Review of 2005

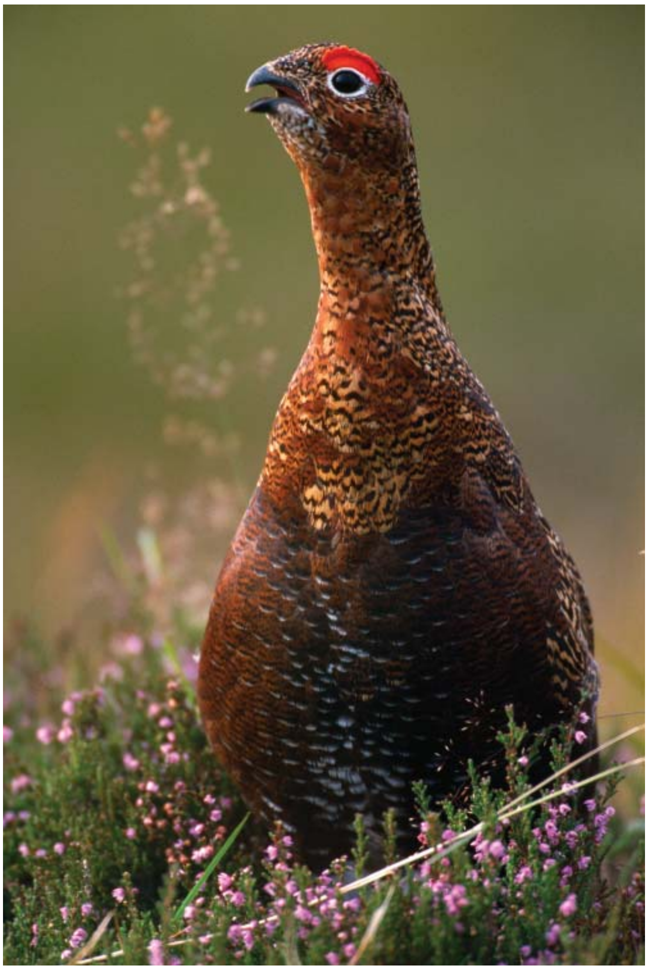
A full report of the activities of
The Game Conservancy Trust
and Game Conservancy Limited

www.gct.org.uk

THE GAME CONSERVANCY TRUST

Supported by
SUBARU ISUZU HISCOX

Review of 2005



Issue 37

A full report of the activities of The Game Conservancy Trust Limited (Registered Charity No. 1112023) during the year

www.gct.org.uk

The Game Conservancy Trust Limited's 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.

Produced by: Natterjack Publications Limited
Nether Cerne, Dorchester, DT2 7AJ
Tel: 01300 341833 or 07740 760771
smiles@natterjackpublications.co.uk

Editing, design, layout: Sophia Gallia

Printing and binding: Raithby Lawrence, Leicester

Front cover pictures: Laurie Campbell

Photography: The Game Conservancy Trust wishes to thank the photographers who have contributed to this publication. Their details can be obtained from Sophia Gallia.

The Game Conservancy Trust, Fordingbridge, Hampshire, SP6 1EF
Tel: 01425 652381 Fax: 01425 651026/7 Email: info@gct.org.uk

Printed on elemental chlorine-free paper from sustainable forests

Corporate sponsorship

The Game Conservancy Trust acknowledges the exceptional support of its Corporate Sponsors in 2005, Hiscox (with Oval), Subaru and Isuzu, in assisting vital research and educational work to conserve game, wildlife and their habitats in Britain.

HISCOX

SUBARU

ISUZU

JUBILEE YEAR 2005/6
25 YEARS AS A WILDLIFE CONSERVATION CHARITY
75 YEARS OF GAME MANAGEMENT

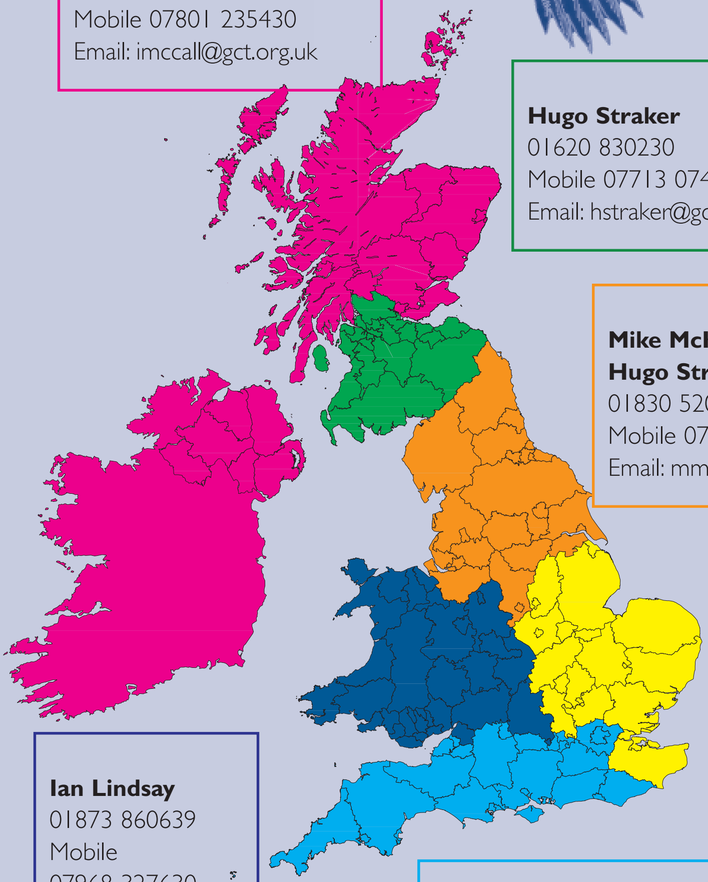
THE GAME CONSERVANCY TRUST

Sound advice

through scientific understanding

- **Professional conservation advice**
- **Training courses**
- **Demonstration days**

- **Game population counts**
- **Harvesting suggestions**
- **Grouse worm counts and louping ill tests**



Ian McCall
01828 650543
Mobile 07801 235430
Email: imccall@gct.org.uk

Hugo Straker
01620 830230
Mobile 07713 074147
Email: hstraker@gct.org.uk

Mike McKendry & Hugo Straker
01830 520835
Mobile 0779 3593783
Email: mmckendry@gct.org.uk

Martin Tickler
01379 586551
Mobile 07730 065935
Email: mtickler@gct.org.uk

Ian Lindsay
01873 860639
Mobile 07968 327630
Email: ilindsay@gct.org.uk

Mike Swan
01425 651020
Mobile 07801 413209
Email: mswan@gct.org.uk

Your GCL advisor provides professional advice to help you with:

Grants, stewardship, biodiversity.
Woodland siting, establishment and improvement.
Pond creation and wetland management.
Fishery management.
Woodland deer management.
Game crop selection, siting and establishment.
Maximising agri-environment schemes for game and wildlife.

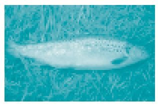
Grouse and moorland management.
Strongyle worm counting.
Grouse counting.
Louping ill testing.

Game and wildlife management courses.

Advisory Services,
Game Conservancy Limited
Fordingbridge,
Hampshire SP6 1EF
Tel: 01425 651013
Email: advice@gct.org.uk

GAME CONSERVANCY LIMITED

Contents



The Game Conservancy Trust Council

as at 1 January 2006

Chairman's report

2005 was a landmark year for us at The Game Conservancy Trust – 25 years as a wildlife research, education and conservation charity, and 75 years of research and advice on game. We are grateful to all who have supported us financially or physically during the year and especially our main sponsors, Hiscox (with Oval) insurers and Subaru and Isuzu, who underwrite our key publications including this *Review*. Thanks also to our other many sponsors who help us put on events around the country.

2005 saw the opening of the new research centre (pictured below) in the walled garden of Burgate Manor. This is a very welcome – and long overdue – improvement and we thank the Garfield Weston Foundation and Barrie Webb for their most generous donations in making this possible.

2005 was also a financial success and it is vital that we maintain this as a sound base on both the research and advisory fronts. We are working hard to attract new funds and our fundraising team, led by Edward Hay, are doing just that. I pay tribute to Teresa Dent and her fellow executives for their sound financial management.

A key part of our fundraising effort has always been through volunteers who work through our County Groups. In 2005 they raised £1,835,940 – a 16% increase on the previous year. I am sure they will keep it up.

We were all delighted when our Director of Research, Dr Nick Sotherton, won not one, but two prestigious scientific awards during 2005. Firstly, at the Royal Show, he was awarded the Royal Agricultural Society of England's research medal in recognition of 23 years of studies in farmland ecology. The second award was from the British Crop Protection Council for his contribution to crop protection over many years. Our warmest congratulations to Nick.

This will be my last Chairman's Report as I will step down in June 2006. It has been a privilege to act as Chairman of such a unique and wonderful organisation. My sincere thanks to Teresa Dent and her staff for their unfailing courtesy and co-operation at all times. It has been a pleasure to work with them. I have every confidence that under Mark Hudson, Chairman Elect, The Game Conservancy Trust will remain at the cutting edge of research and debate on conservation and land use.

Andrew Christie-Miller. (The Game Conservancy Trust)

The new research centre in the walled garden of Burgate Manor. (Louise Shervington)

Chief Executive's report

Teresa Dent. (The Game Conservancy Trust)

I am delighted to bring you our "Double Jubilee" *Review*.

Since its inception in 1930, the organisation has transformed from an ICI-owned game research station with a tiny staff, to a wildlife and conservation charity working to provide a scientific basis for game and wildlife management in the countryside. Today it has an annual income of £5.6 million, 96 staff, and 22,000 members. Its wide range of scientific projects (over 50 in all) encompass species recovery, wildlife-friendly farming, and game and wildlife management. Of its research and conservation spend, nearly 40% is funded from the public sector. Government and conservation agencies along with many leading universities are often project partners.

We pride ourselves on practical and applied research, seeking conservation solutions that are compatible with economic land use. Over 75 years we have

Practical demonstration is the most effective way to show farmers and land managers what can be achieved. It is where we stand apart from many other organisations (Sophia Gallia/Natterjack Publications)

provided evidence for the conservation benefits of good game management, demonstrated the role of wildlife management in the countryside, improved practice, taken the principle of wildlife management into conservation policy, and educated the public on these issues.

Predicting the next 25 years is no easy task. What is clear is that we can do nothing without the support of you, our members, supporters and volunteers. Indeed, we could have done nothing in the last 25 years without you. We hope that you are proud of what we have achieved.

We need big plans if we are to get our message across: to ensure that game management is recognised as a central plank of wildlife management and conservation in the countryside.

We start the next 25 years with a changed structure. At the end of 2005, The Game Conservancy Trust incorporated (becoming a charitable company limited by guarantee) and we have merged with the Allerton Research and Educational Trust (ARET) which, since 1992, has been running our demonstration farm at Loddington in Leicestershire.

Trustees have decided to put more resource into "delivering" our science. Our research is only useful if it influences policy, practice, and public awareness – the three "P"s. Education has always been central to our work, but we have appointed a new Director of Education who will widen the remit of our educational work.

New research is vital. We are winning the arguments today with research that, in some instances, saw its origins 30 years ago. We have to be constantly looking ahead. The next 25 years should include the fullest possible research programme.

The organisation has a great team of staff, trustees and supporters. My thanks to them for all that we have achieved to date. I am confident that together we can meet the challenges ahead.

The Allerton Research and Educational Trust, which ran the farm at Loddington, has now merged with The Game Conservancy Trust. (Sophia Gallia/ Natterjack Publications)

Make no little plans; they have no magic to stir men's blood… make big plans, aim high in hope and work

Daniel H Burnham, US architect and city planner (1846-1912)

Translating research into training and advice

A farm walk in Dorset showing what the farmer is doing for wildlife. (Sophia Gallia/Natterjack Publications)

From The Game Conservancy Trust's earliest days as a game research organisation a key element of our activities has been to provide practical, science-based advice to farmers, landowners and others wishing to improve game and wildlife populations. Today, much of our research and management prescriptions are key components of the Government's agri-environment schemes and, in our sector, we undoubtedly provide a disproportionate contribution to wildlife management in the UK.

Above all, our work is aimed at "making a difference": to make available to those who can use it, the most up-to-date, practical guidance on managing game and wildlife. To advance this role, during 2005, we launched a major expansion of training courses, demonstration days, seminars and events to provide advice across a wide range of species and habitats.

We have a unique legacy and expertise in delivering "hands on" training. As long ago as the late 1940s, game management training courses were held at Burgate Manor and, by the early 1950s, farm and estate demonstration events were a regular feature of our activities. Fifty years ago these events concerned principally the ecology and management of game species. Today, however, reflecting the increasing breadth of our research, we provide practical training through a partnership of research and advisory staff on a wide range of habitats and species. We also organise training events on behalf of a wide range of statutory and educational organisations.

In 2005, we achieved a successful example of improved "delivery" of our research and management prescriptions through the launch of a number of regional partridge groups. Kindly sponsored by Saffery Champness, these provided farmers, landowners and others with a series of up-to-date technical workshops aimed at maximising the benefits of current agri-environment schemes for the grey partridge and other farmland birds. Based on their initial outstanding success, further groups are planned for 2006 and beyond.

Like the grey partridge, the brown hare, black grouse and water vole are examples of important and declining wildlife species for which our research has developed key management prescriptions. Reflecting this, we have developed a number of new training courses, both regionally and at Fordingbridge, to provide the latest management advice. Now, courses covering fisheries and river management, mink control and management for brown hares are central to our training courses, in addition to specialist game management events. The successful development of these courses is strongly symbolic of the widening relevance of our research beyond our traditional game audience to those concerned with managing a wider range of species, and of a 75-year heritage of providing wildlife management advice in the UK.

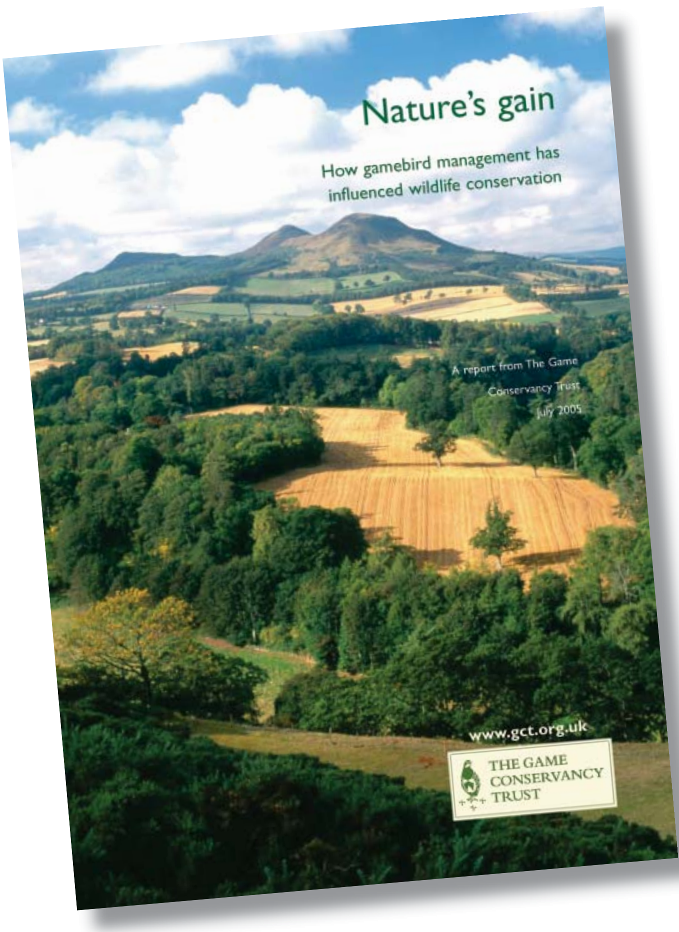
A trial area of pollen and nectar mix at Loddington – a good example of how our research influences policy and informs farmers. (Sophia Gallia/Natterjack Publications)

Jubilee year 2005

JUBILEE YEAR 2005/6
25 YEARS AS A WILDLIFE CONSERVATION CHARITY
75 YEARS OF GAME MANAGEMENT

Although it passed largely uncelebrated at the time, 1980 was a turning point in our history. Until that year, the Game Conservancy had been more or less defined by its aim to develop game management in a way that would enable landowners to run better shoots and solve critical questions about the loss of some stocks – most notably the grey partridge. We had a strong advisory team which promoted game management across the country. "Turning words into birds" was the motto of the era. However, during the 1970s our research work had been widening: farmland ecology was becoming a dominant theme, we had begun studies on restoring wildlife on gravel pits, and there were studies on roe deer, brown hares and woodcock. Much of this new work was being funded not by membership subscription, but through research grants, especially from government-funded research councils. So, without much fanfare, we opted to become a research and education charitable trust. This significantly broadened our outlook so we embraced wildlife management in general and adopted the concept of "conservation through wise use". Although this change happened in 1980, it wasn't until the 1990s that we began using the title The Game Conservancy Trust to describe ourselves.

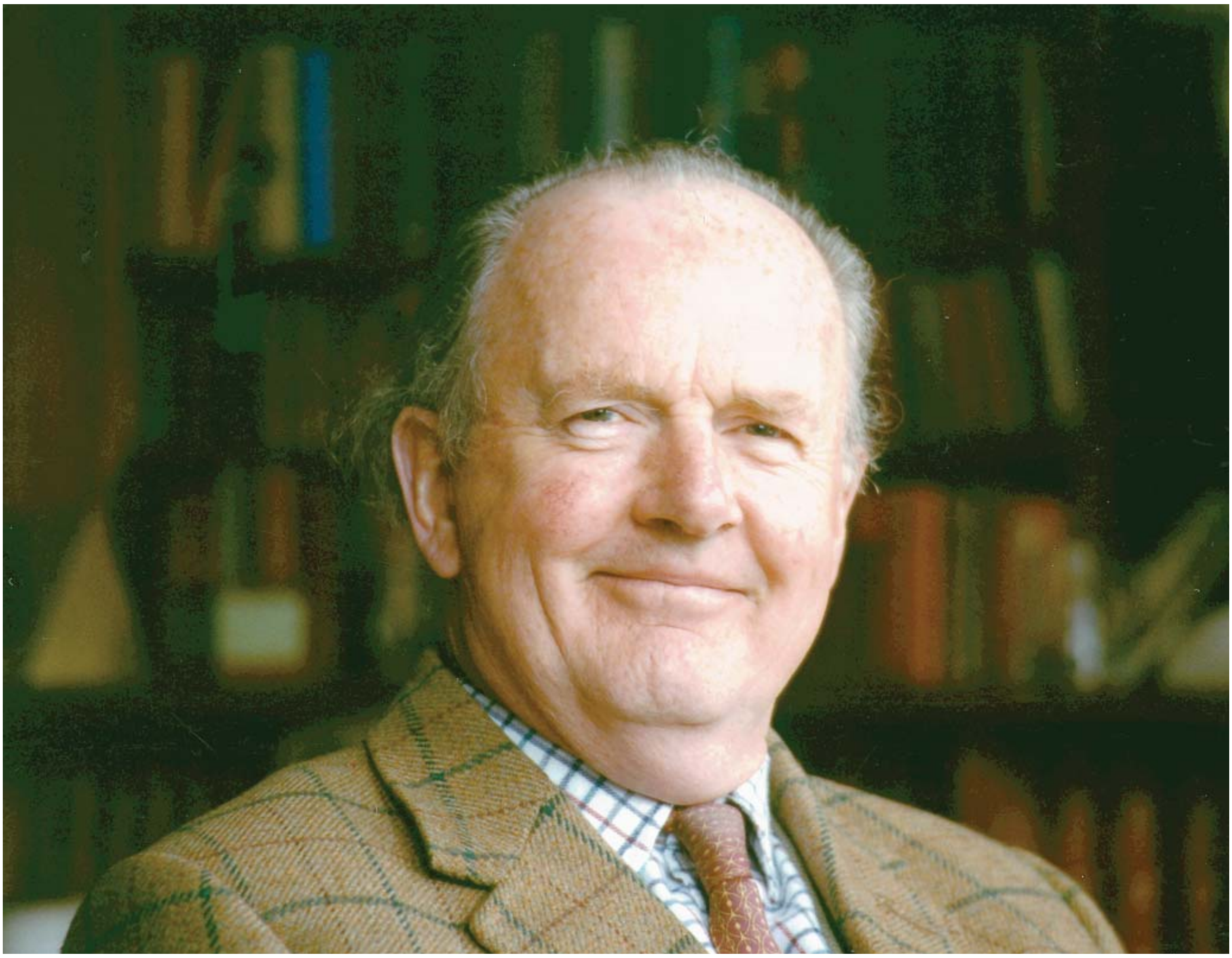
2005 was therefore our 25th birthday as a charity. But because, under one name or another, we had been doing research on game since 1931, we celebrated 2005 as a double jubilee (25 years as a wildlife conservation charity; 75 years of game management). To mark the occasion we published a report on game management and conservation. Published in time for the 2005 CLA Game Fair, *Nature's Gain* has been well received and provides a history of how shooting has influenced the countryside and is continuing to influence the fauna and flora today. Although there is always more room for those who manage game to do more to help improve biodiversity, it is clear that they are already doing a lot. Indeed some of the best sites for wildlife in Britain are those that are principally managed for game.



