge, pheasant, and brown hare. These studies (Salisbury Plain, Loddington and Royston) have been carried out by the same gamekeeper, Malcolm Brockless, who moved from one to the next. The studies had different purposes. Only Salisbury Plain (1985-91) was a formal scientific experiment in which 'predator control' was compared with 'no predator control' both spatially and sequentially. Loddington (started 1993) and Royston (started 2002) are demonstrations of game and wildlife management, with limited scope for experimental design, but both had areas nearby that could be monitored for comparison. At Loddington, predator control was stopped in 2002 deliberately to create a sequential comparison. Throughout all three studies, hare density was monitored by annual winter spotlight counts.

The sequence of events and associated trends in brown hare numbers are shown in Figure 1 overleaf. In each study, the onset of predator control corresponded with increasing hare numbers, whereas on comparison areas, hare numbers declined or remained stable. On Salisbury Plain, predator control was limited to three years, and no habitat improvement took place. At Loddington and Royston, habitat improvements and longer periods of predator control led to brown hare densities (respectively up to 78 and 87 hares per 100 hectares) that would be considered exceptional anywhere in Britain. At Loddington, the hare population also supported substantial winter shoots (up to 30 per 100 hectares) without decline. When both shooting and predator control ceased there in 2002, hare density collapsed even though habitat improvements remained in place. Simultaneously, as predator control and habitat improvement began at Royston, hare numbers there began to build rapidly.

Given that this sequence of studies was not designed specifically to determine the impact of predator control on hare numbers, it is important that this interpretation is supported by statistical analysis. After all, hare populations are also heavily influenced by weather, parasites, and potentially by other farming-related factors. We must be convinced that the trends in hare numbers really were related to predator control and not to coincidental effects of site and year. Across all three studies, regression modelling of the proportional change in hare numbers between successive years showed that, after

KEY FINDINGS

- The onset of predator control was always accompanied by increases in hare numbers.
- Predator control explained 46% of the variation in hare population change.
- Where habitat is improved, predators can stop hare numbers responding fully to it.

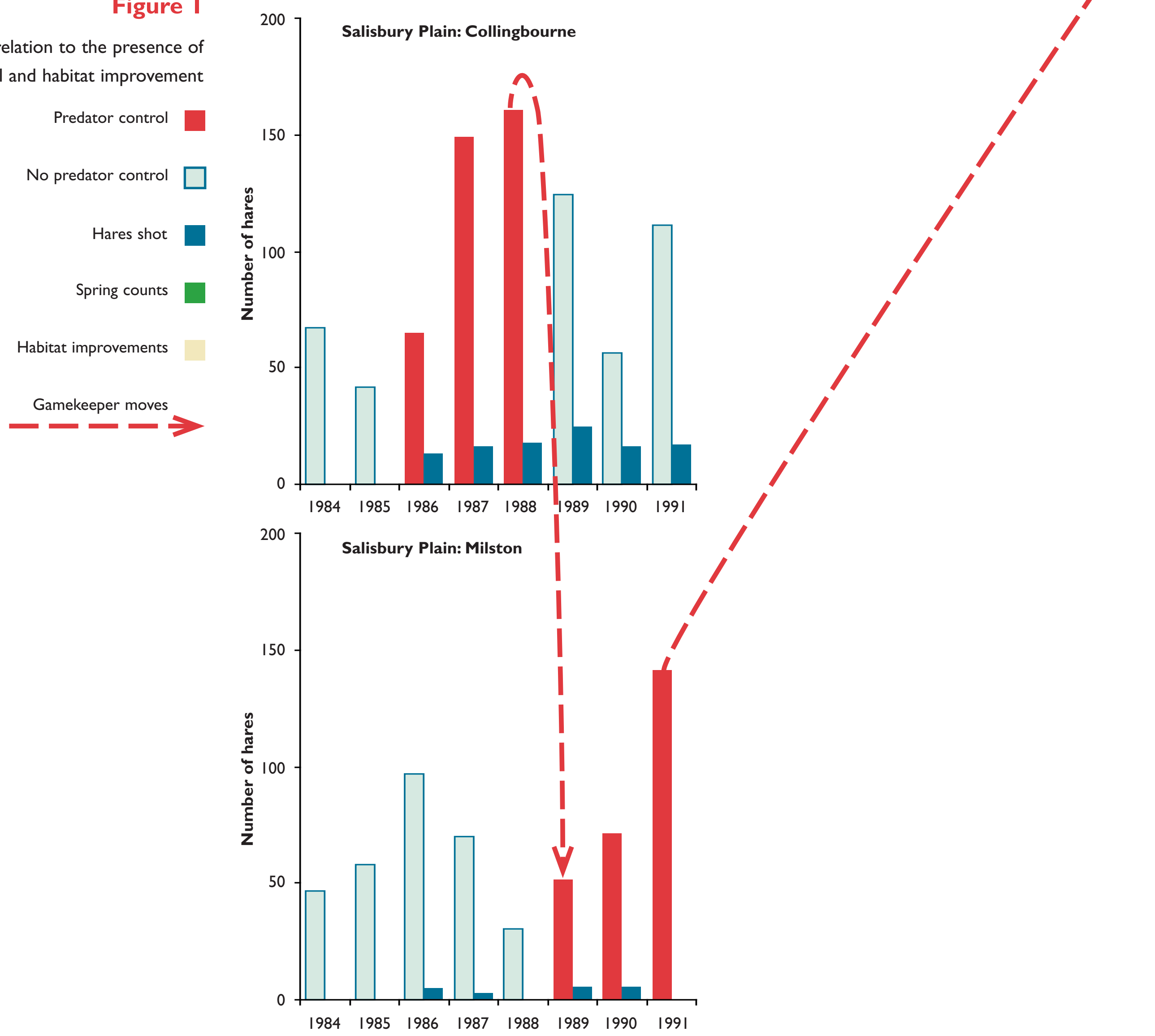
Jonathan Reynolds

Brown hares respond to fox control.
© Laurie Campbell

Wherever Malcolm Brockless goes, hares appear like mushrooms! © Laurie Campbell

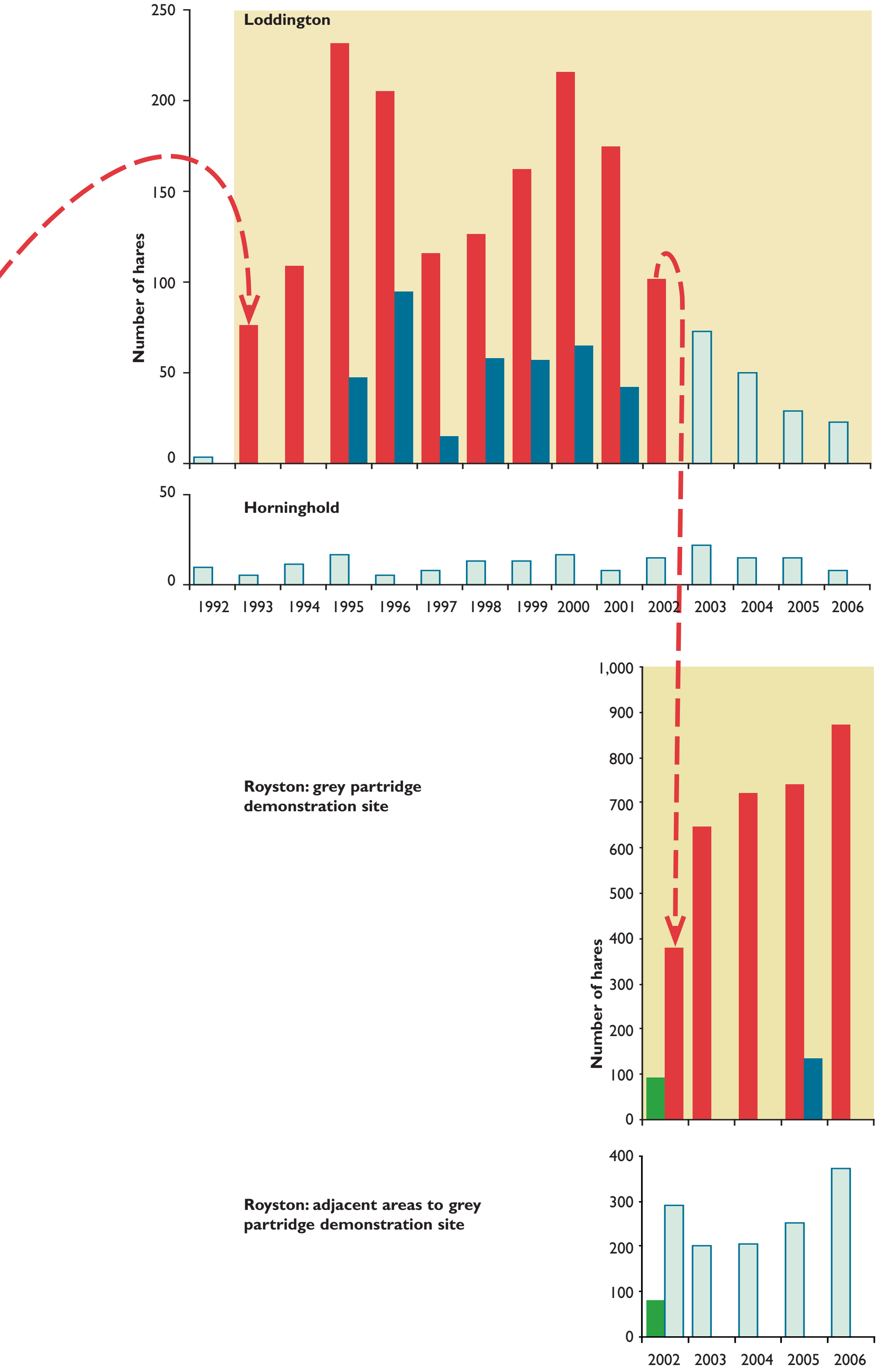
Figure 1

Hare numbers in relation to the presence of predator control and habitat improvement



site and year differences and shooting were accounted for, predator control was indeed a significant determinant of population change, explaining 46% of the variation in it.

There has been a good deal of debate about the relative importance of predation and habitat quality for brown hares in modern European landscapes. On reviewing available evidence (little of it experimental or involving predator control) other scientists have concluded that habitat was ultimately the driving factor behind 20th century declines experienced throughout Europe. Our studies are valuable in that they illustrate the effects of manipulating predator density and habitat, both separately and together. Although habitat improvement or predator control alone supported relatively modest increases in hare density, together these factors were super-additive. The implication is that where habitat is improved, predators can prevent hares from increasing to take full advantage of it. In a commercially-driven agricultural landscape, the extent to which habitat can be improved is limited. Suppression of predator numbers well below their typical densities is probably necessary to allow an abundance of hares.



Across three long-term studies (opposite and this page), hare densities increased wherever predator control was implemented (red bars and arrows), in comparison to sites and years without predator control (pale blue bars). In each study, starting hare density was similar on the two areas surveyed (indicated by spring counts in 2002 at Royston). The most dramatic increases occurred at Loddington and Royston where habitat improvements were also made, but improved habitat alone was insufficient to maintain hare density at Loddington after 2002 when predator control was transferred to Royston. Substantial bags of up to 30 hares per 100 hectares (dark blue bars) were also made from hare populations while at high density.

What links foxes and fish?

Our quest for optimal management of predators like the fox now draws on techniques from fisheries science. © Laurie Campbell

What do an 18th century cleric and the assessment of fish stocks have to do with a PhD project aimed at improving fox control strategy? The answer lies in the sparse, indirect and often misreported data on which fisheries scientists must base their models of fish stocks. Although the models must mimic population processes (mortality, reproduction, immigration, harvesting), often the only data available derive from harvesting, with whatever ancillary information scientists can piece together. Essentially the same problem arises on land in many wildlife control issues. For instance, the only data available by which game managers can assess a particular approach to controlling fox numbers are the number of foxes killed. In fisheries management, the past two decades have seen a huge amount of research to develop models that perform well given 'uncertain' data, leading to appropriate management decisions. We are now making use of the same techniques to devise more focused – and therefore more effective – management strategies to control vertebrate pest species. Tom Porteus has joined a team of fisheries scientists at the University of British Columbia to learn these techniques and apply them – in the first instance – to fox control.

Consciously or otherwise, wildlife management involves strategic decisions, such as how much effort to put in, and when. Typically, strategy is guided by 'rules of thumb', generalisations based on experience or on wildlife research. This does not result in particularly focused management because the information on which the strategy is based is necessarily dated, and not specific to current local conditions or to local aims. Quite commonly, much of the effort put into control is mis-spent, and overall it may fail to achieve its aims. However, given the modelling techniques normally used, scientists could help to improve the strategy only through an intensive study to gather detailed local data.