Nature's Gain

Copies of the publication, *Nature's Gain*, are available free of charge from The Game Conservancy Trust. Please call 01425 652381 to obtain a copy.

The Hon Sir Charles Morrison, 1932-2005



by Philip Astor,
Vice Chairman of Trustees

Sir Charles Morrison, Chairman of The Game Conservancy Trust (1987-1994), had a long connection with the GCT. As far back as 1959, he helped establish the Game Research Association, which evolved into the Game Conservancy and later became a charitable trust. He was one of the first members elected to our Council and he remained an active and enthusiastic Vice President until he died in May 2005.

It was under Charlie Morrison's leadership that we developed the broad science base that now underpins our management and policy advice. Some of those studies on farmland wildlife and the effect of predation on partridge populations certainly had a positive influence on our new agri-environment schemes and current licensing arrangements for predator control.

Charlie was also MP for Devizes from 1964 to 1992, and he helped arrange meetings for us with civil servants and Ministers, encouraging the latter to visit our projects at Fordingbridge, Manydown, Great Linford, and Loddington.

His quiet, good humoured and avuncular support is fondly remembered by all of us who worked with him. Dick Potts, our former Director of Research and later Director General, summed it up: "No member of the Trust has contributed more to the organisation than Charlie Morrison. Nobody can begin to compare with his track record of friendly leadership founded on an extraordinary breadth of knowledge and political acumen. His record of attendance at Council and Committee meetings will surely never be matched. How he managed it with such a busy professional life is astonishing."

Much of our research today continues thanks to Charlie's enthusiasm and encouragement in the past. We have every expectation that his legacy will continue well into the future.

Sir Richard Southwood DL, DSc, FRS (1931-2005)

by Dr Stephen Tapper,
Director of Policy and Public Affairs

Followers of science, and especially ecology, will not have overlooked the death last October of Dick Southwood. His obituary in *The Times* described him as a towering figure among British zoologists, with a career that saw him first as a young dynamic entomologist at Rothamsted Research Station and then for 14 years at Imperial College, where he was Director of the Silwood Park Field Station and later Dean of Science. He went on to be the Head of the Department of Zoology at Oxford, and then Vice-Chancellor.

Given the breadth of his achievements, it is perhaps not altogether surprising that his obituaries have overlooked his link with The Game Conservancy Trust. Soon after he started at Imperial College, he helped our own fledgling research department sort out the problem of dwindling partridge numbers at the demonstration shoot at West Park, Damerham. A nice wild partridge shoot had been built up at West Park since 1947 only to collapse from the mid-1950s. Regular counting had been done annually so there was a good set of data for analysis. So it was that one of the first things that Dick Southwood did in his career at Silwood was to help Terence Blank and Richard Cross unravel what was going on. In a series of three papers published in the late 1960s in the *Journal of Animal Ecology*, they showed that the most likely cause of the drop in numbers was reduced survival of partridge chicks due to a drop in insect numbers. The suspicion was that the newly introduced herbicides had caused this. Following on, in 1968, Dick Southwood encouraged our new study on the Sussex Downs called the Partridge Survival Project, based at North Farm near Findon. Here Dick Potts took on the whole idea of looking at cereal insect numbers, how they were affected by modern farming and what were the consequences for farm wildlife – especially the grey partridge. This study runs even today as our Sussex study. Because of his links with this work, Dick Southwood later chaired our first Scientific Advisory Committee as our research department expanded in the 1970s, and then led a review panel of our science some years later. For his help and his guidance over many years, Dick Southwood was made a Vice-President of The Game Conservancy Trust.

Sir Richard Southwood helped our fledgling research department sort out the problem of dwindling grey partridge numbers on our West Park shoot, near Damerham (below). (The Game Conservancy Trust)

Loddington in 2005

Key achievements

- Integrated research projects into soil and water.
- Loddington recognised as key environmental demonstration farm.
- Audiences of over 2,000 people heard about our research.

Alastair Leake

Seeing how wildlife reacts to the cessation of predator control continues to be central to our research. As this is observational rather than experimental work, we must continue it for some years. Meanwhile we have four soil and water experiments on the farm looking at ways farmers manage soils and how cultivation can affect wildlife and water quality. We also want to know how drainage affects water supply for animals – particularly birds.

Our projects complement one another and make Loddington a valuable agri-environment demonstration farm. This has attracted many visitors, including over 300 in a single day for the annual LEAF Innovation Centre farm walk, when we joined other experts at 10 points on the farm, talking to groups of 20 throughout the day.

In 2005 we ran courses on soil management, waste management, Entry Level Stewardship (ELS), biodiversity and environmental training and gave Cross Compliance advice. Over 2,000 people either visited the farm in 2005 or formed part of other audiences across the country to whom we spoke.

Although the "dos" and "don'ts" of Cross Compliance and ELS are set out in various Defra publications, often it is the "how to" that our audience seeks; that is where our experience and practical approach is appreciated.

Allerton Research & Educational Trust projects in 2005

Project title	Description	Staff	Funding source	Date
Effect of predation control (see page 16)	*Effect of ceasing predator control on nesting success and breeding populations of game and songbirds*	*Chris Stoate, Alastair Leake, John Szczur, Antony Mould, Kate Driver*	*ARET*	*2001 - on-going*
Monitoring wildlife at Loddington	*Annual monitoring of game species, songbirds, invertebrates and habitat*	*Chris Stoate, Alastair Leake, Steve Moreby, Sue Southway, Kate Driver, Barbara Smith*	*ARET*	*1992 - on-going*
SOWAP	*Demonstrating use of conservation tillage to protect and enhance soil resources, water quality and biodiversity*	*Alastair Leake, Chris Stoate, Kate Driver, Matthew Davis*	*EU Life*	*2003 - on-going*
Songbird ecology (see page 18)	*Ecology of songbirds at Loddington, including studies on tree sparrow and flycatcher*	*Chris Stoate, John Szczur, Kate Driver*	*ARET*	*1992 - on-going*
Phosphorus from agriculture: riverine impact study (PARIS)	*Impacts of agriculturally-derived sediment and phosphorus on aquatic ecology in the Eye Brook catchment*	*Chris Stoate*	*Defra*	*2004-2008*
Herbicides for conservation headlands	*Evaluating dose rate and timing on weed populations in conservation headlands*	*Alastair Leake, Phil Jarvis, Kate Driver*	*Monsanto*	*2004 - on-going*
Mitigation of phosphorus and soil loss to water (MOPS)	*Examining effect of cultivation on soil erosion and phosphate loss*	*Alastair Leake, Chris Stoate, Phil Jarvis, Kate Driver*	*Defra*	*2005-2008*
Nutrients and sediment in water	*Assessing nutrients and sediment in field drains and stream, and potential mitigation*	*Chris Stoate, Kate Driver, Alex Berry*	*Environment Agency, Habitat Research Trust*	*2002 - on-going*
Wetting up farmland for wildlife	*Assessing bird conservation potential of small wet features on farmland*	*Chris Stoate, John Szczur, Mark Speck*	*Defra*	*2004-2007*
Pollen/nectar mixes	*Establishing pollen/nectar mixes under stewardship and use by pollinating insects*	*Chris Stoate, Kate Driver*	*ARET*	*2003-2006*
Muntjac and ground flora	*Assessing and mitigating damage to woodland ground flora by muntjac deer in Leighfield Forest*	*Chris Stoate, Alex Berry*	*English Nature*	*2004-2007*
'Pathfinders'	*Investigating farmers' motivation for participation in agri-environment schemes*	*Alastair Leake, Chris Stoate*	*Defra*	*2003-2005*
Conservation and Cross Compliance advice	*Providing farmers and landowners with advice on the rules and options*	*Alastair Leake, Chris Stoate, Phil Jarvis*	*Defra*	*2005-2007*
Biodiversity and environmental training for advisors (BETA)	*BASIS-accredited training for agronomists in biodiversity and environmental issues*	*Alastair Leake, Chris Stoate, Peter Thompson*	*Course fees*	*2003-2007*
Soil and waste management	*Training for farmers in understanding Soil Management Plans and the EU Waste Directive*	*Alastair Leake, Phil Jarvis*	*Course fees, Defra*	*2005 - on-going*
Wildlife seed mix agronomy using organic methods	*Developing methods for organic farmers growing wildlife seed mixes*	*Alastair Leake, Kate Driver*	*English Nature*	*2004-2006*
PhD: Songbird productivity and farmland habitats	*Productivity of songbirds in relation to habitat, predation and weather*	*Patricia White (Supervisors: Chris Stoate, GCT; Ken Norris, Reading University)*	*BBSRC CASE*	*2005-2008*
PhD: Birds and bees	*Role of pollinating insects on autumn berry abundance as food for birds*	*Jenny Walker (Supervisors: Chris Stoate, GCT; Ian Denholm, Juliet Osborne, Rothamsted Research; Dave Goulson, Southampton Univ)*	*BBSRC CASE*	*2004-2007*

Key to abbreviations: BBSRC = Biotechnology and Biological Sciences Research Council

The farming year at Loddington in 2005

2005 saw the biggest shake-up in the way EU farm subsidies are paid. Since the UK joined the EU in the early 1970s farmers have been paid according to the tonnage or areas of crops grown. This connection has been broken, and farmers now claim a new subsidy called the Single Farm Payment. To be entitled to this, each farm must register all land they wish to claim on. Subsequently, they are paid a rate per hectare across the board, but they must observe various EU Directives and a number of new standards keeping this land in 'good agricultural and environmental condition'. This has meant that we have spent more time than usual understanding these new requirements, so that we can comply, but also so that we can help our many visitors understand the new rules.

Shortly after the introduction of the Single Payment Scheme, Defra launched a new Environmental Stewardship Scheme which pays farmers for care of the countryside. Many of the options in this new scheme have either been tested or developed at Loddington and so we think that they will have a beneficial effect on biodiversity once adopted nationally. Our stewardship application was completed in December

Key results

- Crops, except oilseed rape performed acceptably.
- Spring beans proved a useful break-crop.
- It was a productive year for sheep with 500 lambs born in spring.
- Game strips grew exceptionally well.

Alastair Leake

Table 1

Arable crop yields (tonnes/hectare) at Loddington 1994-2005

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Est 2005
Winter wheat	7.66	8.61	10.19	7.00	9.34	9.62	8.89	7.25	8.20	8.35	8.20	8.80
Winter barley	5.62	7.38	7.38	7.11	5.60	6.20	4.96	3.89	4.52	-	-	-
Winter oilseed rape	2.13	3.47	3.62	2.61	2.23	3.59	2.93	1.61	3.67	3.03	3.30	2.30
Spring oilseed rape	1.26	-	-	2.01	-	-	-	-	-	-	-	-
Winter beans	1.56	3.19	3.52	4.44	3.64	2.99	3.95	2.29	2.99	4.35§	3.84§	4.30§
Winter oats	-	-	-	-	-	-	-	-	6.37	7.10	7.10	6.10
Linseed	0.82	0.93	-	1.16	-	1.36	-	-	-	-	-	-

§ spring beans

Loddington (Chris Stoate)

Table 2

Arable gross margins (£/hectare) at Loddington 1994-2005

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

* revised figures § spring beans †estimated figures

Table 3

Farm conservation costs at Loddington 2005 (£ total)

Set-aside *(wild bird cover)*[1]	
(i) Farm operations	932
(ii) Seed	983
(iii) Sprays and fertiliser	388
Total set-aside costs	**2,303**
Conservation headlands[2]	
(i) Extra cost of sprays	0
(ii) Farm operations	75
(iii) Estimated yield loss	814
Total conservation headland costs	**889**
Grain for pheasants	1,108
Grass strips	188
Stewardship	7,018
Other conservation work	249
Total conservation costs	**11,755**
Project-funded seed	(749)
Stewardship income	(5,263)
Total profit foregone	
- conservation	**5,743**
- research and education	**2,217**
	7,960

[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 Conservancy Trust

and involves hedgerow management, buffer strips, pollen and nectar mixes as well as a number of management plans.

Support payments continue to be important to financial viability as crop prices remained severely depressed for another year. Autumn 2004 was a difficult sowing period: early crops established well, but some of the later crops suffered from a deluge of rain in November and some of these had to be re-drilled. Crops generally went on to perform acceptably, with the exception of oilseed rape, which never recovered from the delayed drilling. Black-grass control was better than in previous seasons. Spring beans are proving a very useful break crop, producing good yields, spreading the work-load and giving us a cultural control mechanism against problem grass weeds. The sheep flock had a productive year with 500 lambs born in the spring, although our tight stocking rate meant that many were sold as stores. The game strips grew exceptionally well owing to careful planning and diligent attention. Quinoa, kale,

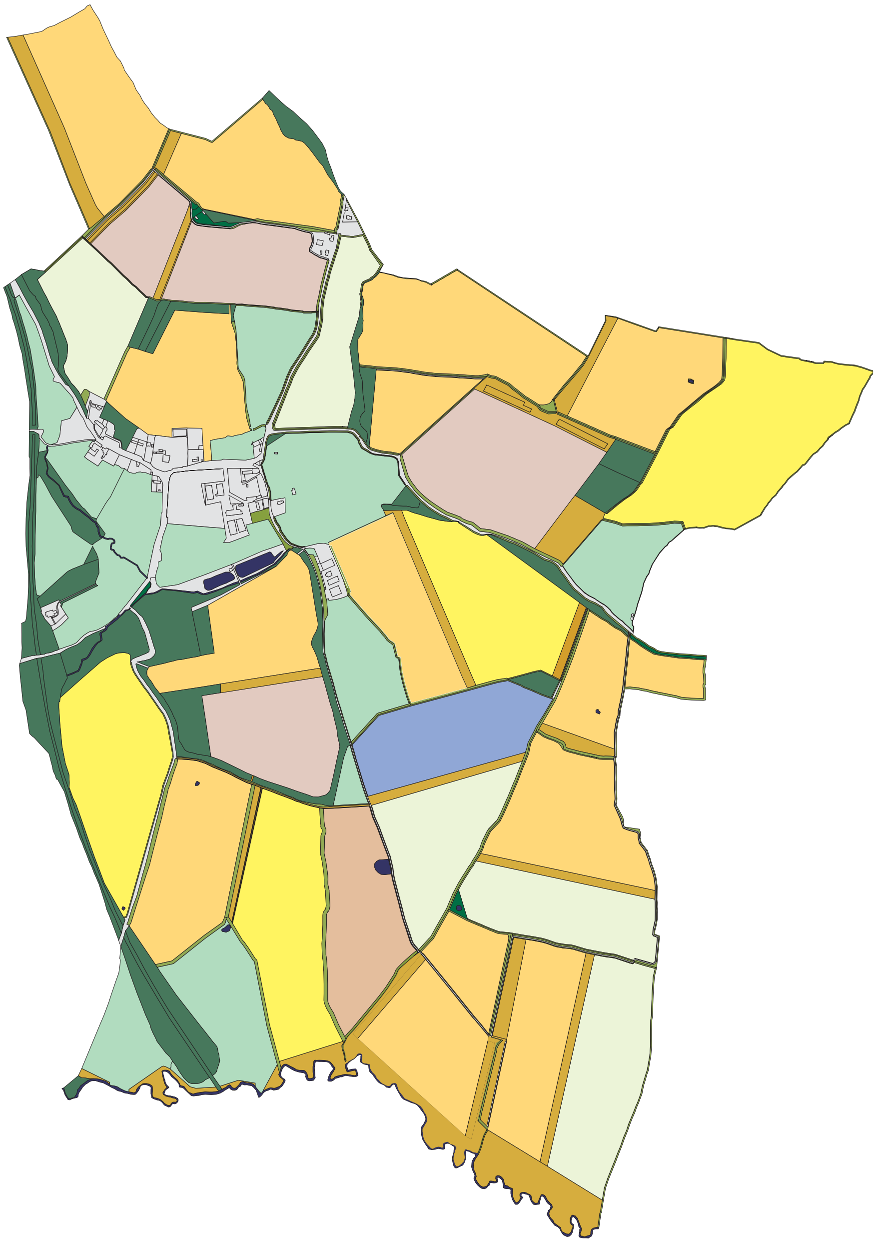


Figure 1

Loddington Estate cropping 2004/05

- Woodland
- Permanent pasture
- Winter wheat
- Spring beans
- Winter oilseed rape
- Winter oats
- Spring oats
- Phacelia on set-aside
- Set-aside
- Hedgerow/verge

triticale and linseed formed the basis of many mixes, but we also grew sunflowers, teasels, maize, sorghum and forage rape. This has given us a range of seed-yielding strips with different canopy structures across the whole farm. Drilling was completed in autumn 2005 in good time and crops went into the winter in good condition for the 2006 harvest.

Opposite: a bumble bee on phacelia, grown on set-aside at Loddington in 2005. (Sophia Gallia/ Natterjack Publications Limited)

Table 4

Loddington profit and loss 1994-2005 (£)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total gross margin	146,170	217,193	219,540	159,705	137,323	143,173	141,896	111,952	144,318	194,144	146,365	138,171
Total direct costs	(41,534)	(70,835)	(62,946)	(84,622)	(64,484)	(63,216)	(82,820)	(62,463)	(75,558)	(78,840)	69,966	79,320
Gross profit	104,636	146,358	156,593	75,083	72,839	79,957	59,076	49,489	68,760	115,304	76,399	58,851
Total overhead costs	(41,421)	(23,615)	(30,544)	(23,059)	(15,329)	(17,287)	(12,302)	(14,246)	(15,482)	(16,339)	22,539	24,813
Profit before depreciation	63,215	122,743	126,049	52,024	57,510	62,670	46,774	35,243	53,278	98,965	53,860	33,985
Total profit foregone	4,563	6,588	3,453	4,637	3,643	3,533	2,605	3,642	4,907	6,567	7,002	7,960
Farm profit (loss)	35,746	114,927	96,925	21,594	25,422	35,550	26,046	3,895	15,064	55,220	32,206	25,998

Loddington game and songbirds

Key findings

- Autumn game numbers fell to an all-time low.
- Magpie numbers remained below pre-keepering levels.
- Spring game and songbird numbers were lower than in years with keepering.
- Winter feeding and predator control combine to influence game and songbird numbers.

Chris Stoate

2005 was the fourth year since predator control stopped and our gamekeeper left Loddington. Using remaining staff, we continued other keepering activities such as winter feeding and habitat management. During the 2003/04 and 2004/05 winters, we took on additional help for winter feeding.

Game numbers

Autumn pheasant abundance dropped again in 2005 with only 88 birds compared with up to 629 before the change in game management (see Figure 1). This is an all-time low with fewer birds than at the start of the project in 1992. The greatest decline was in hens and young birds, suggesting that nest predation is the main cause of loss. Autumn numbers of red-legged partridge also dropped to only 17, compared with 140 in 2001.

Autumn hare numbers also declined again, to a level close to that of 1992 (see Figure 2). Although the improved habitat at Loddington is likely to have helped their food supplies, predation of leverets by foxes could have countered such benefits.

Spring pheasant numbers dropped for two years after predator control stopped, but increased again in 2004, and subsequently fell back to 121 birds (of which 37 were territorial cocks; see Figure 3). This compares with a total of 84 in 1992, before we started our management at Loddington. Spring numbers of pheasants at Loddington may be influenced as much by availability of food in winter as by breeding success the previous summer.

Figure 1

Pheasant numbers in autumn at Loddington

Young

Cocks

Hens

Predator control in place

Autumn pheasant numbers continue to drop

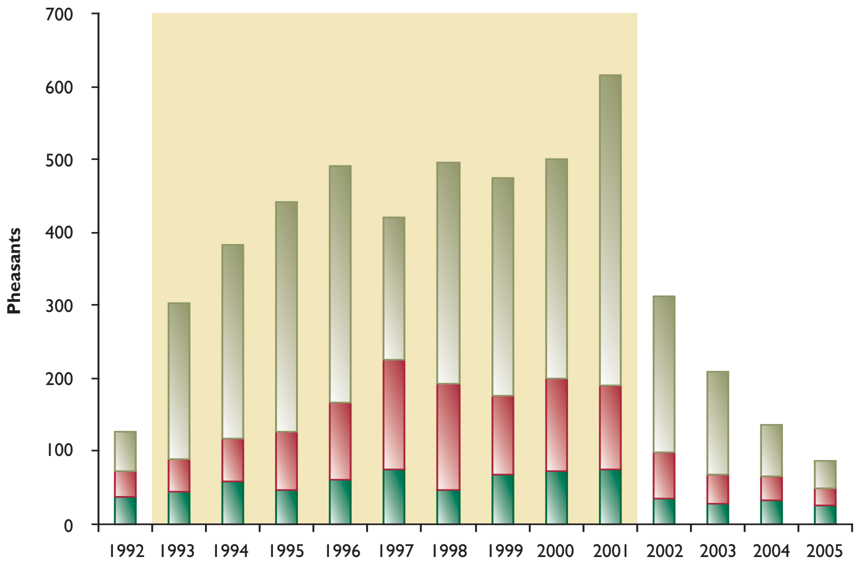
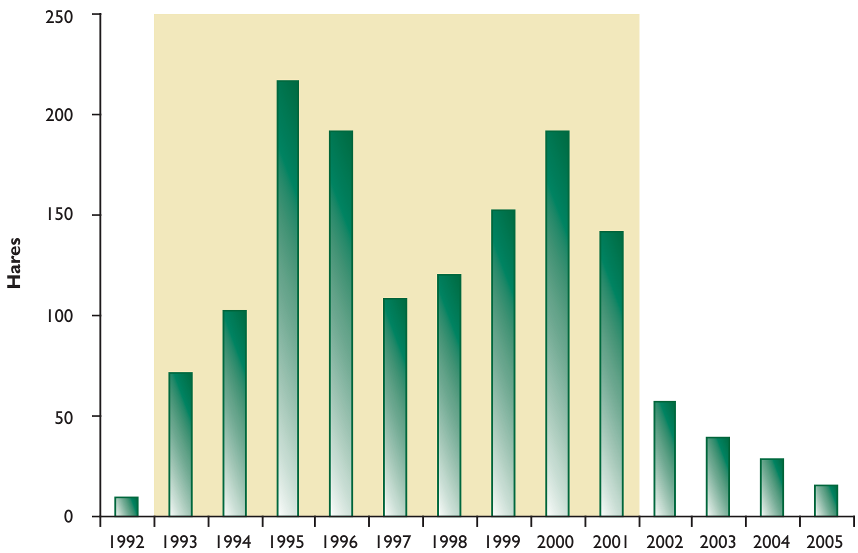


Figure 2

Hare numbers at Loddington

Hares

Predator control in place



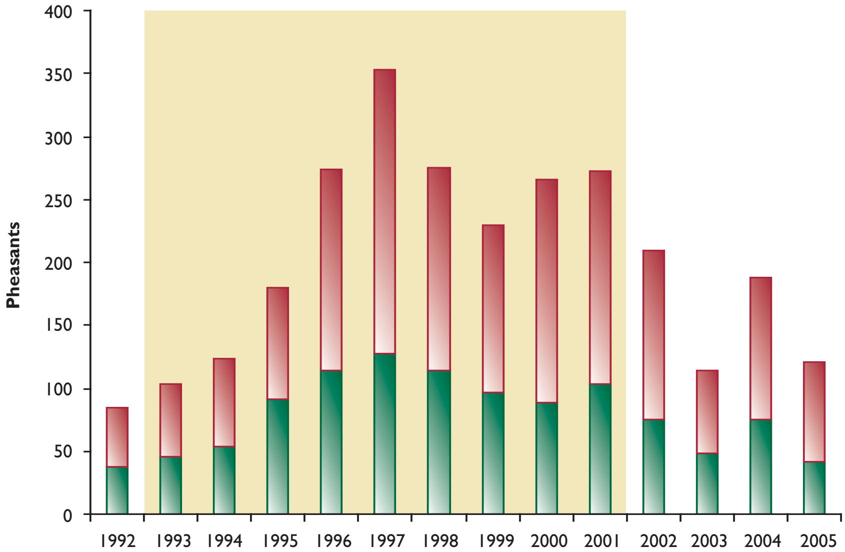


Figure 3

Pheasant numbers in spring

Cocks

Hens

Predator control in place

Songbird and corvid numbers

Carrion crow numbers increased to nine pairs, slightly higher than the eight pairs in 1992. However, numbers of magpies, the main nest predator of many songbirds, were only back to six pairs in 2005, compared with 10 when the project started in 1992. This is probably because neighbouring farmers now control magpies more than they did before.

Annual transects of birds each spring indicate that songbird numbers declined in 2002, the first year with no predator control, and again in 2003, but increased slightly in 2004 and again in 2005. In 2006, we plan a more detailed assessment of bird numbers, using intensive territory mapping, which will provide a more detailed insight into what is happening for some key species. We already know, for example, that breeding numbers of spotted flycatchers have declined at Loddington in recent years (see article on page 18).

Influences on game and songbird abundance

It is difficult to isolate the effect of predators from habitat improvement or winter feeding. All are important duties of a keeper and clearly influence abundance of game and songbirds, but the benefits of predator control for songbirds are not as clear as they are for game!

Key dates

1992	Project started
1993	Habitat management and keepering started
2002	First year with no predator control

Feeders designed for pheasants are also a source of food for many songbirds. (Chris Stoate)

Spotted flycatchers at Loddington

Key findings

- Nesting success was higher when predators were controlled.
- When predators were not controlled, nesting success was higher in gardens than in woods.
- Changes in flycatcher numbers associated with change in management were apparent in woodland, but not in gardens.

Chris Stoate
John Szczur

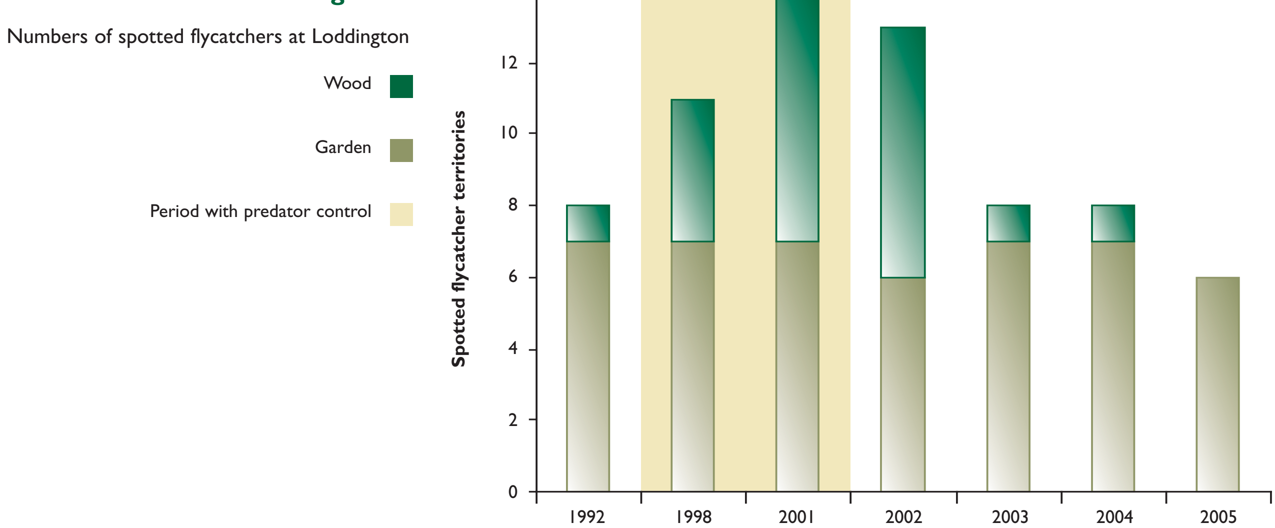
A spotted flycatcher's nest at Loddington. (Chris Stoate)

Spotted flycatchers have declined substantially in recent years and are designated as a Biodiversity Action Plan (BAP) species. They are popular birds as they frequently nest close to house walls or in hanging baskets. They fly from prominent perches to catch insects, and are an endearing sight in country villages, so it is sad that their numbers have declined by about 80% over the past three decades.

Flycatchers cross the Sahara twice a year on their way to and from wintering areas in sub-Saharan Africa, where a loss of woodland may have reduced survival. Another explanation is that breeding success has fallen because of fewer insects, loss of habitat, and because of increased predation by woodland predators such as grey squirrels.

Figure 1

Numbers of spotted flycatchers at Loddington



The change in predator control at Loddington has provided a chance to look at how spotted flycatchers respond to gamekeeping.

Flycatcher pairs increased at Loddington between 1992 and 2001 during our period of predator control, but declined after 2002 when predator control stopped. This year's delay in the decline following cessation of predator control is indicative of a change in numbers resulting from reduced nesting success. Most of this change in number was attributable to the establishment or abandonment of breeding territories in woodland, whereas numbers of breeding territories in village gardens remained largely unchanged through this period (see Figure 1). This initial increase, followed by a decline, is unlike the national trend where there has been a sustained decline throughout this period. As a migratory species, spotted flycatchers cannot have been affected by the abundance of winter food at Loddington, which appears to have influenced numbers of non-migratory species there, but must have been influenced by our management in summer.

During our nest monitoring, we found that nests were made broadly in either woods, or in village gardens. The nests themselves could be in cavities, creeping plants on tree trunks, walls, or in three cases in old thrush nests. Some were more than nine metres off the ground but three metres was more typical. Nest survival to fledging was 73% in the years with predator control, but only 26% in the years without it. In the absence of predator control there were differences between habitats, with nest survival in gardens being 75%, whereas that in woods was just 20%.

It seems that predation does reduce the breeding success of spotted flycatchers at Loddington, especially in woodland, and this is a likely explanation for reduced breeding numbers in subsequent years. This is one bird which certainly appears to benefit from predator control carried out for game.

Spotted flycatchers are popular birds and are an endearing sight in country villages. Sadly numbers have dropped by 80% in the last 30 years. (David Mason)

The Eye Brook and its rural catchment

Key findings

- EU policy and local interest in wild trout combined to generate concern about water quality in the Eye Brook.
- Trout breeding success is low because of soil erosion resulting in sedimentation of stream gravels.
- Several integrated research projects investigate this process, and how to reverse it, in the Eye Brook catchment.
- This is a long-term study involving local people.

Chris Stoate
Dylan Roberts

The Water Framework Directive is likely to have a significant effect on how land is managed. It aims to achieve 'good chemical and ecological status' by 2015. What exactly this means is not yet clear, but it certainly will have implications for farming, the landscape, fishing, and wildlife conservation.

Loddington is in the middle of the Eye Brook catchment, which gives us an ideal opportunity to investigate the relationship between farming and water quality. We started in 2003 with a workshop for local people, to find out more about their interests and knowledge of catchment issues in the area. They attached a high value to the local environment, especially the Eye Brook and its wildlife, including the wild brown trout population. We surveyed this population along the whole 17 kilometres of the stream and found that young fish were only present in any number at one site and represented only 33% of the population overall (see Figure 1). We suspect this is because most of the stream bed is heavily silted, and unsuitable for spawning fish.

Stream silt comes mostly from the arable land and carries phosphorus, which is tightly bound to the soil particles. This can damage the stream ecology because it alters the nutrient balance. How this happens in streams is not well understood and we have started a new research project to investigate. Early results suggest that concentrations of phosphorus bound to particles are about eight times higher in the arable sub-catchment at Loddington than in a low input pasture sub-catchment upstream (see Figure 2).

Half a century ago, the area around Loddington was almost all pasture and the stream was probably in better condition. The trend to arable cropping is unlikely to reverse in the near future, so we need to understand how soil erosion occurs, and to find ways of reducing it. The Soil and Water Protection Project aims to do this. Loddington is one of five sites in this European project, which is looking at how different cultivation methods affect soil erosion and run-off. The project is also investigating the effect of cultivation on earthworms and soil fungi as these can influence porocity and soil stability. We have started another project to investigate whether surface run-off can be reduced by cultivation direction and beetle banks.

There may be other ways to improve water quality. One way is to make sure that field drains empty into buffer strips rather than run underneath them. The phosphorus concentration is reduced by up to a half as water passes through pools in the buffer strip. The Ponds Conservation Trust found that these pools had between 20 and 60 species of aquatic invertebrate, including a couple of scarce beetle species. The rank vegetation supports nesting birds such as pheasant, whitethroat and reed bunting.

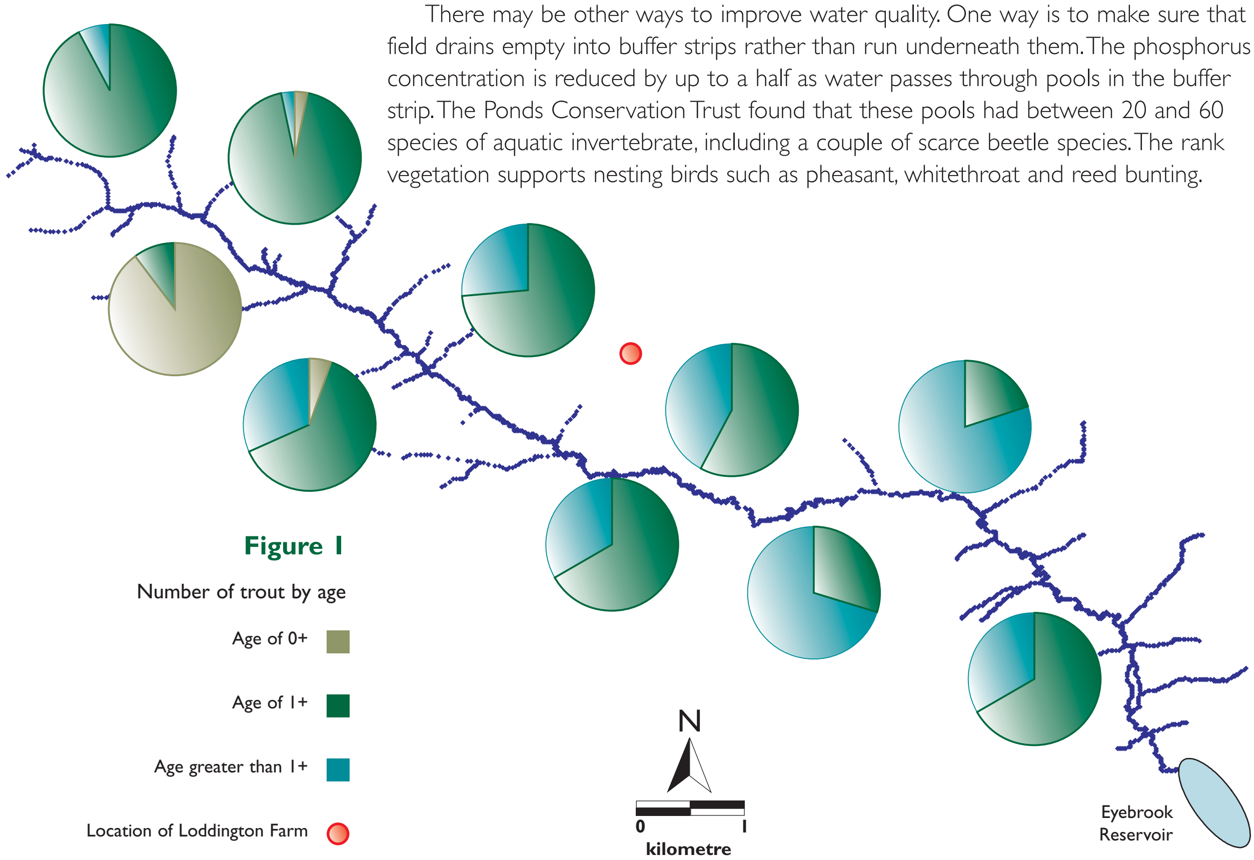


Figure 1

Number of trout by age

Scaling this approach down to the field corner, we are looking at the potential of small 'paired ponds' in reducing the impact of arable cropping and contributing to wildlife conservation.

It is largely as a result of our work on the Eye Brook, a tributary of the River Welland, that the Welland has been classed as an 'operational' UNESCO Hydrology for the Environment, Life and Policy river basin – one of just 67 worldwide. Feedback from visiting farmers and local people is important to this work and we will continue to develop links locally for this and other landscape-scale projects.

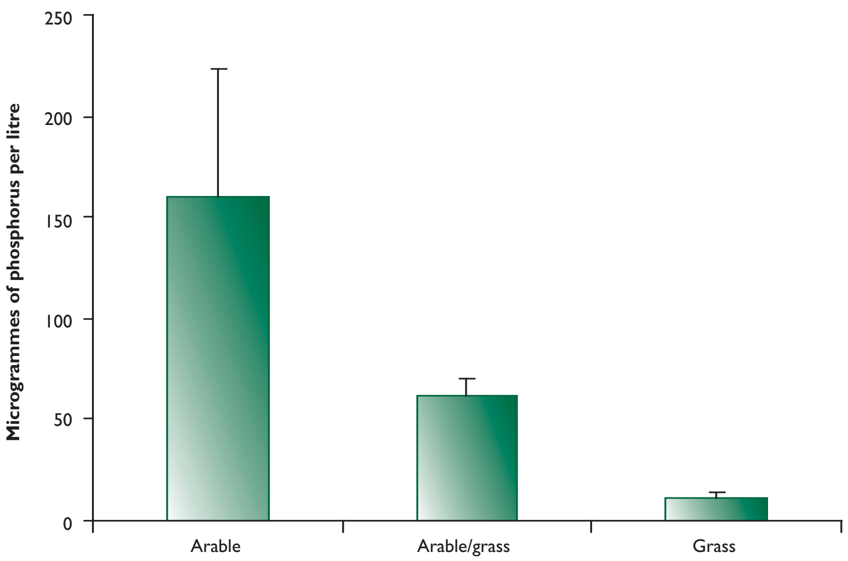


Figure 2

Total phosphorus concentrations in streams feeding in from different farming patterns along the catchment

Our established constructed wetland reduces nutrient movement to water courses and provides a habitat for aquatic life and birds. (Chris Stoate)

Woodland game ecology in 2005

Key achievements

- We completed a five-year DTI-funded project on short rotation coppice, which showed that these are good for wildlife.
- We provided more information on the benefits of pheasant releasing to woodland wildlife.
- We used long-term National Gamebag Census data to explore trends in shot deer regionally and over time.

Rufus Sage
Nicholas Aebischer

Several of our studies on the effects of releasing lowland game for shooting on habitats and wildlife finished in 2005. These have dominated our work in the last three years and now we have a clearer picture of the positive and negative effects of releasing game. On page 28 and 30 we present further evidence of some of the benefits to woodland of management undertaken for released pheasants and on page 42 our English Nature-funded study of red-legged partridges and chalk grassland butterflies is heading to a, perhaps unexpected, conclusion.

In June 2006 we will finish our work on the effects of releasing on hedgerows. We aim to complete this work and report by July 2006. This will include recommendations on best practice when releasing.