The non-conformist Reverend Thomas Bayes (1702-1761) invented a theorem about probability which was found and published after his death. That theorem led to

KEY FINDINGS

- 'Bayesian' statistical models allow the use of relevant prior knowledge.
- Using 'Bayesian' methods, we aim to provide advice on fox control that is tailored to local circumstances.

Tom Porteus

a totally different, looking-glass way of using observations to test our understanding of a system. This is now known as 'Bayesian' statistics, distinguishing it from the 'frequentist' methods on which modern wildlife research was built. Frequentist statistics estimate the probability that the data observed (eg. fish catch) would have arisen if a particular understanding of the system (eg. a model of the fish population's size, age structure and growth rate) was correct. Bayesian methods do the opposite: they calculate the probability of the model being true, given the data (the 'posterior' probability). This allows the continuous comparison of alternative models to see which is most likely correct, and leads to more intuitive answers to the questions asked above – eg. how much control effort is necessary? Unlike frequentist methods, a Bayesian analysis allows relevant prior knowledge (eg. the range of values for population size from previous counts) to be incorporated with the recently observed data to improve estimates from models.

Bayesian methods were not widely adopted until computers made it possible to calculate posterior probabilities with speed. Their use enables an 'adaptive' approach, simply expressed as 'modify your understanding in light of new data'. Management is treated as a series of actions, each based upon accumulated experience and relevant knowledge from elsewhere, and each informing the next. In fisheries management, this approach has been revolutionary, allowing managers to make effective use of imperfect data about the populations they wish to control.

Compared with many fisheries, our understanding of fox population dynamics and the impact of control by man is pretty good, thanks to our long interest in the subject, and a sequence of studies both local and extensive. Such historical and general knowledge doesn't lead to very practical advice, however, because circumstances vary so much between estates. We want to be able to offer advice that can be personalised to each operator. To this end, we are using Bayesian methods, and data we already have, to construct general models of fox control that can be adapted using local information to provide best-strategy advice for individual estates. It's all part of our aim to improve the focus of wildlife management, which is in everyone's interest.

Reverend Thomas Bayes (1702-1761)

The use of Bayesian methods has greatly improved the usefulness of fish stock models.
© Laurie Campbell

Summary of fisheries research

KEY ACHIEVEMENTS

- We completed a report on triploid and diploid trout stocking.
- We organised a major conference on salmonids.
- We nearly completed work on farm management and siltation in rivers.

Dylan Roberts

In 2007 we completed a report for the Environment Agency on the stocking of triploid and diploid brown trout (see page 84), which we expect to influence the agency's *National Trout and Grayling Fisheries Strategy*. We have also written papers for scientific journals, including on the diploid and triploid work and the impacts of riparian fencing on upland and lowland rivers.

Our future work will focus on three areas: addressing further brown trout stocking issues, habitat manipulation to increase production of juvenile salmon and measuring the effect of pike on the abundance of other fish and fisheries (see page 86).

In September, with the University of Southampton, we organised a four-day international conference on habitat management for salmon and trout to help commemorate the 40th anniversary of the Atlantic Salmon Trust. 150 delegates from around the world attended this very successful event. We presented two papers, both of which will be published in the conference book.

Our work on measuring the effectiveness of farm management in reducing siltation in rivers is nearing completion. This forms Dominic Stubbings' PhD, which is due for submission in 2008.

In June, Ravi Chatterji obtained his PhD following the defence of his thesis on adult and juvenile diploid brown trout stocking.