Our DTI-funded research on the biodiversity in short rotation coppice (SRC) biomass plantations finished in 2005 (see page 23), coinciding with renewed government and public interest in energy crops. We have been studying the ecology of these crops under the DTI programme continuously for over 10 years now and we are the leading experts in the field. The Rural Economy and Land Use programme, however, will fund a new study of SRC and *Miscanthus* in a new project led by Rothamsted. Rothamsted has asked us to undertake much of the biodiversity work.

Our wild pheasant counts are now in their 10th year and these are discussed on page 26.

Woodland wildflowers including bluebells and aconites in April. (Sophia Gallia/Natterjack Publications Limited)

Pheasant and woodland game research in 2005

Project title	Description	Staff	Funding source	Date
Pheasant population studies (see page 26)	*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 short rotation coppice (see page 23)	*Monitoring wildlife in commercial short rotation coppice plantations*	*Rufus Sage, Mark Cunningham*	*DTI*	*2000-2005*
Pheasant releasing density studies	*Investigating relationships between different release densities and biodiversity*	*Rufus Sage, Maureen Woodburn, Roger Draycott*	*Research Funding Appeal*	*2001-2006*
Releasing and woodlands survey (see page 28, 30)	*Comparing woodlands with and without game management*	*Rufus Sage, Andrew Hoodless Roger Draycott*	*Research Funding Appeal*	*2004-2006*
Game crops and wild game	*Relationship between cropping and gamebird productivity in East Anglia*	*Roger Draycott, James Palmer*	*Chadacre Trust*	*2005-2006*
CRoW Act: access and wildlife impacts	*Literature review of access disturbance impacts on birds*	*Rufus Sage, Royal Agricultural College, Mike Swan*	*Countryside Agency*	*2005*
PhD: Dispersal of released pheasants	*Radio-tracking released pheasants to determine mortality and dispersal in relation to density and habitat quality*	*Clare Turner Supervisors: Rufus Sage, GCT Simon Leather, Imperial College*	*Research Funding Appeal*	*2001-2005*
PhD: Lees Court Estate Project	*To quantify the biodiversity and economics of a quality, released bird shoot following management for game, including comparison sites*	*Tracey Greenall, Supervisor: Rufus Sage, GCT Prof N Leader-Williams, DICE at Kent University*	*Sir John Swire Charitable Trust, Lees Court Estate, Holland & Holland*	*2000-2006*

Key to abbreviations:
DTI = Department of Trade and Industry.

Short rotation coppice for the long term

Short rotation coppice (SRC) is likely to become a widely grown energy crop. Since 2005 we have been studying 22 commercially grown willow SRC plantations, linked to the ARBRE renewable energy project in South Yorkshire. Of these, 12 were planted on arable land and 10 on grassland. Each of the SRC plantations were paired with arable and grassland controls.

Once established, SRC plantations rapidly develop into a scrub habitat, and attract a different bird community from arable and grassland. Finches (0.75 ± 0.07 per hectare), thrushes (0.46 ± 0.05 per hectare), tits (0.64 ± 0.08 per hectare) and warblers (1.08 ± 0.07 per hectare) were all more abundant in the SRC. Migrant warblers were especially common, with approximately one singing willow warbler per hectare in spring. Overall there were more bird species in the SRC (6.60 ± 0.30 per visit) than in the controls (2.40 ± 0.19 per visit), both in the SRC and along its edges.

One aim was to determine if birds associated with open farmland would be displaced by planting SRC. We found few skylarks on grassland controls (0.09 ± 0.02 per hectare), so SRC would be unlikely to harm their numbers in this habitat. Crows (0.58 ± 0.16 per hectare) and starlings (0.41 ± 0.16 per hectare) were more abundant in grassland and may be displaced, so SRC could reduce their populations. The arable controls did have more skylarks (0.15 ± 0.03 per hectare) than established SRC, which did not support this species. However, recently planted or cut SRC supported more skylarks (0.31 ± 0.08 per hectare) and lapwing (0.85 ± 0.25 per hectare) than the arable controls. SRC is harvested approximately every three years and this creates an open habitat which suits these species.

In winter, although lapwings were hardly recorded on SRC sites, both snipe and woodcock were three and 20 times, respectively, more common in the SRC (see Figure 1). 86% of cut and standing SRC plantations supported woodcock at some point during the winter, and 73% held snipe. Snipe numbers varied between years, with a maximum of 20 birds recorded from a single plot at any one visit.

We sampled vegetation within 1x10 metre quadrats at various distances from the edge of the SRC and control crops during July. We counted the plant species present

Key findings

- In winter, snipe and woodcock prefer short rotation coppice crops to arable and grass fields nearby.
- As the SRC crop established, perennials in the ground flora took over from annuals.
- As the crop matured, the headlands of SRC attracted higher numbers of butterflies than the controls.
- The canopy of SRC attracted a diverse insect fauna.

Mark Cunningham

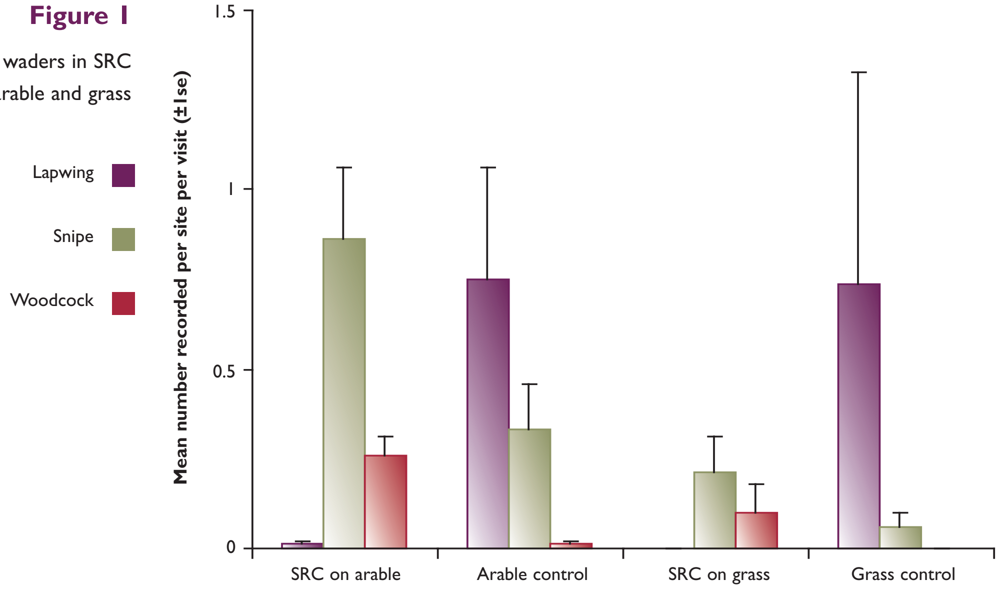
Many birds use SRC in the winter., including species like fieldfare. Other species like snipe and woodcock are also common. (Rufus Sage)

Blue willow beetles are a major pest of commercial SRC plantations. (Rufus Sage)

within each quadrat, and categorised them into annuals and perennials. Recently planted/harvested SRC was dominated by annual plants, such as groundsel, fat hen and creeping thistle. With growth, the proportion of annuals declined and perennials increased. The number of different plant species increased by 39% after one year's

Figure 1

Average number of wintering waders in SRC plantations compared with arable and grass



Native willows are the food plant of caterpillars of a wide range of butterfly and moth species. We see many of the same species on SRC varieties. (Rufus Sage)

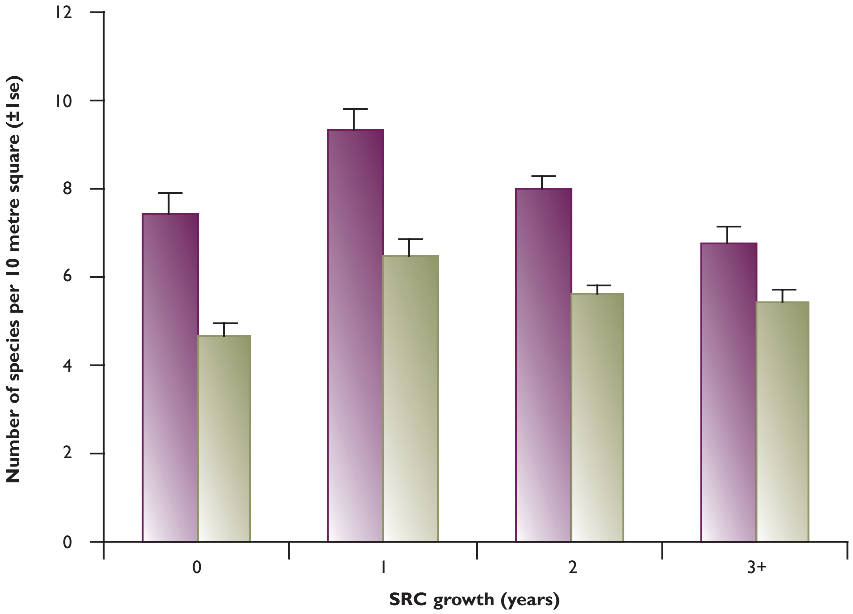


Figure 2

Number of plant species in the edge and interior of 22 SRC plantations at different growth stages

Edge

Interior

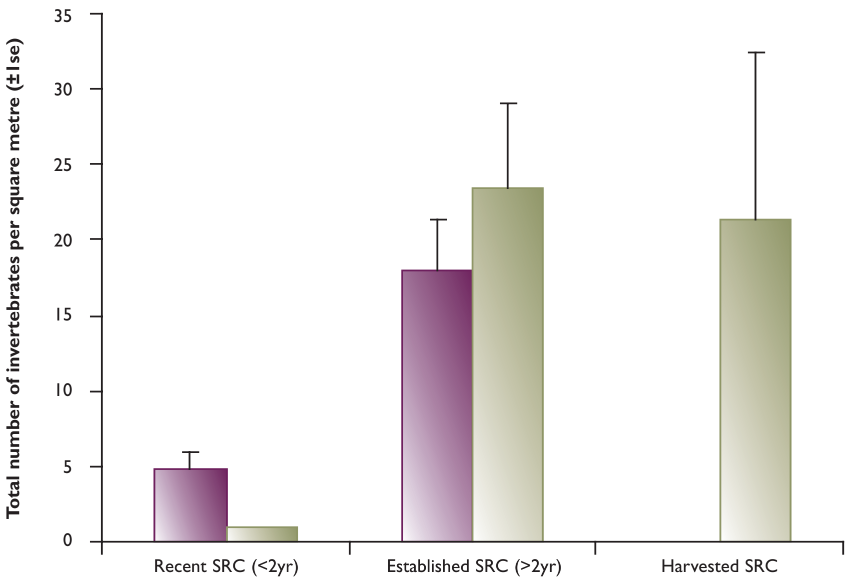


Figure 3

Number of canopy invertebrates found per metre square in recent SRC, established SRC and SRC harvested in the previous year

SRC on arable

SRC on grass

growth with, on average, 31% more at the crop edge (see Figure 2). Vegetation cover increased by 34% in the first year with, on average, 44% more cover at the crop edge than the crop interior.

We surveyed the headlands of SRC and control plots for butterflies by walking transects for an hour three times during the summer. The headlands around the SRC plantations supported more butterflies, such as browns and skippers, than control areas. The more mobile and generalist 'white' butterflies were common everywhere, ranging from 12.52 ± 3.92 per hour in ex-arable SRC to 5.19 ± 1.30 per hour in grassland. 'Blue' butterflies were more abundant around the ex-grassland (1.38 ± 0.45 per hour) than ex-arable plantations (0.30 ± 0.13 per hour), although this could reflect the slightly more southerly location of the ex-grassland plots. Numbers of butterflies increased by 130% in the ex-arable SRC plantations as the willow crop established and more sheltered conditions became available.

We collected invertebrates by beating the willow stems three times during the summer between May and August. Numbers were higher in established SRC plantations than in recently planted ones (see Figure 3). We identified 15 different groups in the SRC plantations; with *Hemiptera* (true bugs) and beetles being the most abundant, especially in July/August. We also found high numbers of blue willow beetle (25% of total invertebrates collected), which is the major insect pest of coppice willow.

This diverse insect fauna in the canopy of SRC makes these crops good foraging habitat for farmland breeding birds.

Future work

In 2006, we begin a new study of SRC and *Miscanthus* grass, funded by the Rural Economy and Land Use programme. Lead by Rothamsted Research, the project includes social, economic as well as environmental implications of these energy crops. We will undertake all the biodiversity work in southern England.

Acknowledgements

The Central Science Laboratory and Future Energy Solutions, funding by the Department of Trade and Industry.

Pheasant counts in 2005

Key findings

- Annual harvests of released and wild pheasants have been stable over the last 10 years.
- The average annual harvest of pheasants on released pheasant shoots between 1995-2004 was 185 birds per 100 hectares and 58 birds per 100 hectares on wild pheasant shoots.
- Breeding numbers of wild pheasants have been stable over the last three years.

Roger Draycott

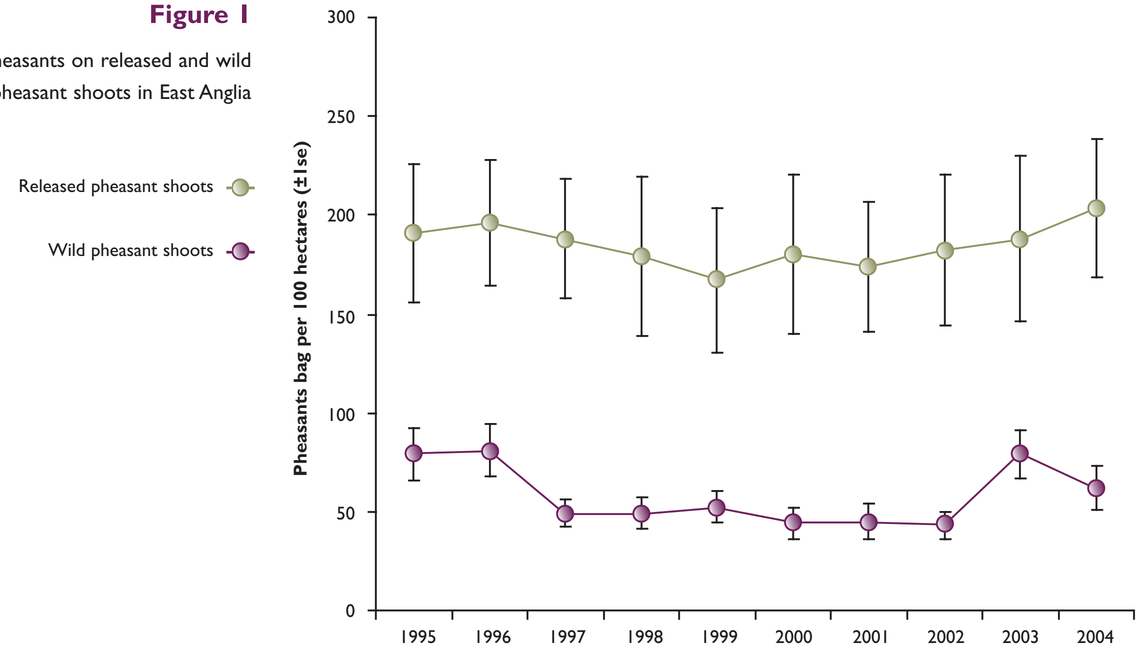
Monitoring wild pheasants in East Anglia

The eastern counties of England are good for wild pheasants because of a landscape dominated by arable cropping with small woodlands, low rainfall, and a strong tradition of gamekeeping. Consequently, the region holds the highest abundance of wild pheasants in Britain and there are driven shoots based entirely on wild birds. Several of these contribute to the National Gamebag Census. Over the last 10 years the average annual number of pheasants harvested on these shoots was 58 per 100 hectares compared with 185 per 100 hectares on released bird shoots in East Anglia. Bags of both wild and released pheasants in this region over the last 10 years have been stable (see Figure 1).

We count pheasants on a sample of these managed wild shoots each year, first in the spring to determine breeding numbers of territorial cocks and hens and then in late summer to assess breeding success. There is a clear relationship between the breeding success and the annual pheasant bag (see Figure 2). This information can help to ensure that stocks are shot at a sustainable level. The game counts also show long-term trends in abundance. Figure 3 shows breeding pheasant numbers per 100 hectares on count sites from 1996-2005. Numbers have remained stable over the last three years and increased slightly over the last 10. Annual productivity (young:old)

Figure 1

Harvest of pheasants on released and wild pheasant shoots in East Anglia



Pheasant counting in spring in East Anglia. (Roger Draycott).

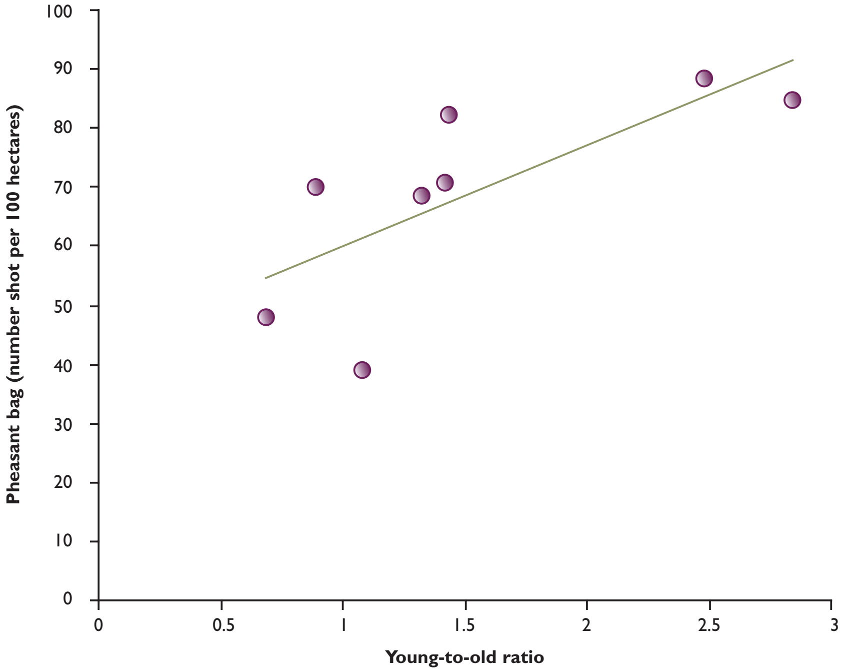


Figure 2

Pheasant bags compared with productivity on a Norfolk wild pheasant shoot

This graph shows the importance of a good breeding season to the following winters' shooting on a wild pheasant shoot.

Late summer, when crops are harvested, is when our counts measure breeding success. (Roger Draycott).

on wild shoots in 2005 was 1.7:1, similar to 1.6 in 2004. In future we intend to study how the spatial distribution and management of different crops and habitats influence pheasant abundance on these areas.

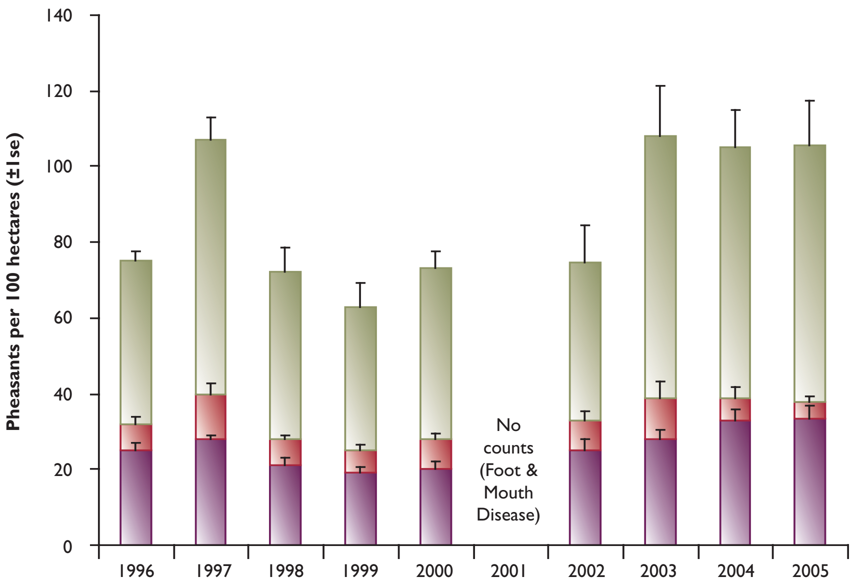


Figure 3

Breeding densities on wild pheasant shoots in East Anglia 1996-2005

- Hens
- Non-territorial cocks
- Territorial cocks

Songbird use of pheasant woods in winter

Key findings

- Bird numbers in November-December were 1.5 times higher in woods where pheasants were released than in a comparable sample of non-game woods.
- On average, 13 species were recorded in game woods compared with 10 species in non-game woods.
- Bird communities of game woods contained higher proportions of woodpigeons and finches than those of non-game woods.
- Habitat management and supplementary feeding in game woods appear to explain these differences.