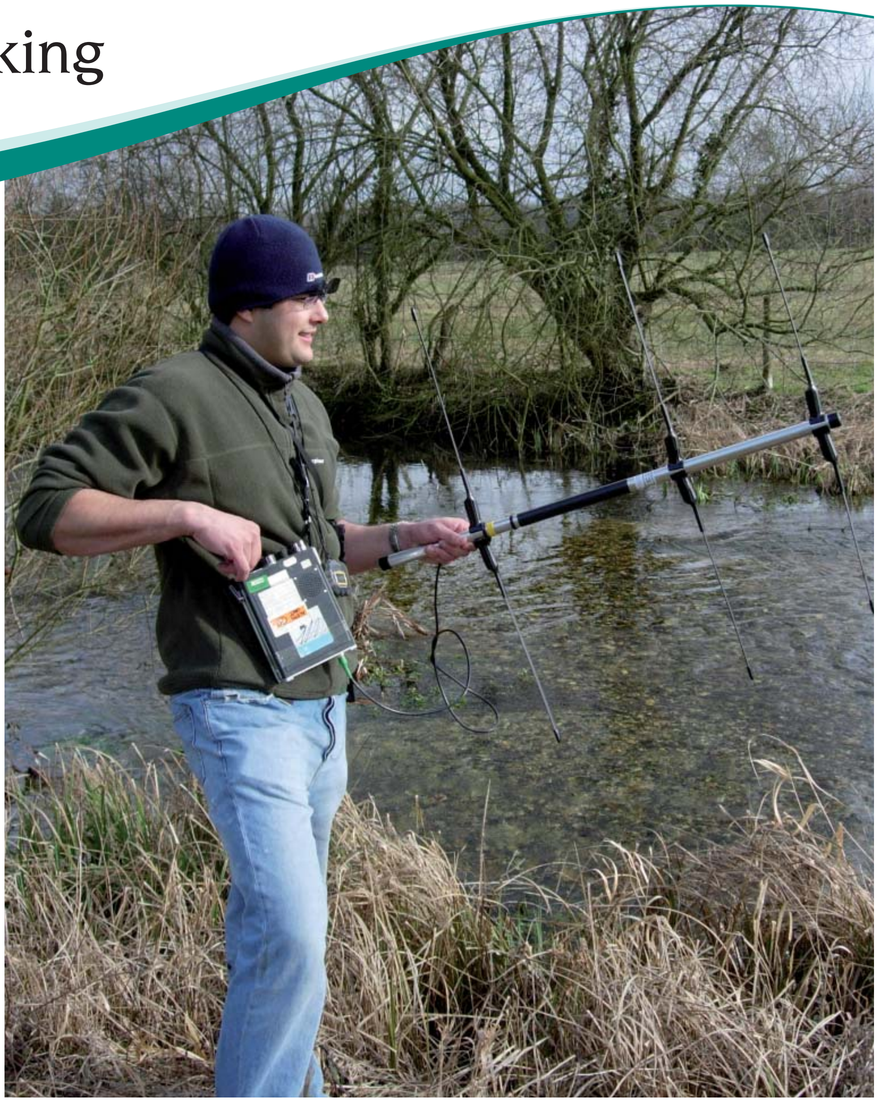
FISHERIES RESEARCH IN 2007

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*
Assessment of habitat improvement on brown trout and salmon	*Monitoring brown trout and juvenile salmon abundance after fencing and coppicing on River Clywedog, 1997-2000*	*Dylan Roberts*	*Environment Agency Wales*	*1998-2007*
Monnow 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*
Trout stocking project (1)	*Diploid stocking*	*Ravi Chatterji, Dominic Stubbing*	*WTT, Core funds*	*2002-2007*
Trout stocking project (2) (see page 84)	*Triploid stocking*	*Dylan Roberts, Dominic Stubbing, Ravi Chatterji, Dean Sandford*	*Environment Agency, Riparian landowners, Houghton Club, Fishmongers, S&TA*	*2005-2007*
Swans and water crowfoot	*Quantify the impact and likely knock-on effects of swan grazing of water crowfoot, River Wylye, Wiltshire*	*Jonathan Reynolds, Mike Short Tom Porteus, Dominic Stubbing*	*Environment Agency, Wiltshire Fisheries Association*	*2004-2008*
Salmon habitat	*Pilot study to investigate bank-side habitat improvements on salmon*	*Dylan Roberts*	*Atlantic Salmon Trust*	*2006- on-going*
Pike management (see page 86)	*Investigation into the effects of pike management on pike and other fish*	*Dominic Stubbing, Dean Sandford, Ravi Chatterji*	*Core funds*	*2007- on-going*
Silt run-off management	*Investigation into the effects of catchment management on brown trout egg survival in Cornwall*	*Dominic Stubbing*	*Core funds*	*2005- on-going*

Key to abbreviations: S&TA = Salmon & Trout Association; WTT = Wild Trout Trust.

A local chalk stream to our Fordingbridge head office. © Sophia Gallia/Natterjack Publications

Trout radio-tracking study



KEY FINDINGS

- Farm-reared female triploid trout did not make any concerted movement into the spawning grounds and were not observed interfering with wild spawning or consuming wild trout eggs.
- Farm-reared female triploid trout showed higher survival and maintenance of condition than farm-reared female diploids over the winter.
- Farm-reared female diploid trout undertook spawning migrations and were seen spawning, almost certainly with wild trout.

Ravi Chatterji

Above: Ravi radio-tracking trout. © Ravi Chatterji/GWCT

Chris Davis and Dean Sandford suturing a trout after a radio tag implantation. © Ravi Chatterji/GWCT

A completed suture. © Ravi Chatterji/GWCT

In a previous Review we described one component, an angler perception survey, of our recent investigation into the success and effects of triploid (infertile) and diploid (fertile) brown trout stocking. The use of infertile fish for stocking removes any risk of interbreeding between farm-reared and wild fish, thereby maintaining the genetic fitness of wild stocks. We have undertaken our investigation in partnership with the Environment Agency and our findings will help to guide its *National Trout and Grayling Fisheries Strategy*.

We are now able to present the findings from another component, a radio-tracking study undertaken on the River Allen, Dorset. The aims of this study were to establish the distribution of three types of female trout during the winter spawning period: a. wild, b. farm-reared diploid and c. farm-reared triploid brown trout, to observe behaviour and to record the over-winter survival and condition of the three groups.

This study was prompted by concerns that farm-reared triploid trout would follow wild trout onto spawning grounds and, once there, disrupt their activity thereby affecting spawning success and subsequent recruitment. Concern has also been raised that if triploids enter spawning grounds they may either actively (by excavating redds) or passively (by drift feeding) consume the eggs of wild trout.

We began work in September 2005 and finished in March 2007, which covered two winter spawning periods. In each winter, we surgically implanted 20 female farm-reared diploid, 20 female farm-reared triploid and 20 female resident wild brown trout adults with radio transmitters (weight: 3.5g; volume: 1.4cm^3) and released or returned into adult habitat (deep, vegetated glides) immediately downstream of good spawning grounds (shallow, fast-flowing and gravelly riffles).

We tracked the fish on foot twice-weekly over the winter to establish their distribution. We also employed fixed listening stations in key areas to monitor fish movements between spells of tracking.

The main spawning window on the River Allen occurred between the middle of November and the middle of January. The female triploid trout group displayed no clear migratory movements into the spawning areas and we found no evidence of

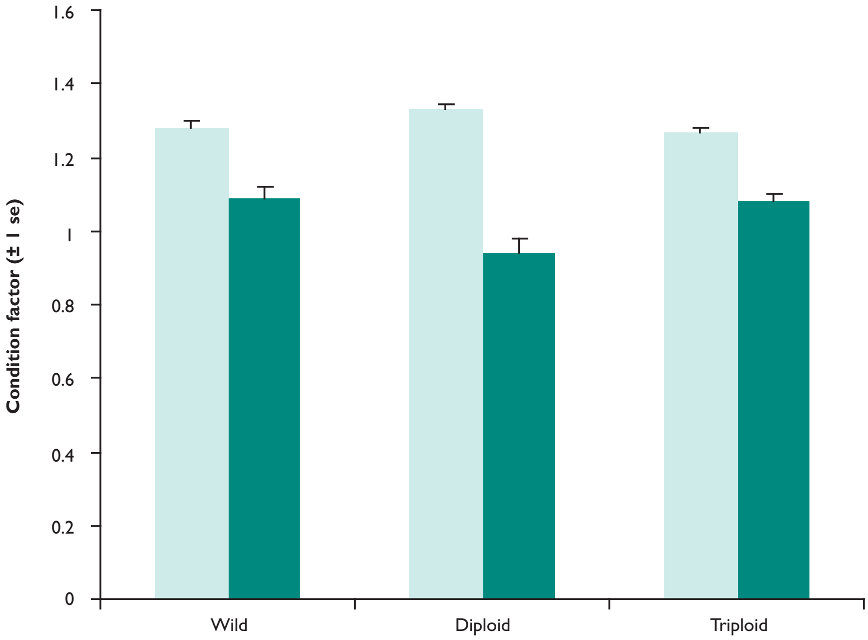


Figure 1

Comparison of mean initial and final condition factors of radio-tagged wild diploid and triploid brown trout

Before spawning (September)

After spawning (March)

Notes: condition factor ($K = 100{,}000\ W / L^3$, where W = fish weight in grams and L= fish length in millimetres) of radio-tagged wild: n = 40; 11 respectively; diploid: n = 40; 12; triploid brown trout: n = 40; 21. Both years pooled.

triploid trout interfering with wild trout spawning. However, most of the farm-reared female diploid trout and the female wild brown trout spawned. Members of the farm-reared diploid group must have spawned with wild males as only female farm-reared trout have been stocked in the study river in recent history and the only fish farm in the area produces just females. We recorded no evidence of predation of wild brown trout eggs by farm-reared female diploid or triploid trout.

The female diploid group began spawning earlier than the female wild brown trout group in one year and later in the other although there was overlap in both years. In the first study year, triploids appeared to be slightly more susceptible than the other groups to displacement during an isolated period of very high flow. Overall mortality (most of which was attributed to predation) was lowest in the female triploid group, with 53% surviving over the winter compared with 31% of wild females and 30% of female diploids, suggesting an increased vulnerability to predation during spawning activity.

Overall, despite female farm-reared diploids being in slightly better condition at the time of stocking, they were in significantly worse condition than the other two groups at the end of the spawning period (see Figure 1). The condition of triploids at the end of the spawning period was better than that of diploids due to the latter having spawned. We believe that the loss of condition of wild trout was because of spawning, whereas the loss of condition of triploid trout was because of their farm-reared origin and the significant loss of condition of the diploid trout was due to a combination of these factors.

A fixed listening station. © Ravi Chatterji/GWCT

A triploid (top) and a spawned diploid (bottom) at the end of one of the winter periods. © Ravi Chatterji/GWCT

ACKNOWLEDGEMENTS

Significant support was received from Kimbridge on the Test, The Shaftesbury Estate, Allenbrook Fish Farm, The British Trout Farmers Restocking Association, The Salmon and Trout Association, Sir Chips Keswick, Lloyd George, The Houghton Club, The Worshipful Company of Fishmongers, The Balmain Trust, W Chippendale, Riparian owners of the study site, and Dr David Solomon for providing expertise on radio-telemetry.

Pike on the River Piddle

Electro-fishing is a typical method of removing pike from a river. © *Dominic Stubbing/GWCT*

Pike predation has always been a problem for river keepers and fishery managers trying to maintain and restore trout and salmon fisheries. In the UK netting, electro-fishing and rod fishing are typical methods used to remove pike. A study on the upper River Avon in Wiltshire by the Freshwater Biological Association showed that pike removal reduced pike numbers. From our experience of the upper Avon, some pike are probably left in the river after removal operations and repopulate the river by immigration or breeding. The Centre of Hydrology & Ecology radio-tracking work on the River Frome in Dorset showed that pike move around at times of spawning or flooding. Removing pike is therefore usually an annual task.

From 1993 to 2001 all pike caught by electro-fishing were removed on two kilometres of the River Piddle at Tolpuddle in Dorset. This was done twice a year and, although 32 pike were removed in the first year, after a few years no more than a single fish per year was caught. Additionally, most of the river up to the source and down to two kilometres below the site had pike removed during the beginning of this period. Thus it could be argued that pike predation was not an issue after the first couple of years in the Tolpuddle site. During this time we showed that trout numbers increased, although later annual growth was reduced (see *Review of 2001*).

After pike removal stopped in 2002, we monitored 50-metre sections of the site using electro-fishing and, in 2004, some sections had as many as five young pike (with an average length of 216mm). The following year a pike measuring 347mm was caught.

So in the autumn of 2007, we went back to the site at Tolpuddle to do a full survey to assess the re-population by pike and to gauge any effects on salmon and trout. We electro-fished the site and measured the densities of salmon and trout along with pike numbers. We also collected length and weight data for all fish. We deduced the age of the pike using a sample of scales from their backs, and we recorded stomach content and maturation.

We found that pike numbers had reached 27, but no fish was bigger than 476mm and 900g. Investigation of the scales showed that the oldest fish was four years old, which confirms the earlier findings of one-year-old fish in 2004, so these fish hatched in

KEY FINDINGS

- Almost as many pike have returned to a previously culled site as were taken out in the initial removal. This happened in seven years and probably as a result of local spawning.
- Pike were less than half the size that they were in the initial removal.
- As yet, this evidence alone does not prove that pike reductions improve numbers of trout.

Dominic Stubbing
Dean Sandford

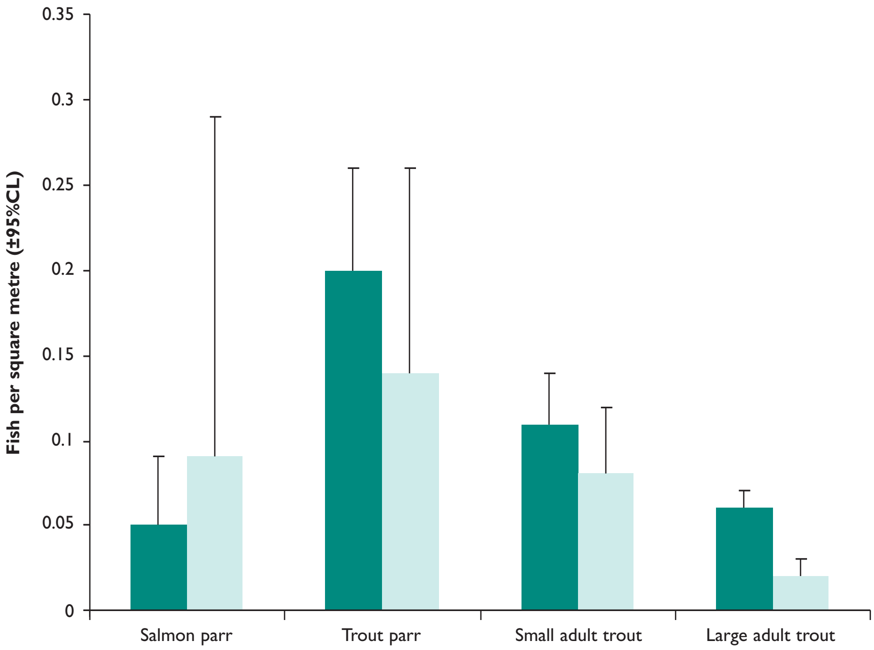


Figure 1

Mean densities of salmon and trout during the period when pike numbers were under control (1997-2000) and seven years after the control had stopped (2007) on the River Piddle, Dorset

Pike controlled (1997-2000)

After seven years of no pike control (2007)

2003. This probably means that these pike are the result of local spawning (brood fish origin is unknown). We also found that the bigger fish had developing gonads, which together with the presence of one-year-old and three-year-old fish, suggested that the pike population was self-sustaining.