Andrew Hoodless
Rob Lewis
James Palmer

We know much less about what woodland birds need in winter than we do about their needs in the breeding season. In winter songbirds have to move around more to find food and they use more energy in cold weather. Managing woods for game alters habitat and food supply and we were interested to learn how this affected songbirds in winter.

We counted birds seen and heard along a one-kilometre transect at each of 70 semi-natural oak and ash woods on the Hampshire and South Wessex Downs in November and December. Of these, 35 woods had pheasant release pens and a supply of extra winter food. The remaining 35 woods had no recent (within the last 25 years) history of game management. We measured vegetation cover in the field, shrub, understorey and canopy layers as well as tree diameter at breast height, which is related to tree age.

Our analysis took account of weather and neighbouring woodland. Overall, we found that there were 1.5 times as many birds in game woods compared with non-game woods (see Figure 1). The number of species was also higher, averaging 13.0 in game woods compared with 10.4 in non-game woods. The three most numerous species in both game and non-game woods were woodpigeon, long-tailed tit and blackbird. However, the bird communities differed between game and non-game woods, with higher proportions of woodpigeons and finches in game woods. Nevertheless, bird numbers were still 1.4 times higher in game woods even when woodpigeons and rooks, another flocking species, were excluded.

How can we explain these differences? Separating the effects of habitat management and supplementary feeding will require more work, but we think that both play a role in attracting more birds. We found that bird numbers increased as tree canopy decreased (see Figure 2). On average, the canopy was more open in game woods than non-game woods (37% compared with 45%) and tree diameter was larger (42cm compared with 37cm). This indicates that more thinning or skylighting has been done in game woods and partly explains the higher bird numbers. However, although pheasant release pens are generally sited strategically, game managers may select better, older woods for release pens, which may have had more songbirds in the first place.

To look at the effect of food (typically wheat) put out for pheasants, we split the game woods into those where food was supplied using a spinner on a quad bike (17 woods) and those where food was supplied via hoppers, either solely or in conjunction with spinner feeding (18 woods). We had seen various songbirds feeding at

Figure 1

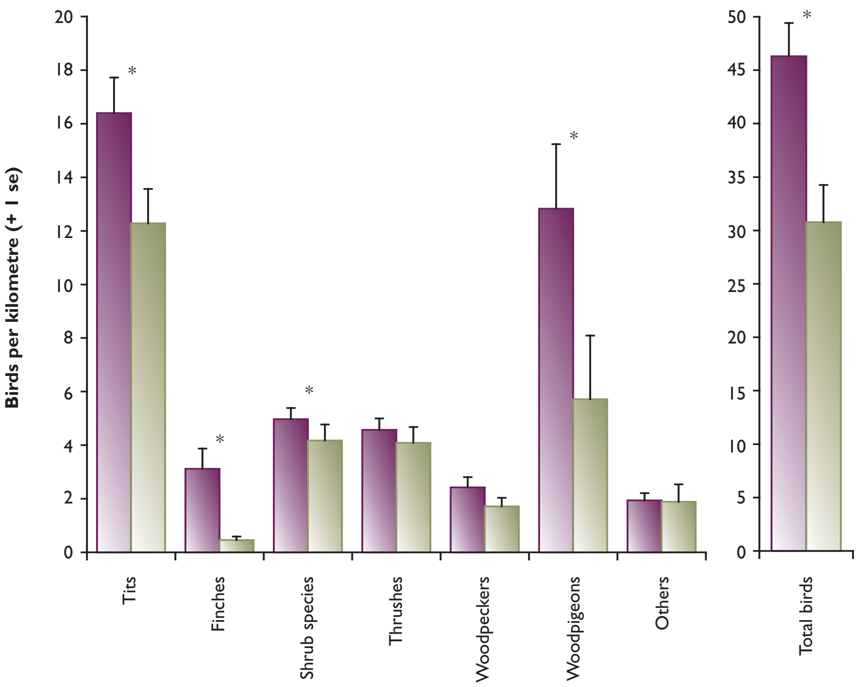
Mean bird numbers per kilometre in 35 game and 35 non-game woods on the Hampshire and South Wessex Downs in November-December

Game woods

Non-game woods

Significant difference *

Shrub species = robin, dunnock and wren.
Tits includes goldcrest and firecrest.
Woodpeckers includes nuthatch and treecreeper.
Others are mainly corvids and raptors.



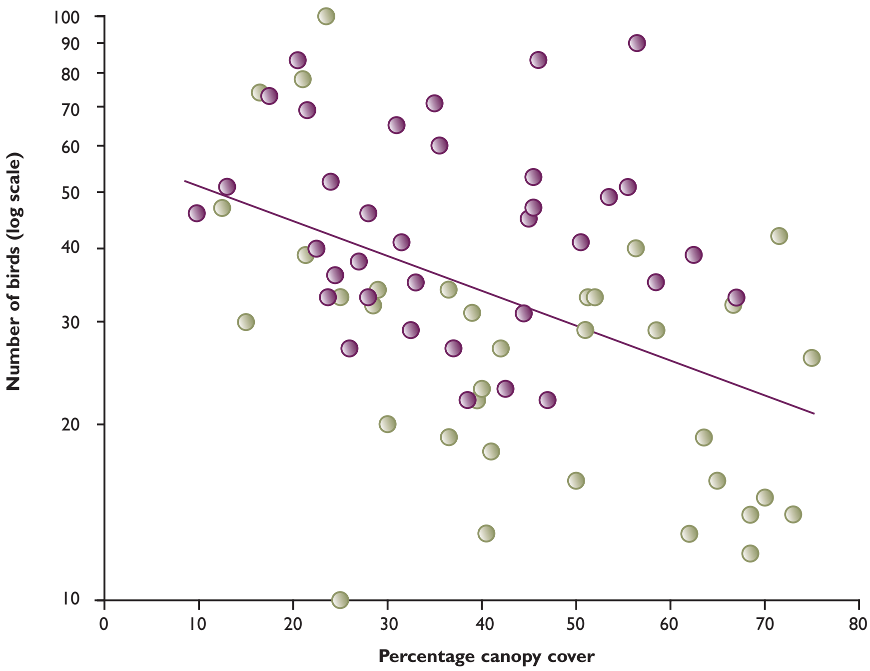


Figure 2

Relationship between total number of birds and canopy cover

Game woods

Non-game woods

Note the tendency for game woods to have less canopy cover and higher bird numbers.

hoppers and supposed that if supplementary food influenced their numbers, the effect might be more pronounced in woods where the food was concentrated and easily obtained (ie. at hoppers) than in woods where it was less abundant and harder to find. This was indeed the case for chaffinch, the species most commonly seen at hoppers, whose numbers were 2.5 times higher in woods with hoppers. We also found that woodpigeon numbers were 3.5 times higher in these woods.

In future, we aim to clarify and support these findings, but our first impression is that pheasant management does increase the attractiveness of oak-ash woods for many birds in winter.

Chaffinches were particularly abundant in woods managed for game, and were often seen at pheasant feed hoppers. (Laurie Campbell)

Effects of pheasant management at wood edges

Key findings

- The edges of woods managed for pheasants had a more sloping profile and 1.3 times greater shrub cover up to four metres high than non-game woods in East Anglia, but not in Hampshire.
- There were 1.3 times more shrub species and 2.3 times more shrubs in flower at the edges of woods in Hampshire than in East Anglia, but game woods in East Anglia had 2.5 times as many flowering shrubs as non-game woods.
- Shrub density 10 metres inside the wood was 1.7 times higher in game woods than non-game woods in East Anglia, but not Hampshire.
- Butterfly numbers were 2.2 times higher and the number of species 1.5 times higher at game woods than non-game woods in East Anglia, but not in Hampshire.

Andrew Hoodless
Roger Draycott

Last year we reported on the effects of pheasant releasing and management on vegetation structure and songbird numbers within woods (see *Review of 2004*, page 38). In this *Review* we look at woodland edges. Specifically, we document differences in the diversity of shrub species, the amount of shrub cover and butterfly numbers resulting from pheasant management at the edges of semi-natural oak and ash woods. Pheasant density during winter and spring is affected by the amount of shrub cover, particularly along wood edges, and our advisors advocate creating graded, shrubby woodland edges to improve pheasant habitat.

We compared woods that contained pheasant release pens and had winter supplementary feeding, with ones that had no recent game management (within the last 25 years). In East Anglia, we surveyed 30 game woods and 29 non-game woods and on the Hampshire and South Wessex Downs we surveyed 41 game and 41 non-game woods. During July and August we recorded woodland edge profile, shrub species in five height categories and a measure of flowering shrubs at 50 points along a 250-metre section of south-facing edge at each wood. We also counted butterflies and bumblebees along this same section. Along each edge, we recorded the density of shrubs at 50 points in a 10-metre wide zone located 10 metres inside the wood.

Inside the woodland edge zone, we found that shrub density was 1.7 times higher for game than non-game woods in East Anglia, but we found no difference in Hampshire (see Figure 1). On average there was a greater number of shrub species in this zone in game woods than non-game woods (5.8 ± 0.3 compared with 4.6 ± 0.3) in both regions. Shrubs afforded more understorey cover at two to eight metres in game woods (50 ± 4%) than in non-game woods (40 ± 4%), and there was typically a denser understorey in Hampshire woods.

Viewed from outside, we found that game woods in East Anglia had a more sloping edge profile with fewer over-hanging trees than non-game woods, but found no difference in Hampshire. Overall shrub cover to a height of four metres along the wood margin was significantly greater for game woods (62%) than non-game woods (48%) in East Anglia, but not for Hampshire (both about 59%). There was no difference in the number of shrub species per sampling point between game and non-game woods, but there were 1.3 times more in Hampshire than in East Anglia. In East Anglia, game woods had 2.5 times as many flowering shrubs as non-game woods (see Figure 2); the most common being bramble, clematis and honeysuckle. Total butterfly numbers followed the same pattern (see Figure 3), as did the number of different butterfly species (East Anglia averaged 4.0 species in game woods and 2.6 in non-game woods; Hampshire had 4.3 overall). We could detect no effect of game management on bumblebees in either region.

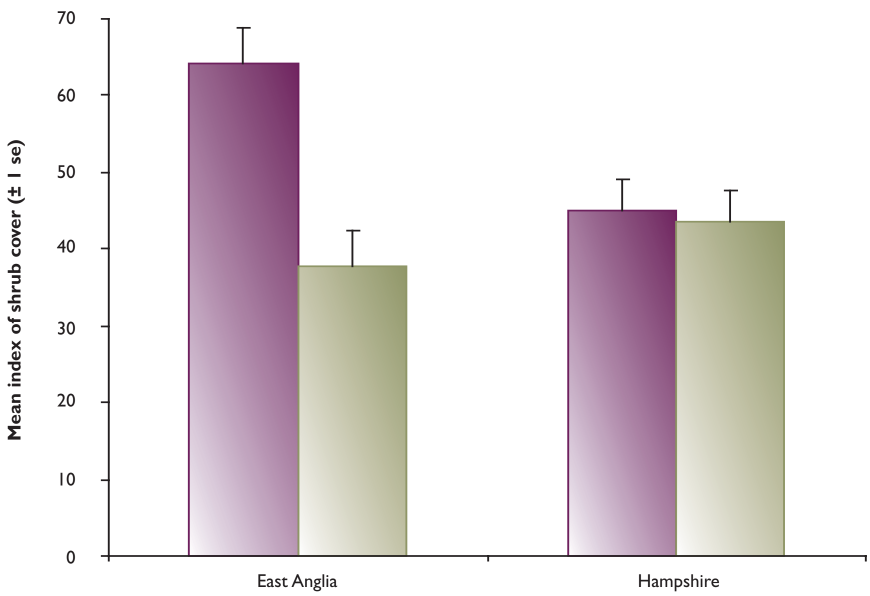
Figure 1

Shrub cover 10 metres inside woods

Game woods

Non-game woods

The index is the sum of 50 point counts of shrubs within five metres either side of a transect running parallel to the wood edge.



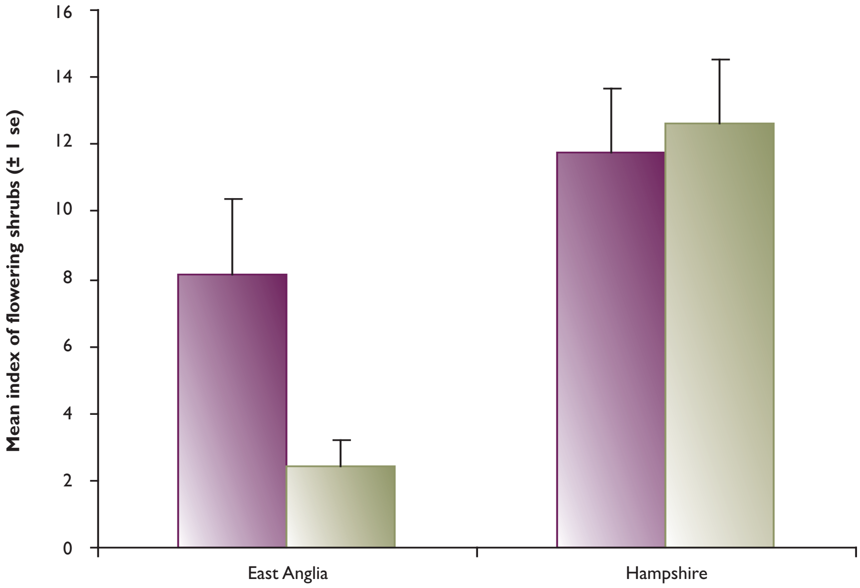


Figure 2

Shrubs flowering at woodland edges

Game woods

Non-game woods

Values have been adjusted for the effect of survey date.

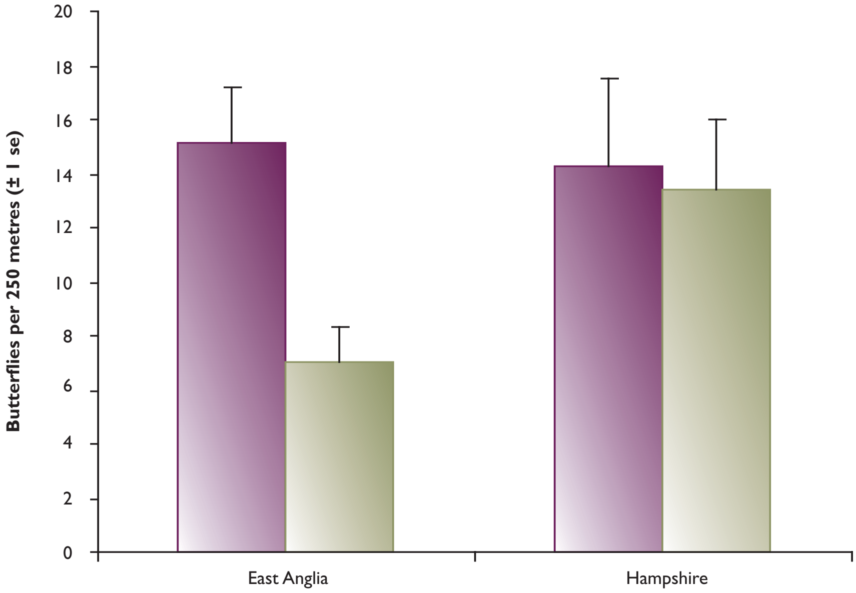


Figure 3

Butterfly numbers at woodland edges

Game woods

Non-game woods

Numbers have been adjusted for the effects of cloud cover, wind, rain, month and time of day.

In East Anglia, woodland constitutes a smaller proportion of the landscape than in Hampshire, so perhaps game managers put greater effort into these smaller areas of woodland than in Hampshire. East Anglian shoots also rely more on wild pheasant production, so breeding habitat is more important than in Hampshire.

Game woods in East Anglia had more flowering shrubs than non-game woods. One of the most common was wild honeysuckle. (Laurie Campbell)

Deer in the National Gamebag Census since 1960

Key findings

- The British distribution of shot roe and fallow deer has increased spectacularly over the last 40 years.
- Densities of shot red deer have remained high in Scotland throughout; the distribution is slowly expanding across north-western, eastern and southern England.
- First recorded in the 1980s, the introduced Chinese muntjac is now commonly shot in much of the south-eastern half of England.

Nicholas Aebischer
Peter Davey

As well as bags of gamebirds and mammals, the National Gamebag Census (NGC) collates information on the numbers of native and introduced deer that have been shot each year on the area managed by contributing shoots. Our participation in the Tracking Mammals Partnership has prompted us to examine, for the first time, the trends in numbers of deer shot in different parts of Great Britain between 1960 and 1999. Too few records of Sika and Chinese water deer were available for analysis, so we concentrated on roe deer, fallow deer, red deer and Chinese muntjac.

We split the data according to decade (1960-1969, 1970-1979, 1980-1989 and 1990-1999). For each decade, we then summed all the records of numbers shot within each county across England, Wales and Scotland, and also summed the areas shot over. Dividing one by the other gave a deer bag density for each county over that period, which we then mapped according to six colour-coded categories of abundance (the palest shade corresponding to the lowest bag density, the darkest shade depicting the highest density, on a geometric scale). This gave us four maps per deer species, showing how distribution and abundance had changed from decade to decade. Sadly, we had too few records from Northern Ireland to be able to include it in this mapping excercise.

Roe deer (Figure 1)

The expansion of the roe deer is spectacular. In the 1960s, bags were restricted to Scotland, north-east England and a handful of southern counties. Ten years later, it had consolidated its hold throughout the northern half of Britain and across practically all southern-most counties. Thereafter the expansion swept through East Anglia and density generally increased, especially in the south where bag density now exceeds one per 100 hectares. Throughout the period, little change occurred in Wales and the Midlands, where very few roe deer are shot.