Numbers of large trout are now significantly lower than they were during the period of pike removal (see Figure 1). The pike were small and so probably favour predating the smaller salmonids, which raises the question of effects by cormorants or otters known to be present. Bank-side and in-stream habitat in the study area have remained rich throughout the study. Sediment loads in the river have been variable, but good numbers of parr appear every year.

Non-significant reductions in smaller trout may be related to the fact that the total biomass of pike is still lower than in 1993, before any pike reductions. The large variation seen for salmon is most likely to be caused by the location of sampling section in relation to spawning activity. We examined pike stomachs and found that only three had prey fish inside them - these were all small trout.

This pike had two small trout in its stomach. © Dominic Stubbing/GWCT

Scientific publications

by staff of the Game & Wildlife Conservation Trust
in 2007

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Note: the publications listed as 2006 did not appear in print before the Review of 2006 went to press. For a complete record of the scientific publications by staff of the Game & Wildlife Conservation Trust, we therefore include them here.

Financial report

for 2007

KEY POINTS

- A surplus of income on the general fund.
- The reserves target is met.
- Overall budget targets were met.

The summarised accounts for the year ended 31 December 2007, set out on pages 92 to 93, are not the statutory accounts but are a summary of information relating to the consolidated Statement of Financial Activities and Balance Sheet of the Game & Wildlife Conservation Trust. These incorporate the results of the two wholly-owned subsidiaries Game & Wildlife Conservation Trading Limited and Game Conservancy Events Limited. The full annual accounts, which were approved by the Trustees on 24 April 2008, and from which the summarised accounts have been derived, have been independently audited; and the auditors' report was unqualified. The full accounts, the auditors' report and the Trustees' annual report, all of which have been submitted to the Charity Commission, may be obtained from the Trust's Headquarters.

The core of our work continues to be scientific research, supported by four broad educational initiatives (policy, profile, education and practice) aimed at using our science to better effect and ensuring better understanding of the contribution game management makes to conservation.

Review of financial performance

The year ended 31 December 2007 was a satisfactory year financially, with a surplus of £219,979 on the General Fund and an overall surplus of £96,979. There was a planned reduction in total income and expenditure due to the completion of a major river restoration/conservation project in the previous year.

The charity spent £3.9 million, or 63% of its total expenditure on its charitable objects this year (2006: 66%).

Total income decreased by 5.4% in the year and unrestricted income increased by 1.3%. Increasing unrestricted income was one of the Trust's fundraising activities. Total costs decreased by 3.7%.

Despite some small losses on the investments, the Trust's net assets increased by £144,109 and it continues to meet its reserves target.

Plans for future periods

The key elements of our medium to long-term strategy remain:

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

Our main objectives for the next year are to roll out marketing strategy to improve member numbers and increase profile, to complete the new tertiary education programme, to continue to improve the delivery of our science into policy and practice through an enhanced programme of public affairs, profile raising and educational activity and to start new science projects. It is also our objective to achieve a surplus on general funds and to maintain a reasonable level of reserves.

M H Hudson
Chairman of the Trustees

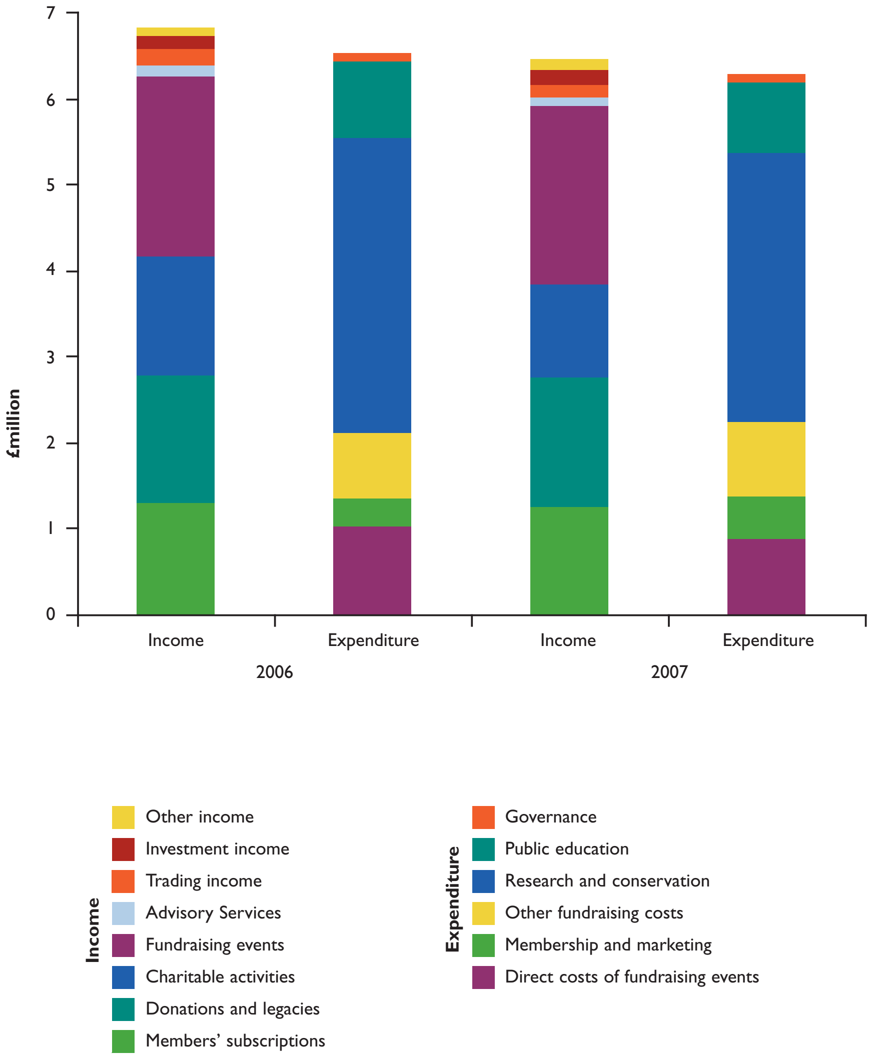

Figure 1

Incoming and outgoing resources in 2007 (and 2006) showing the relative income and costs for different activities

Independent auditors' statement

to the Trustees and Members of The Game & Wildlife Conservation Trust

We have examined the summarised accounts set out on pages 92 and 93.