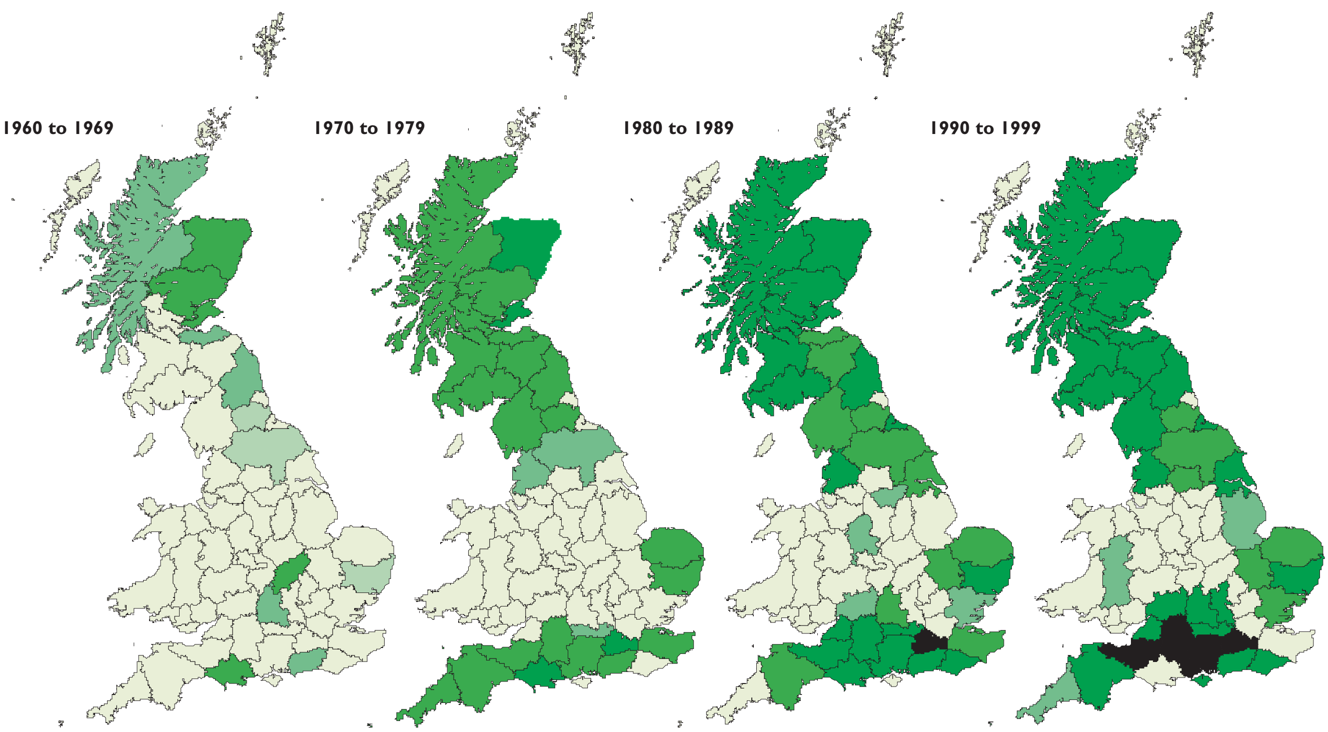
Fallow deer (Figure 2)

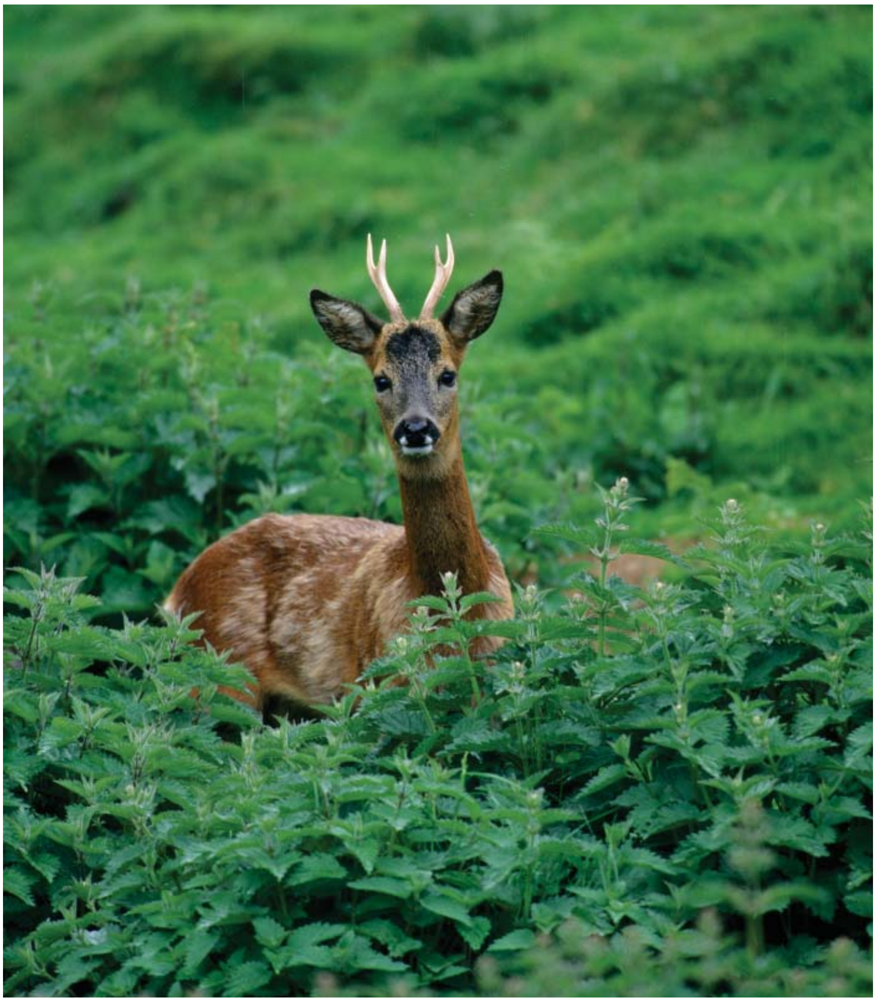
The expansion of the fallow deer is equally as impressive, but has taken place mainly in the southern half of Britain. In the 1960s, it was shot in only a few localities, then began to make a sporadic appearance in other county bags in the 1970s. By the

Figure 1

Roe deer bag density (number shot per 100 hectares) synoptically by county and by decade from 1960 to 1999

1-10
0.1-1
0.01-01
0.001-0.01
0.0001-0.001
0-0.0001





The roe deer expansion has been impressive. (Laurie Campbell)

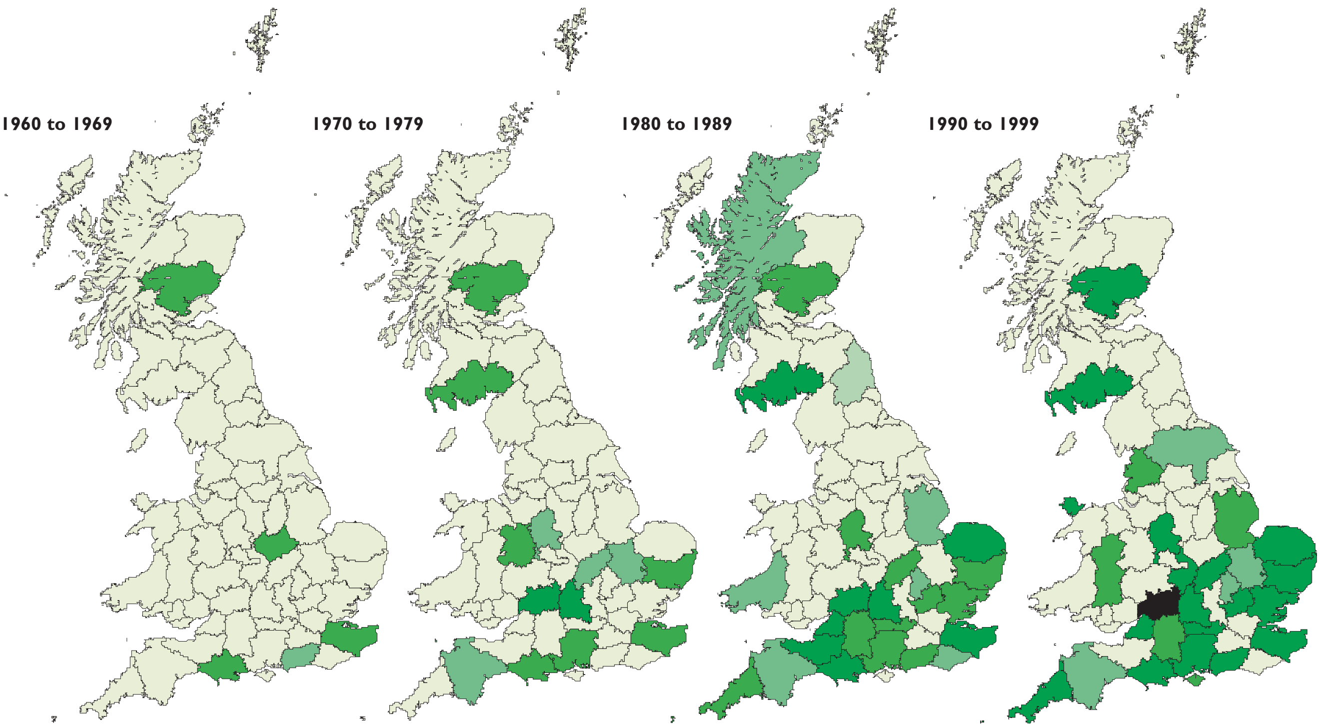
The expansion of fallow deer has mainly been in the southern half of Britain. (Laurie Campbell)

1980s, its distribution was almost continuous south of a line from the Bristol Channel to the Wash, and density has increased since then. In Scotland, the fallow deer has been shot in Tayside throughout the period, and expanded primarily into Dumfries and Galloway. Numbers shot have remained very low elsewhere.

Figure 2

Fallow deer bag density (number shot per 100 hectares) synoptically by county and by decade from 1960 to 1999

1-10	0.001-0.01
0.1-1	0.0001-0.001
0.01-01	0-0.0001



Although the Scottish Highlands are the traditional stronghold of red deer, this species has now expanded into many pockets of lowland Britain. (Laurie Campbell)

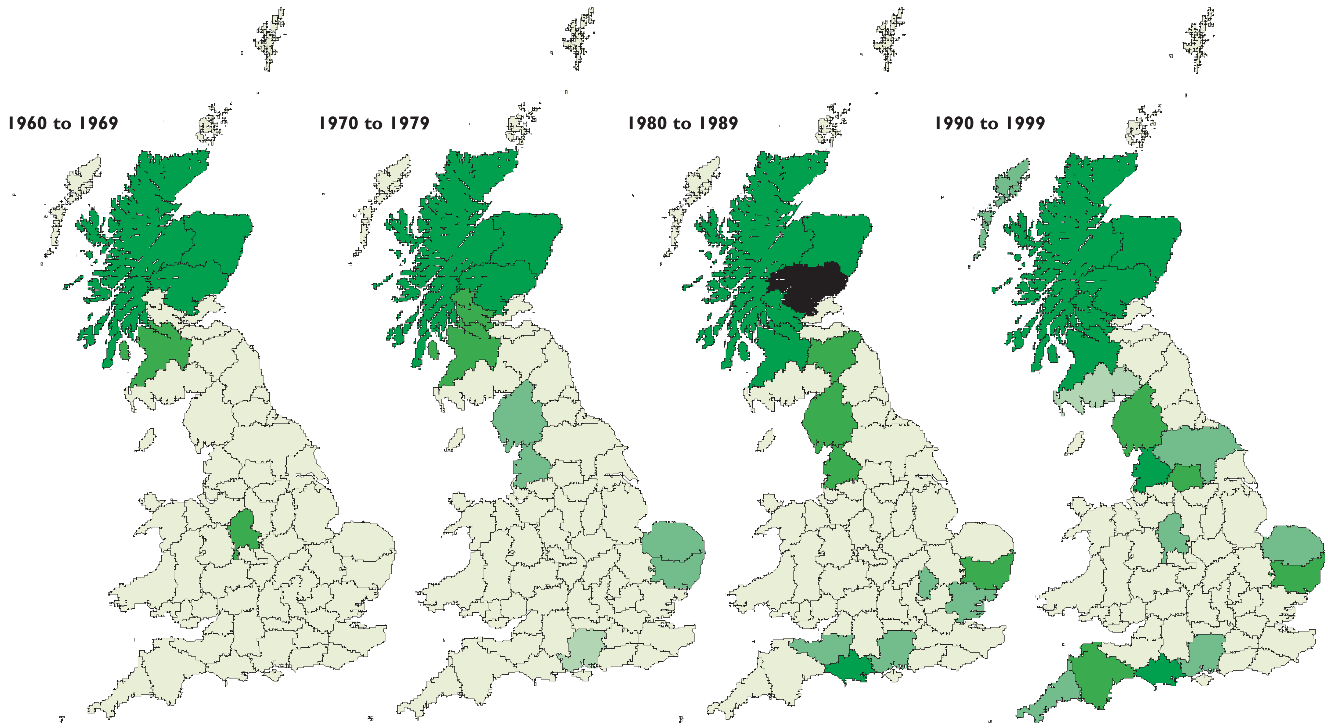
Figure 3

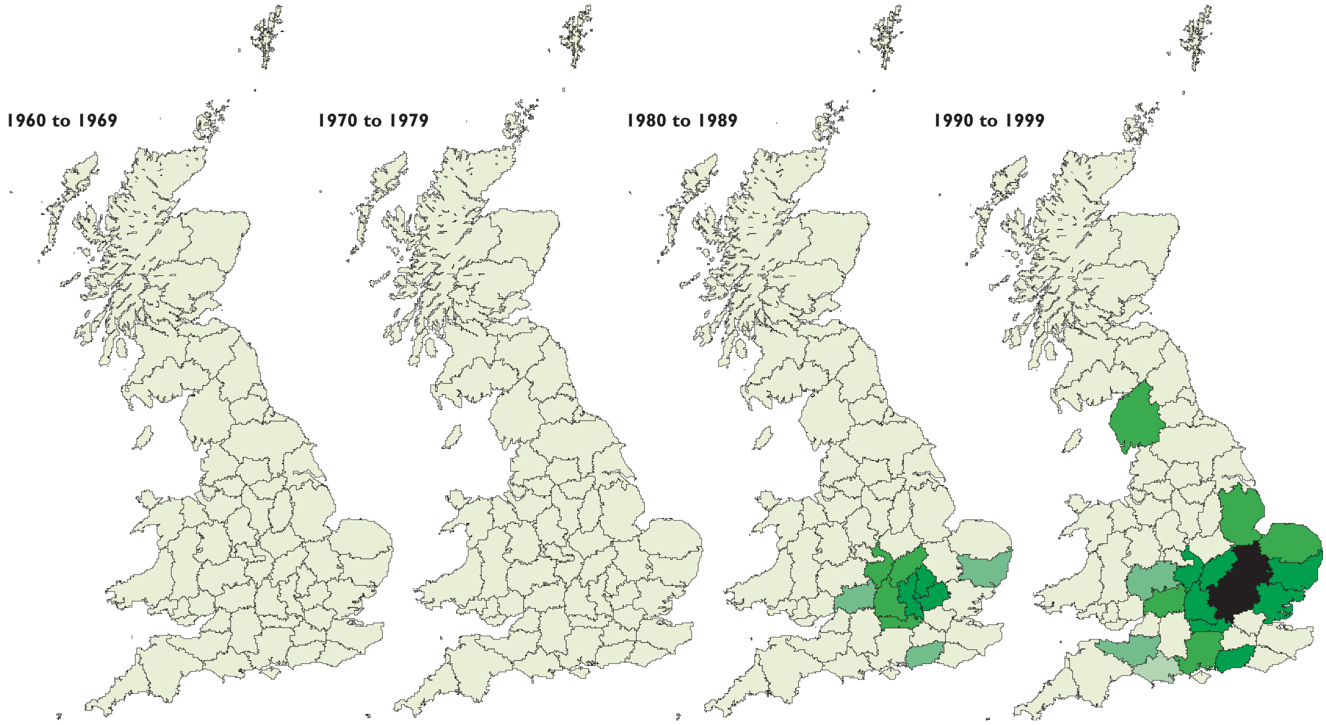
Red deer bag density (number shot per 100 hectares) synoptically by county and by decade from 1960 to 1999

1-10	0.001-0.01
0.1-1	0.0001-0.001
0.01-01	0-0.0001

Red deer (Figure 3)

Traditionally, the Scottish Highlands have been the stronghold of the red deer in Britain, and the maps indicate that the densities shot there have remained roughly constant throughout. In the 1960s, very low numbers were also shot in Strathclyde and Staffordshire. Over the next three decades, shooting gradually increased in south-west Scotland, north-west England, East Anglia and, recently, in south-west England. Over the 40-year period, no red deer were shot in Wales, the Midlands or south-east England.





Chinese muntjac (Figure 4)

This species was originally introduced to Woburn Park, Bedfordshire, in 1894. Subsequent escapes led to its establishment in the wild towards the middle of the 20th century, and surreptitious releases have hastened its spread. The first muntjacs appeared in NGC records during the 1980s, primarily between London and the Severn estuary. By the 1990s, they were being shot from the southern Welsh border across to East Anglia and central southern England. Densities shot are especially high in the Home Counties.

Figure 4

Muntjac bag density (number shot per 100 hectares) synoptically by county and by decade from 1960 to 1999

- 1-10
- 0.1-1
- 0.01-01
- 0.001-0.01
- 0.0001-0.001
- 0-0.0001

The Chinese muntjac has spread from an initial release in Bedfordshire just over 100 years ago. Now high numbers are shot in the south and east especially. (David Mason)

Partridge research in 2005

Key achievements

- Grey partridge demonstration project achieves four-fold increase in breeding pairs since its start.
- On land covered by the Partridge Count Scheme, the grey partridge decline has been reversed.
- We furthered understanding of how best to release grey partridges for restocking.
- We completed work investigating effects of red-legged partridge releasing on chalk downland.

Nicholas Aebischer

As lead partner for the grey partridge Biodiversity Action Plan, for which we are charged with achieving key goals by certain dates, we have a stiff challenge. No funds come with the 'lead partnership' so any goal successfully reached is entirely down to the inclination, enthusiasm and pockets of those doing it! It is no mean achievement therefore that we have, it appears, reversed the decline of the grey partridge in the UK – at least our Partridge Count Scheme (see page 44) suggests that those in the scheme have reversed it on their land. We have yet to see the official verdict from the national counts done by the BTO, but we are hopeful. Many thanks indeed to all those involved in the Partridge Count Scheme – it is only by counting that we know what is there and that we have achieved the first of the BAP goals.

Our demonstration at Royston of how to provide the best possible environment for grey partridges has completed another successful year with a 40% increase in spring pairs since 2004 and a 36% increase in autumn numbers (see page 38). Increasingly, enthusiastic members of our Partridge Count Scheme are learning from this demonstration about what they can replicate on their ground to boost grey partridge numbers.

Another of the BAP targets is to expand the grey partridge range. This is more difficult as it requires the birds to shift into areas where they have become locally extinct. Without help, we feel that this goal is beyond reach by the date given. We are therefore trialing different approaches to determine the most successful way to release partridges for population expansion into areas where suitable habitat is in place (see page 40). Until now, our knowledge has been based on releasing for shooting, but experience has shown that this is no good for providing a breeding population. Once the study is complete, we will be able to provide clear guidelines for enthusiastic land managers wishing to have breeding greys again.

With these projects and our committed members, we are very hopeful for the future of this iconic gamebird.

On the subject of red-legged partridges, we completed a study during 2005, which has been assessing the impact of these gamebirds on a ecologically valuable area of

Although much of our research focuses on grey partridges, the redleg is also the subject of some important studies. (Laurie Campbell)

chalk grassland. The chalk downland site was designated a National Nature Reserve by English Nature owing to its unique assemblage of plants, birds and insects. A neighbouring shoot was releasing large numbers of redlegs, which were spilling over onto the chalk downland and were thought to be eating caterpillars of the rare Adonis blue butterfly and generally damaging the fragile area. Despite searching for signs of damage for four years, we have found no evidence on which to condemn the birds (see page 42).

Partridge and biometrics research in 2005

Project title	Description	Staff	Funding source	Date
Grey partridge recovery project (see page 38)	*Restoration of grey partridge numbers: a demonstration project*	*Malcolm Brockless, Tom Birkett, Stephen Browne, Julie Ewald, Nicholas Aebischer*	*GC-USA, Research Funding Appeal, Core funds*	*2001-2008*
Partridge Count Scheme (see page 44)	*Nationwide monitoring of grey and red-legged partridge abundance and breeding success*	*Nicholas Aebischer, Stephen Browne, Julie Ewald, Nina Graham, Dave Parish*	*Core funds*	*1933 - on-going*
Partridge releasing experiment (see page 40)	*Determining best release methods as a tool for restoring grey partridges in the UK*	*Nicholas Aebischer, Francis Buner, Stephen Browne, Des Purdy*	*Westminster Overseas Fellowship, GC-USA*	*2004-2006*
Ecology of reared grey partridges	*Population monitoring of reared and wild partridges to determine the feasibility of releasing as a restocking measure*	*David Parish*	*Scottish Fair, various charitable trusts*	*1997 - on-going*
Genetics of the grey partridge	*Comparing partridge genetics for populations from different regions of England*	*David Parish*	*Land-Catch Natural Selection*	*2005-2006*
French partridge project	*Monitoring partridges and invertebrates on two French farms*	*Dick Potts (consultant), Steve Moreby, Nicholas Aebischer*	*Core funds*	*2001-2005*
National Gamebag Census (see page 32)	*Monitoring game numbers with annual bag records*	*Nicholas Aebischer, Julie Ewald, Gillian Gooderham*	*Core funds*	*1961 - on-going*
Sussex study (see page 52)	*Long-term monitoring of partridges, weeds, invertebrates, pesticides and land use on 62 square kilometres of the South Downs*	*Nicholas Aebischer, Julie Ewald, Steve Moreby, Dick Potts (consultant)*	*Core funds*	*1968 - on-going*
GIS project (see page 90)	*Investigating the extent and consequences of game and fish management for wildlife in Britain*	*Julie Ewald, Neville Kingdon, Stephen Tapper, Nicholas Aebischer*	*Countryside Alliance*	*1999-2005*
Impact of pesticides	*Developing an indicator of the impact of pesticides on farmland wildlife*	*Nicholas Aebischer, Julie Ewald, Nina Graham*	*PSD, Environment Agency, English Nature*	*2005-2006*
Mammal population trends	*Analysing mammalian cull data from the National Gamebag Census under the Tracking Mammals Partnership*	*Nicholas Aebischer, Jonathan Reynolds, Gillian Gooderham*	*JNCC*	*2003 - on-going*
Game crops and farmland birds	*Use of game crops by songbirds in grassland regions throughout the year*	*David Parish*	*SNH, Tesco, John Ellerman Foundation, various charitable trusts*	*2003 - on-going*
Monitoring East Lothian Local BAP	*Monitoring effects of LBAP measures on bird populations in East Lothian*	*David Parish, Hugo Straker*	*Various charitable trusts*	*2001 - on-going*
Unharvested crops and songbird populations	*Large-scale field experiment investigating the impact of winter feeding on songbird populations*	*David Parish*	*SEERAD*	*2004-2008*
Testing effects of unharvested crops on songbird populations	*Large-scale field experiment investigating the impact of winter feeding on songbird populations*	*David Parish*	*SEERAD*	*2004-2008*
Montiroing SEERAD's agri-environment schemes	*Camparing biodiversity on in- and out-scheme farms across Scotland*	*David Parish Non-GCT collaborators*	*SEERAD*	*2004-2008*
PhD: Released partridges on NNR chalk grassland (see page 42)	*Comparing flora and fauna on high density partridge release sites on chalk downland NNR with similar chalk downs*	*Sarah Callegari Supervisors: Rufus Sage, GCT; Graham Holloway, Reading Univ*	*English Nature Research Funding Appeal*	*2002-2006*

Key to abbreviations:
JNCC = Joint Nature Conservation Committee; PSD = Pesticides Safety Directorate; SNH = Scottish Natural Heritage;
SEERAD = Scottish Executive Environment and Rural Affairs Department

Grey partridge recovery project

Key findings

- The number of spring pairs on the demonstration area in 2005 was 3.8 times higher than at the start.
- Autumn numbers in 2005 have increased eight-fold on the demonstration area.
- Equivalent figures for the increases on the reference area were 1.6 and 2.3 times respectively.

Nicholas Aebischer
Malcolm Brockless
Nina Graham

The Grey Partridge Recovery Project is now in its fourth year, and here we report on the results for 2005. The project seeks to demonstrate how to restore numbers of wild grey partridges, as part of our commitment to the grey partridge Biodiversity Action Plan. It is situated south-west of Royston on 1,000 hectares of arable land on chalk, flanked by a reference area of similar size. Based on our predictions as set out in *A Question of Balance*, we expect to achieve a spring density of grey partridges of 18.6 pairs per 100 hectares through targeted management.

The management includes habitat creation, predation control and supplementary feeding. Since the project began in 2002, habitat improvement has been ongoing on the demonstration area. Through the use of set-aside and the Countryside Stewardship Scheme, the amount of nesting cover (eg. beetle banks and new hedgerows) available to partridges is equivalent to 18% of land area. The amount of insect-rich brood-rearing habitat made available through wildlife mixtures, game-cover crops and some set-aside equates to 10% of land area. Predation control is targeted at foxes, mustelids, rats and corvids. Supplementary feeding is carried out by providing wheat in hoppers from autumn to late spring, with at least two hoppers per grey partridge pair.

We monitor the partridges by counting in March (spring pair counts) and again in early September, just after harvest (autumn counts). We record the sex of all grey partridge adults, and in the autumn, the number of young birds present in each covey. In spring 2005 we had a further increase in density on the demonstration area, to 11.2 pairs per 100 hectares (see Table 1). On the reference area, the density remained low, at 2.1 pairs per 100 hectares.

Figure 1

Distribution of grey partridge coveys at Royston in autumn 2005, showing barren pairs, single males and brood sizes

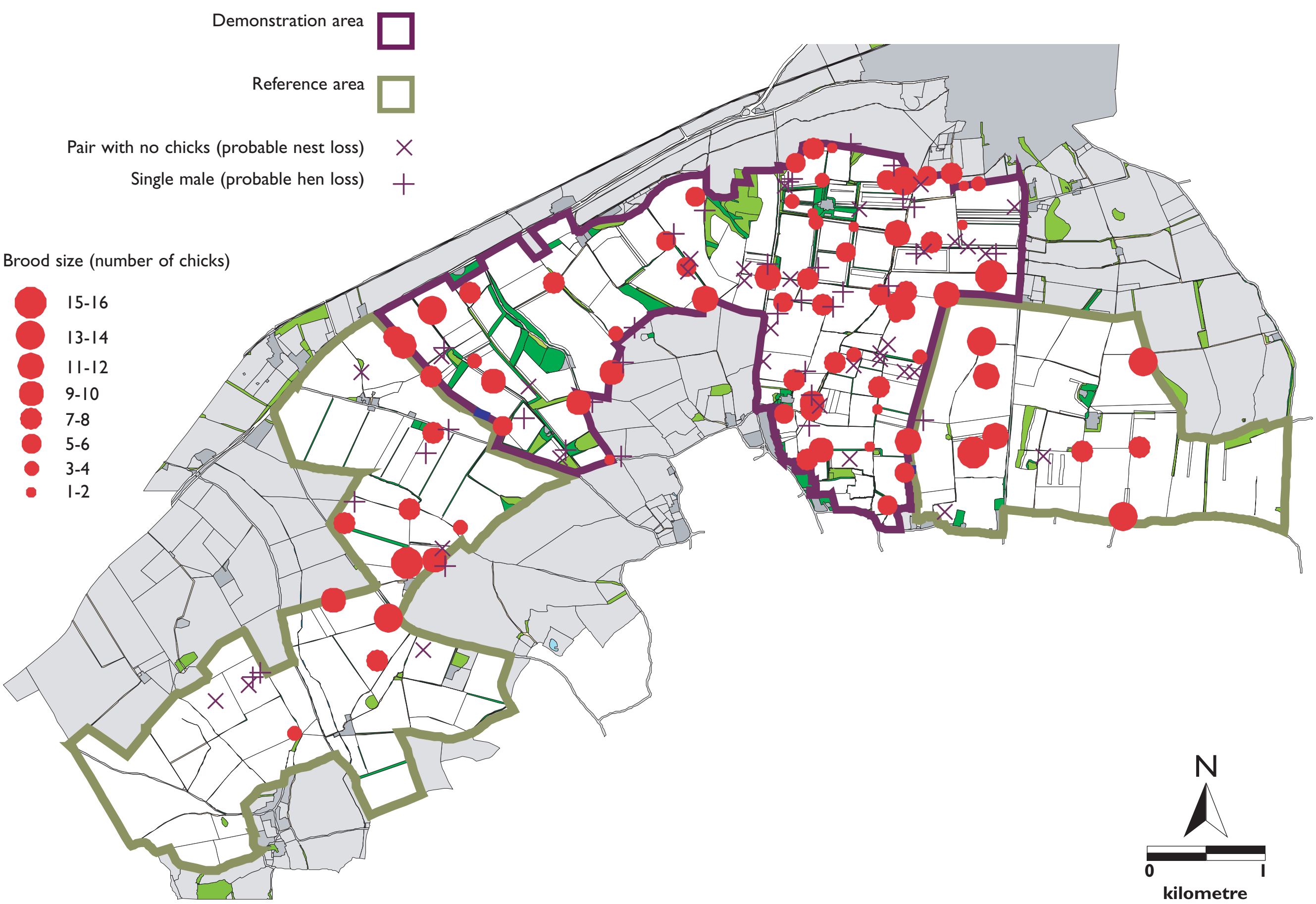


Table 1

Grey partridge counts on recovery project at Royston

a. Spring pairs per 100 hectares

Area	**2002**	**2003**	**2004**	**2005**	**Expected**
Demonstration	2.9	**5.1**	**8.0**	**11.2**	**18.6**
Reference	1.3	2.1	1.4	2.1	3.7

b. Autumn birds per 100 hectares

Area	**2002**	**2003**	**2004**	**2005**	**Expected**
Demonstration	7.6	**28.8**	**39.2**	**53.4**	**60.8**
Reference*	8.1	6.4	18.3	11.8	18.6

** Densities differ slightly compared with previous reported results owing to better measurement of the counted area.*
Bold denotes years/area managed for grey partridges.

In July and August 2005, the weather was cooler than in 2004, and 1.3°C below the 30-year average. Grey partridge productivity (see Figure 1) suffered on the demonstration area, with a young-to-old ratio of just 1.9 (2.8 in 2004), but not on the reference area (3.2). The difference may be the result of localised downpours at the end of June, just after hatching, and we also suspect some movement of coveys off the demonstation area after harvesting operations. Nevertheless, in terms of density, the demonstration area held eight times more grey partridges than before management began (see Table 1), whereas the density on the reference area remained similar to 2004.

If autumn counts in 2006 show a similar increase as in 2005, then the number we had expected to achieve will have been surpassed. (Malcolm Brockless)

Grey partridge releasing experiment

Key findings

- After a year, the re-sighting rate of fostered chicks was at least three times higher than that of non-fostered chicks.
- The proportion of birds released by fostering that subsequently bred successfully was twice as high as that of birds released using other methods.
- Post-release settlement depends on supplies of holding crops.

Stephen Browne
Francis Buner

One of the targets of the UK Biodiversity Action Plan for grey partridge is to "maintain and expand the current range". Accordingly, the purpose of this project in the UK is to find the best methods of re-establishing grey partridges through releasing in areas where they have disappeared, and where a suitable environment has been restored. A review of methods in 2004 suggested that the most promising techniques were fostering bantam-reared and artificially-reared young to wild pairs which failed to produce their own chicks (ie. barren pairs), and releasing full-grown family coveys in autumn and pairs in spring. We are field-testing these four methods on 26 sites split between East Anglia and southern England in a two-year project. In each region we follow the fates and breeding success of radio-tagged and colour-ringed birds of individuals released using all four techniques at one site (ie. intensive study site). At a further 12 sites (ie. extensive study sites), only one releasing technique is applied per year and the outcome is monitored by standardised spring and autumn counts of colour-ringed birds. At three of our six fostering sites in southern England, we failed to find suitable barren pairs for our chicks. We therefore had to release them as non-fostered birds. This provided us with survival data for birds released in a way similar to that traditionally used for shooting releases, already known to produce very low survival rates. Here, we present preliminary results from the first year of releases, 2004/05.

Young partridges entering a pen from where they will be fostered by a wild pair. (Arthur Scott)

Table 1

Re-sighting rate (%) of released grey partridges at all sites in East Anglia and southern England, based on the number of marked birds seen during the 2005 spring and autumn counts

Releasing method	**Date of release**	**East Anglia**			**Southern England**		
		No of sites	*Mean re-sighting rate (± 1 se)*		*No of sites*	*Mean re-sighting rate (± 1 se)*	
			March 2005	*September 2005*		*March 2005*	*September 2005*
Bantam-reared	August 2004	4	14.0 (4.5)	16.1 (1.9)	3	19.8 (1.6)	7.8 (2.8)
Artificially reared	August 2004	4	8.4 (1.3)	16.3 (1.5)	2	21.9 (1.8)	10.1 (3.1)
Non-fostered chicks	August 2004	0	-	-	3	14.1 (7.9)	3.1 (3.0)
Autumn release	November 2004	4	14.3 (2.8)	7.1 (1.8)	4	20.0 (4.1)	6.6 (1.4)
Spring pairs	April 2005	4	n/a	21.1 (1.6)	4	n/a	11.5 (2.2)

Francis Buner (top) showed Otto Holzgang from the Swiss Ornithological Institute and Markus Jenny (the photographer) how to set up a fostering pen and how to foster chicks, when they visited the project in the summer. (Markus Jenny)

In March 2005, the re-sighting rate from the spring counts for fostered birds released in August 2004 across intensive and extensive sites averaged 11% in East Anglia and 21% in southern England. That of birds released as full-grown family coveys in November 2004 averaged 14% in East Anglia and 20% in southern England (see Table 1). No data were available for the spring pairs as they were released after these counts (in April). As in other studies, the majority of losses were due to predation.

In the following autumn, the average re-sighting rate of fostered birds was 16% in East Anglia and 9% in southern England. The releases of full-grown birds yielded re-sighting rates of 7% for autumn coveys and 21% for spring pairs in East Anglia and 7% and 12% respectively in southern England (see Table 1).

In terms of fidelity to the release site, the number of ringed individuals in spring 2005 within a radius of 1.5 kilometres of the release point seemed to depend largely on the availability of holding crops and varied between one and 25 individuals. The sites with winter rape or game crops including second-year kale were the ones where the highest number of pairs were recorded. Sites without suitable holding cover remaining in late February produced the lowest counts. At such sites, most released birds were found on neighbouring estates, in either rape, late stubbles, set-aside or game crops.

The percentage of all released females found with broods in autumn (all strategies combined) was nearly three times higher in East Anglia (34%) than in southern England (12%). Bantam-reared fostered females performed the best (48% of 27 females counted) followed by artificially-reared fostered females (42% of 19 counted). Spring-released females appeared to breed better (23% with broods, of 26 counted) than autumn-released females (only 5% with broods, of 21 counted).

The experiment finishes at the end of 2006, by which time we aim to produce recommendations and guidelines for the successful re-establishment of grey partridges in suitably managed areas.

Impact of released gamebirds on chalk grassland

Key findings

- Released pheasants and red-legged partridges spend a lot of time feeding on chalk grassland.
- A wide range of invertebrates are eaten by both species of gamebird.
- We could find no effect of this feeding on invertebrate populations, including butterflies.

Sarah Callegari

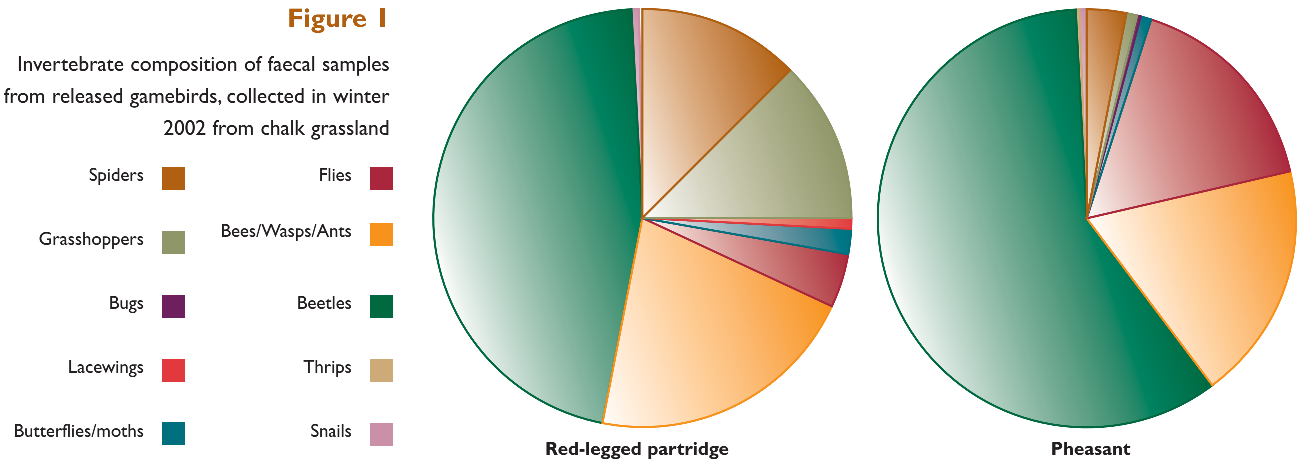
Damage to the Adonis blue butterfly population by released redlegs would not be acceptable. (Rufus Sage)

In 2002, as part of a study looking at the effect of released gamebirds across the countryside, we started a project to investigate a concern of English Nature about released gamebirds on chalk grassland in the South Wessex Downs. The area has steep valleys and coombes, which are ideal for driving high birds. These steep valleys form part of a network of shrinking areas of chalk grassland. Chalk grassland is estimated to cover 25-30,000 hectares across Britain, with major concentrations in Wiltshire and Dorset. The area has declined by almost 50% in the last 50 years as a result of agricultural intensification. The South Wessex Downs is internationally important for chalk grassland and for the diverse range of species associated with it. A number of the species found on chalk grassland in central southern Britain are at the northern limits of their range and as a consequence the habitat tends to support a high proportion of rare or nationally-scarce species, such as the Adonis blue butterfly, a key species in this study.

We looked at six chalk grassland sites in 2003 and 2004: three with large-scale releasing programmes (more than 15,000 gamebirds; pheasants and red-legged partridges) and three with little or no releasing. In winter 2002, we watched released gamebirds and collected faecal samples on chalk grassland to assess what the birds had been eating. We found that released birds spent a lot of time feeding on the grassland (66% for pheasants and 40% for red-legged partridges) and that they consumed a variety of invertebrate groups (see Figure 1). This suggested that direct consumption (of invertebrates and potentially vegetation) was likely to be the mechanism for any gamebird effect on the chalk grassland ecosystem.

Figure 1

Invertebrate composition of faecal samples from released gamebirds, collected in winter 2002 from chalk grassland



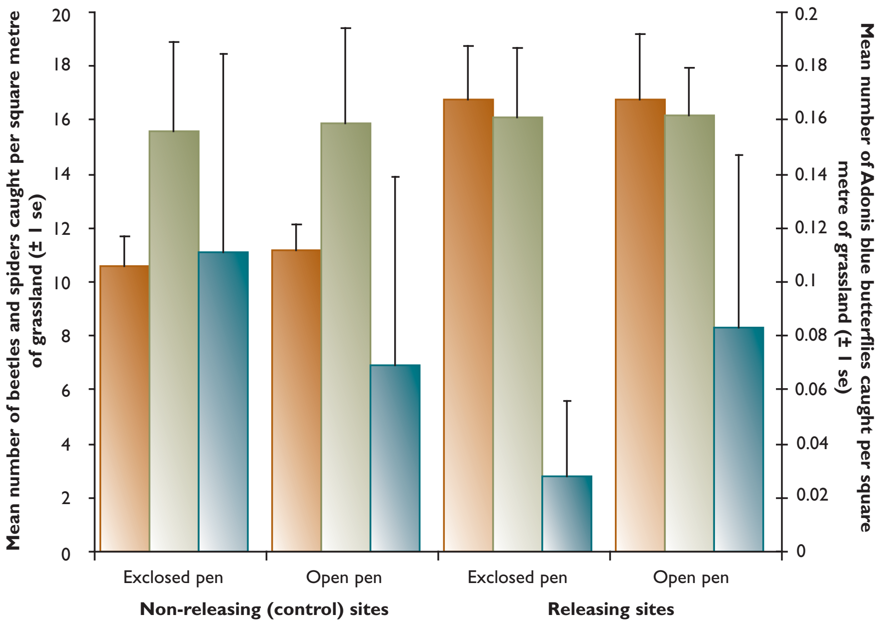


Figure 2

Numbers of beetles, spiders and Adonis blue butterflies caught May/June 2004

- Beetles
- Spiders
- Adonis blue butterflies

With this in mind, we designed an exclosure experiment to establish whether invertebrate numbers were affected by released gamebirds on areas to which they had access compared with areas from which they were excluded. In 2003 and 2004 at each of the six sites, we set up six plots before the gamebirds were released, each consisting of a square metre exclosure and a similarly sized open control pen. These remained in place during the shooting season. In the following spring, we placed emergence boxes over both exclosed and open areas and set pitfall traps in each for invertebrates. We also counted emerging Adonis blue butterflies.