Respective responsibilities of Trustees and Auditors

The Trustees are responsible for preparing the summarised accounts. Our responsibility is to report to you our opinion on the consistency of the summarised accounts within the Annual Review with the full annual Consolidated Accounts and Trustees' Report. We also read the other financial information contained within the Annual Review and consider the implications for our report if we become aware of any apparent misstatements or material inconsistencies with the summarised accounts.

Basis of opinion

We conducted our work with reference to Bulletin 1999/6 'The auditors' statement on the summary financial statement' issued by the Auditing Practices Board for use in the United Kingdom.

Opinion

In our opinion the summarised accounts are consistent with the full annual Consolidated Accounts and Trustees' Report of The Game & Wildlife Conservation Trust for the year ended 31 December 2007.

FLETCHER & PARTNERS
Chartered Accountants and Registered Auditors
Salisbury, 30 April 2008

Consolidated

Statement of financial activities

	Unrestricted Funds £	Restricted Funds £	Endowed Funds £	**Total 2007 £**	Total 2006 £
INCOME AND EXPENDITURE					
INCOMING RESOURCES					
Incoming resources from generated funds					
Voluntary income					
Members' subscriptions	1,264,986	2,659	-	**1,267,645**	1,301,755
Donations and legacies	540,312	958,520	-	**1,498,832**	1,486,514
	1,805,298	961,179	-	**2,766,477**	2,788,269
Activities for generating funds					
Fundraising events	2,028,298	25,261	-	**2,053,559**	2,087,916
Advisory Service	119,385	-	-	**119,385**	138,381
Trading income	143,381	-	-	**143,381**	192,578
Investment income	60,408	111,875	-	**172,283**	138,734
Charitable activities	159,234	926,025	-	**1,085,259**	1,374,292
Other income	86,910	25,945	-	**112,855**	102,410
TOTAL INCOMING RESOURCES	4,402,914	2,050,285	-	**6,453,199**	6,822,580
RESOURCES EXPENDED					
Costs of generating funds					
Direct costs of fundraising events	898,445	-	-	**898,445**	1,034,367
Membership and marketing	491,106	-	-	**491,106**	313,041
Other fundraising costs	847,141	-	-	**847,141**	777,860
	2,236,692	-	-	**2,236,692**	2,125,268
Activities in furtherance of the charity's objects					
Research - Lowlands	929,193	832,985	-	**1,762,178**	1,782,563
Research - Uplands	284,316	427,145	-	**711,461**	711,231
Research - ARET	77,510	475,547	-	**553,057**	507,864
	1,291,019	1,735,677	-	**3,026,696**	3,001,658
Conservation	93,382	16,709	-	**110,091**	407,650
Public education	451,615	354,570	-	**806,185**	888,002
	1,836,016	2,106,956	-	**3,942,972**	4,297,310
Governance	110,227	-	-	**110,227**	111,301
TOTAL RESOURCES EXPENDED	4,182,935	2,106,956	-	**6,289,891**	6,533,879
Net incoming/(outgoing) resources before transfers	219,979	(56,671)	-	**163,308**	288,701
Transfers between funds	(123,000)	123,000	-	**-**	-
NET INCOMING/(OUTGOING) RESOURCES	96,979	66,329	-	**163,308**	288,701
OTHER RECOGNISED GAINS AND LOSSES					
Realised gains/(losses) on investments	3,301	-	(1,135)	**2,166**	49,374
Unrealised gains/(losses) on investments	(18,914)	-	(2,451)	**(21,365)**	242,916
NET MOVEMENT IN FUNDS	81,366	66,329	(3,586)	**144,109**	580,991
BALANCES AT 1 JANUARY	2,635,365	606,998	4,545,539	**7,787,902**	7,206,911
BALANCES AT 31 DECEMBER	£2,716,731	£673,327	£4,541,953	**£7,932,011**	£7,787,902

Consolidated

Balance sheet

		2007		2006
	£	£	£	£
FIXED ASSETS				
Tangible assets		2,991,422		2,927,301
Investments		3,744,028		3,681,929
		6,735,450		6,609,230
CURRENT ASSETS				
Stock	198,223		199,215	
Debtors	1,053,860		1,177,412	
Cash at bank and in hand	868,849		863,260	
	2,120,932		2,239,887	
CREDITORS:				
Amounts falling due within one year	622,564		770,792	
NET CURRENT ASSETS		1,498,368		1,469,095
TOTAL ASSETS LESS CURRENT LIABILITIES		8,233,818		8,078,325
CREDITORS:				
Amounts falling due after more than one year		301,807		290,423
NET ASSETS		£7,932,011		£7,787,902
Representing:				
CAPITAL FUNDS				
Endowment funds		4,541,953		4,545,539
INCOME FUNDS				
Restricted funds		673,327		606,998
Unrestricted funds:				
Total designated funds	227,737		232,330	
Revaluation reserve	344,683		378,859	
General fund	2,265,149		2,031,162	
Non-charitable trading fund	(120,838)		(6,986)	
		2,716,731		2,635,365
TOTAL FUNDS		£7,932,011		£7,787,902

Approved by the Trustees on 24 April 2008 and signed on their behalf

M H HUDSON

Chairman of the Trustees

Staff

of the Game & Wildlife Conservation Trust
in 2007

CHIEF EXECUTIVE	Teresa Dent BSc, FRAgS
Personal Assistant	Wendy Smith
Head of Finance	Alan Johnson ACMA
Finance Assistant - Trust	Stephanie Slapper
Finance Assistant - Limited	Lin Dance
Accounts Clerk (p/t)	Barbara Griffiths *(until October)*
Accounts Clerk (p/t)	Sharon Duggan *(from March)*
Head of Administration & Personnel	Jenny Channell *(until June)*
Head of Administration & Personnel	Ian Collins BA, MCIPD *(from July)*
Administration & Personnel Assistant	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
DIRECTOR OF POLICY AND PUBLIC AFFAIRS	Stephen Tapper BSc, PhD
Head of Media Relations	Morag Walker MCIPR
Publications Officer	Louise Shervington
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
Fisheries Biologist	Dean Sandford BSc
Research Assistant	Michael Dunn *(July-August)*
Research Assistant	Peter Grey *(July-August)*
Head of Lowland Gamebird Research	Rufus Sage BSc, MSc, PhD
Ecologist - Pheasants, Wildlife (p/t)	Maureen Woodburn BSc, MSc, PhD
Senior Scientist - Partridges, Pheasants	Roger Draycott HND, MSc, PhD
Senior Scientist - Pheasants, Woodcock	Andrew Hoodless BSc, PhD
Project Ecologist - Energy Crop Studies	Mark Cunningham BSc, MSc
Field Assistant	Diane Ling *(April-August)*
Bird Surveyor	Chris LeClare *(April-August)*
Bird Surveyor	Sur Wilson *(April-September)*
Placement Student - *(Writtle Agricultural College)*	Alex Keeble *(June-August)*
Senior Scientist - Scottish Lowland Research	David Parish BSc, PhD
PhD Student *(University of Dundee)* - Sawfly genetics	Angela Gillies BSc *(until August)*
PhD Student *(University of Glasgow)* - Ecology of yellowhammers	Graeme Cook BSc, MSc
Head of Wildlife Disease & Epidemiology	Chris Davis BVM&S, MRCVS
Game Technician/Stockman	Des Purdy BSc, PhD *(until September)*
Rearing Field Assistant	Matt Ford *(from March)*
Placement Student - *(Newton Rigg College)*	Matthew Johnson *(April-August)*
Project Officer - Bitting Study	Dave Butler BSc, PhD *(until December)*
Head of Predation Control Studies	Jonathan Reynolds BSc, PhD
Research Assistant	Mike Short HND
PhD Student *(University of Vancouver)* - Bayesian analysis	Thomas Porteus BSc, MSc
Research Assistant	Ben Rodgers BSc
Research Assistant	Owain Rodgers *(from October)*
Research Assistant	Suzanne Richardson BSc, MSc
Head of Entomology	John Holland BSc, MSc, PhD
Senior Scientist	Barbara Smith BSc, PhD
Senior Entomologist	Steve Moreby BSc, MPhil
Entomologist	Sue Southway BA
Ecologist	Tom Birkett BSc, PgC
Ecologist	John Simper BSc, MSc
Assistant Ecologist	Steve Bedford *(until February)*
PhD Student *(Imperial College)* - 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 Bath)*	Louise Bailey *(until September)*
Placement Student *(University of Cardiff)*	Mark Gibson *(until July)*
Placement Student *(University of Plymouth)*	Charlotte Harris *(from September)*
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
Research Assistant	Jenny Owen *(March-June)*
Senior Scientist - Upland Predation Experiment	Kathy Fletcher BSc, PhD
Research Assistant - Upland Predation Experiment	Robin Foster HND
Research Assistant	Francis Atterton *(March-July)*
Research Assistant	Felicity Clarke *(March-July)*
Research Assistant	Helen Foster *(March-August)*
Research Assistant	Emma Mundy *(March-July);*
Placement Student *(University of Durham)*	Richard Goswell *(until July)*
Placement Student *(University of Durham)*	Michelle Phillips *(until July)*

Placement Student *(Harper Adams College)*	Thomas Hornby *(from August)*
Placement Student *(Kings College, University of London)*	Liam Stokes *(from September)*
Head Gamekeeper - Upland Predation Experiment	Craig Jones
Gamekeeper - Upland Predation Experiment	Philip Chapman
Assistant Gamekeeper	Paul Bell
Assistant Gamekeeper	Tony Jenkins
Assistant Gamekeeper	Joe Pattison *(from November)*
Senior Scientist - North of England Grouse Research	David Newborn HND
Senior Scientist - Scottish Upland Research	Adam Smith BSc, MSc, DPhil
Research Assistant - Scottish Upland Research	David Howarth
Research Assistant	Allan MacLeod BSc
Seasonal Research Assistant	Adam Berry BSc, MSc *(April-September)*
Seasonal Research Assistant	Matthew Powell BSc *(May-August)*
Placement Student *(Harper Adams College)*	William Bartholomew *(until August)*
Placement Student *(Harper Adams College)*	Ross Hancocks *(from August);*
Placement Student *(University of Leeds)*	Susannah Harrison *(from August)*
Head of the Allerton Project	Alastair Leake BSc (Hons), MBPR (Agric), PhD, ARAgS, MIAgM, MIAgE, CEnv
Secretary (p/t)	Natalie Augusztinyi
Head of Research for the Allerton Project	Chris Stoate BA, PhD
Research Assistant	Mark Amos *(September-October)*
Ecologist	John Szczur BSc
PhD Student *(University of Stirling)* - Birds and bees	Jenny Jacobs BSc
PhD Student *(University of Reading)* - Songbird productivity & farmland	Patrick White BSc
PhD Student *(University of Nottingham)* - Game as food	Graham Riminton BSc, MSc *(from October)*
Placement Student *(University of Manchester)*	Rebecca Lockyer *(until February)*
Placement Student *(Hartpury College)*	Richard Roberts *(until June)*
Placement Student *(Harper Adams College)*	Oliver Barter *(from September)*
Game Manager - Royston	Malcolm Brockless
Farm Manager	Philip Jarvis HND
Farm Assistant	Michael Berg
Catering Assistant (p/t)	Jeanette Parr *(until 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	Nina Graham BSc *(until November)*
Research Assistant - GIS mountain hare survey	Vikki Kinrade BSc, MSc *(from June)*
Placement Student *(John Moores, Liverpool)*	Katie Hickey *(until September)*
Placement Student *(John Moores, Liverpool)*	James Connell *(from September)*
Placement Student *(University of Bath)*	Marc Edwards *(from September)*

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Co-ordinator Advisory Services (p/t)	Lynda Ferguson
Advisor/Development Officer	Alex Butler *(from May)*
Field Officer – Farmland Ecology	Peter Thompson DipCM, MRPPA (Agric)
Head of Education	Mike Swan BSc, PhD[4]
Regional Advisor - Central & Southern Scotland & Northern England	Hugo Straker NDA[2]
Regional Advisor - Eastern & Northern England (p/t)	Martin Tickler MRAC

[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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The Outlander is full of innovative and versatile features like a split tailgate, satellite navigation and a reversing camera**. It spends most of the time in 2WD due to its clever on-demand 4WD system, the 2.0 diesel Outlander has a combined fuel consumption of over 40 mpg and the lowest emissions of any 7 seat SUV, which means that you pay just £170 a year for your road fund licence.

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