In the first year, we looked at emerging invertebrates and found no difference between the release sites and control sites in the number or diversity of invertebrates emerging from the open and exclosed pens. The numbers of Adonis blue butterflies caught in the emergence boxes were very low (see Figure 2, right hand axis) and we were unable to establish any differences. In the second year, we focused on two of the invertebrate groups shown to be consumed in large numbers (see Figure 1): beetles and spiders. Again we found no differences between release and control sites in beetle and spider numbers (see Figure 2, left hand axis). We will look for differences in the species assemblages found at the release and control sites, as there could be changes caused by gamebirds eating specific groups. So far, our work indicates no dramatic impact of released birds on the Adonis blue butterfly, but we have insufficient data to test for subtle effects.

We could find no effect of released gamebirds on chalk grassland invertebrates, but plan a further project in spring 2006 to investigate more subtle effects.

Our chalk grassland study site in the South Wessex Downs. (Sarah Callegari)

Partridge count scheme

Key findings

- Spring pair densities were up on 2004.
- Over 60% more grey partridges were counted in autumn in 2005 than in 2004.
- Grey partridge densities were up 11% in 2005 compared with 2004.

Neville Kingdon

In January 2005, Edward Darling of Green Globe Consultancy returned the management of the Partridge Count Scheme (PCS) to The Game Conservancy Trust. Edward and Annie Darling had run the scheme successfully since 1999 and expanded volunteer participation in it immensely from 70 to 1,691. We owe them thanks for their tremendous effort since the beginning of the 'Every one counts' campaign.

The results from spring and autumn counts in 2005 are summarised in Table 1. Grey partridge spring pair densities were slightly up on 2004 and this is reflected across most of the country, although Wales suffered from both low participation and densities. The total number of wild grey partridges counted in the autumn was up on 2004's 23,364 to 37,934 in 2005. Overall densities in 2005 were up from an average density of 17.9 birds per 100 hectares in 2004 to 19.9 birds per 100 hectares. This is encouraging news, as many of the increasing number of new participants started at low densities. Although densities are generally up, the young-to-old ratio for most regions except for Scotland are down on 2004. There is a general trend towards higher breeding success in central Britain.

Analysis of long-term trends

The earliest data available in the PCS are autumn counts from 1933. Spring counting did not begin until 1948, and then only really took off in the 1960s. After the historical decline in grey partridge spring pair density, figures are better from 2001 onwards, with an upwards trend for both the long-term and recent contributors to the count scheme (see Figure 1).

Our Partridge Count Scheme now covers 9% of suitable partridge habitat in the UK. (Neville Kingdon)

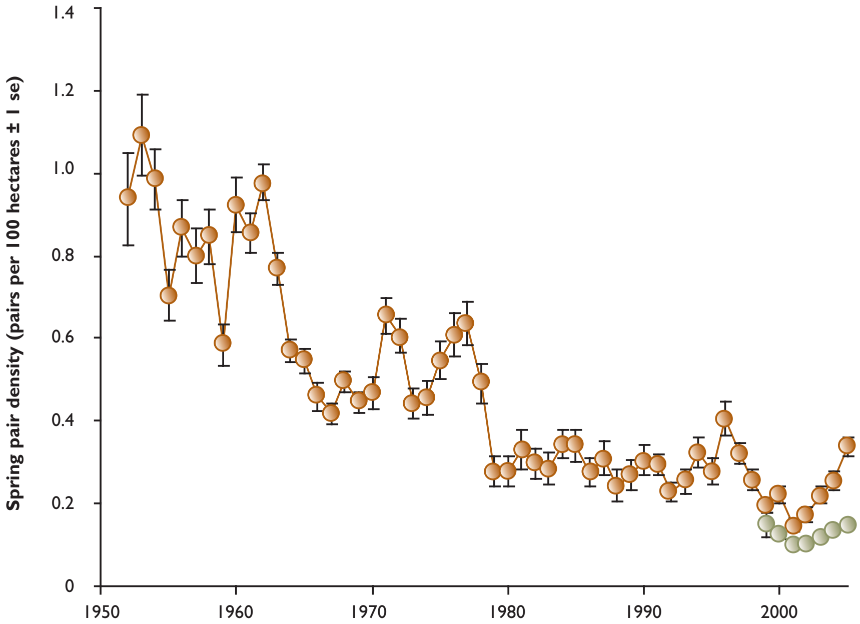


Figure 1

Changes in the average pair density on estates in the Partridge Count Scheme

Recent contributors

Long-term contributors

BAP target for 2005

The BAP target for 2005 was to halt the national decline in numbers of grey partridges. The results of the BTO Breeding Bird Survey are used to judge this, not our scheme. Results from the BTO counts are available up to 2004 and show that the

Table 1

Grey partridge counts

a. Grey partridges in spring 2005

	Number of sites		***Spring pair density (pairs per km² (100ha))***	
Region	*2004*	**2005**	*2004*	**2005**
South	*120*	135	*1.6*	2.1
Eastern	*220*	227	*4.5*	5.8
Midlands	*143*	141	*2.5*	3.2
Wales	*2*	2	*0.0*	0.7
Northern	*135*	158	*4.4*	4.5
Scotland	*140*	162	*3.6*	4.1
Overall	*760*	825	*3.5*	4.1

b. Grey partridges in autumn 2005

	Number of sites		***Young-to-old ratio***		***Autumn density (birds per km² (100ha))***	
Region	*2004*	**2005**	*2004*	**2005**	*2004*	**2005**
South	*89*	147	*2.4*	1.7	*10.9*	11.5
Eastern	*149*	225	*2.5*	2.2	*21.0*	27.6
Midlands	*108*	151	*3.0*	2.0	*14.2*	15.2
Wales	*1*	2	-	-	*0.0*	0.0
Northern	*118*	168	*3.1*	3.1	*24.6*	21.7
Scotland	*102*	143	*2.4*	2.5	*15.6*	19.9
Overall	*567*	**836**	*2.7*	**2.4**	*17.9*	**19.9**

The grey partridge is an iconic gamebird and one for which we must achieve a conservation success. (Laurie Campbell)

decline in grey partridges may have halted. Meanwhile our results indicate a doubling of abundance on PCS sites since 2001 (see Figure 2) – an excellent result.

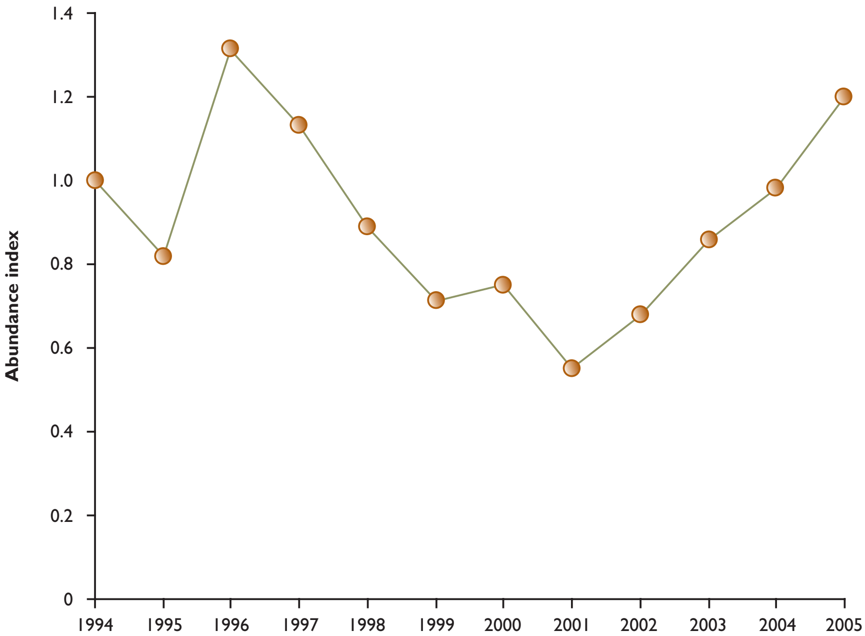
County groups

Our grey partridge group network expanded in 2005 with the addition of the Cotswold, Wessex and Northumberland groups. These join groups in Norfolk and Lincolnshire. The groups raise awareness, give advice and offer discussion of the latest research at a regional level. To support all PCS members, we have published six fact sheets on restoring wild grey partridges, nesting cover, brood-rearing cover, winter cover and food, predator control and using Environmental Stewardship Schemes. These are available free from our website at www.gct.org.uk/partridge or from Neville Kingdon on 01425 651066.

Figure 2

Index of abundance of grey partridges from our Partridge Count Scheme

The index of abundance (relative to 1994 = 1) from our Partridge Count Scheme indicates that participating sites have reversed the decline.



Wildlife diseases and epidemiology in 2005

2005 was a difficult year with politics often overtaking research and advisory work. On the rearing field our main effort was breeding grey partridges for our studies which aim to re-establish these birds into their former haunts (see page 40). This required bantam hens as well as conventional rearing systems. One of the main problems with rearing and keeping pairs of grey partridges on the field for prolonged periods is the almost inevitable infection with the gape worm *Syngamus trachea*. Our hen partridges were particularly hard hit and they needed almost constant dosing with anthelmintics. This highlights why years ago game farmers found that they needed to use raised production units for partridges to keep the worms in check.

Also on the rearing field we undertook some pilot studies for Defra on the welfare aspects of the use of bits. It is too early yet to discuss results, but part of the study will examine the potential of using faecal corticosterone to measure stress. If this proves itself, it will be an excellent research tool for all kinds of work into the welfare of gamebirds. Our rearing field also supplied some birds for the *Mycoplasma* studies at Liverpool University reported on page 48.

The outbreak of Newcastle Disease in Surrey worried us as we were a possible contact. Luckily we tested clear and, apart from keeping some birds on the field for longer than anticipated, we were not greatly inconvenienced. It could have been a different story and it certainly made us re-think our biosecurity – not easy with so many people on site. As it turned out, it was a useful dry run to the travails we might experience if Avian Influenza (AI) comes to the UK. The main spread of AI from wild birds will probably be from faecal contamination of drinking water, so our nipple drinkers used outside must be our first defence against this. So far we have never seen a wild bird attempt to use these. All of our poultry are fed and watered under cover but, however much netting we use for the pheasants, the thrushes, robins and dunnock always seem to get in. Fortunately these birds probably present little AI risk to our stock.

We have, of course, registered our flock with Defra under its new scheme.

Key achievements

- We provided expert advice regarding gamebird welfare and disease to government.
- We completed a research project with Liverpool University into Mycoplasmosis.
- We completed a research project with Cambridge University into Hexamita.
- Our rearing field was used in a number of projects including the partridge releasing study.
- We began a three-year project into the welfare aspects of bitting.

Chris Davis

The rearing field was used in many projects during 2005, including for rearing grey partridges for the partridge releasing experiment. (The Game Conservancy Trust)

Gamebird welfare research in 2005

Project title	Description	Staff	Funding source	Date
Gamebird health	*Disease prevention and control in game and wildlife*	*Chris Davis, Des Purdy*	*Core funds*	*1998 - on-going*
Hexamita *disease*	*Investigating the pathology and epidemiology of* Hexamita *in reared gamebirds*	*Chris Davis, Sheelagh Lloyd (Cambridge Univ) Des Purdy*	*Lord Iliffe Charitable Trust, Roxton Bailey Robinson, Research Funding Appeal*	*2000-2005*
Mycoplasmosis	*Investigating* Mycoplasma *as a respiratory disease agent in reared gamebirds*	*Chris Davis, Janet Bradbury (Liverpool Vet School), Des Purdy*	*National Gamekeepers' Organisation, Research Funding Appeal*	*2002-2005*
Bitting study	*Investigating the welfare aspects of bits and specs*	*Chris Davis, David Butler*	*Defra*	*2005-2008*

Mycoplasma and coronavirus in pheasants

Key findings

- Pheasants with coronavirus and *Mg* developed more severe signs of disease than those with *Mg* alone.
- Pheasants with coronavirus alone showed no detectable signs of disease.
- Lesions found were probably caused by *Mg*.

Janet Bradbury, *et al*
Liverpool University Veterinary School

Mycoplasma gallisepticum (*Mg*) is a respiratory pathogen of poultry and gamebirds. Outbreaks of upper respiratory disease in pheasants and partridges are often associated with *Mg*. Experiments with *Mg* from pheasants have shown that it will infect young pheasants at one-day-old or at 20 weeks of age. However, little is known about mixed infections, although in poultry we know that *Mg* disease can be exacerbated by respiratory viruses. In adult pheasants, we have shown that *Mg* in a co-infection with avian pneumovirus causes a more severe disease than *Mg* alone, despite the fact that disease is not found in birds infected with the virus alone.

Pheasants are reported to be susceptible to coronavirus infections. Coronaviruses isolated from pheasants with kidney problems are different from those isolated from poultry with infectious bronchitis or pheasants with egg production problems.

These viruses replicate in the respiratory tissues (nose, trachea, air-sacs and lungs), oviducts, many parts of the alimentary canal and also in the kidney, causing kidney disease. The virus can usually persist in the bird without a harmful effect until stress brought on by the onset of laying causes the virus to be excreted.

There are many reports in the literature of synergism between *Mg* and infectious bronchitis virus occurring in respiratory disease of chickens, so the aim of our study was to investigate the possibility of a similar phenomenon occurring in pheasants. For this we used an *Mg* isolate together with a pheasant coronavirus recovered in 2004 from respiratory disease in pheasants.

We randomly divided 40 adult (eight to 10 months old) hen pheasants into four groups of 10 birds: a control group; one treated with *Mg* alone; one treated with coronavirus alone; and the fourth treated with a mixed infection of *Mg* and coronavirus. We subsequently monitored the birds for clinical signs, virus isolation, immune response and pathology.

Our results clearly demonstrated, for the first time, that adult hen pheasants co-infected with *Mg* and coronavirus developed more severe signs of disease and with a greater morbidity than pheasants with *Mg* alone (see Figures 1 and 2).

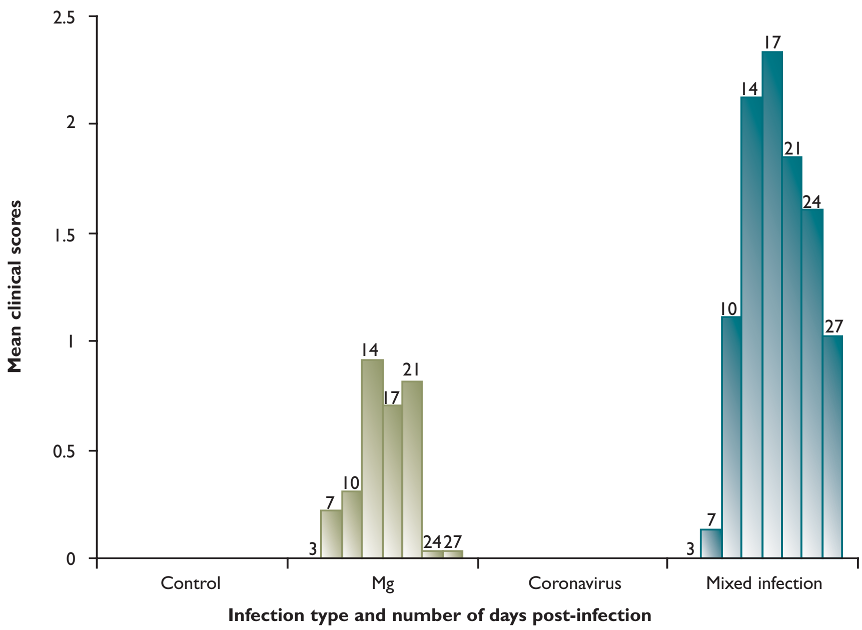
Infection of pheasants with the coronavirus alone resulted in no detectable signs of disease although it did stimulate an immune response in nine out of 10 birds; the same as in the mixed infection. Although the birds in the group with virus alone showed no signs of disease, there was a possibility that they harboured the virus, which may have later re-appeared if the bird had been subject to stress.

Lesions found in the eyes and sinuses of the infected birds in the *Mg* and mixed infection groups were probably caused by *Mg* since such lesions were not reported in

Figure 1

Mean clinical scores on days 3 to 27 post-infection of four groups of pheasants

Birds infected with both coronavirus and Mg showed most signs of illness.



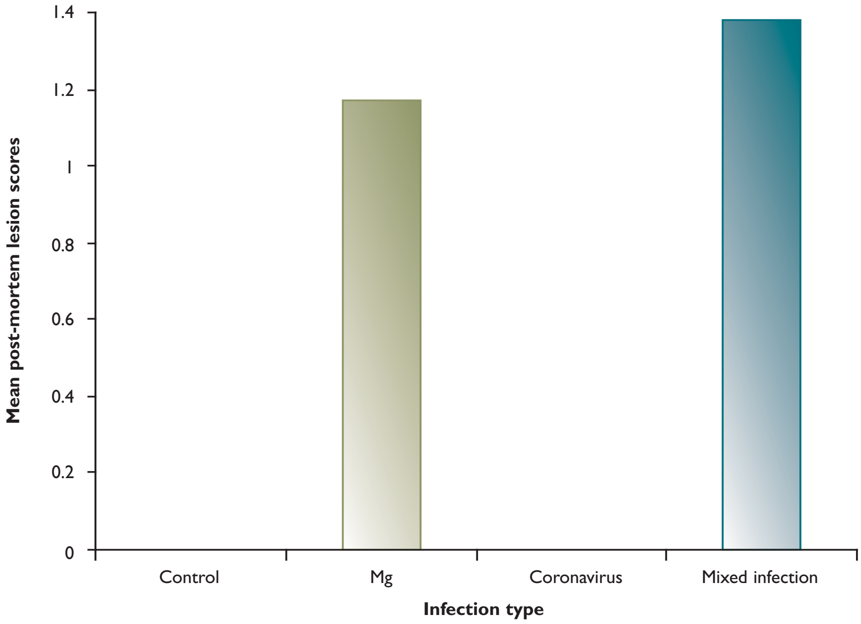


Figure 2

Mean post-morten lesion scores among four groups of pheasants

The mixed infection group showed more disease lesions than those infected with Mg alone.

pheasants naturally infected with coronaviruses. Such birds reveal visceral gout, urolithiasis and gross swelling and pallor of the kidneys. In our trial all kidneys examined in the infected birds appeared to be normal.

Based on the results of this work we were able to set up trials for a vaccine, but as yet these have failed to offer significant protection to birds infected with an *Mg*/ coronavirus co-infection.

Even when birds shown no sign of disease, it is possible that they may harbour viruses such as coronavirus. (The Game Conservancy Trust)

Farmland ecology summary for 2005

Key achievements

- Long-term studies show that chick-food insects remain few in number in UK wheat crops.
- We now have funding for two new research projects.
- We have demonstrated the value of beneficial insects for pest control.

John Holland

This year we started the "re-bugging the system project". Our role in this collaborative study is to investigate whether some of the habitats created under agri-environment schemes are improving the levels of natural pest control within arable crops and whether the scale of adoption is important. This work included studies examining the importance of different beneficial insects. We used net cages to exclude invertebrates on the ground such as beetles and spiders, and those that fly into crops like hover-flies or parasitic wasps. We studied their aerial movement by trapping insects moving between non-crop and farmed habitats using sticky traps. Each cage was infested with 500 cereal aphids and these increased 100-fold in six weeks in the absence of their predators, but where the predators and especially flying ones (hoverflies and parasitic wasps) had access to the pests, then the aphids were almost completely eliminated.

Following the well-publicised trials of genetically-modified crops, Defra has funded a new study to see whether procedures can be developed to test for the indirect effects of changes in crop production. We are part of the consortium that will undertake this work.

Our insect monitoring programmes continued in Sussex and at Loddington, Royston and on two estates in France. We use the insect data to calculate the Chick Food Index (CFI) from which we can predict partridge chick survival and likely population change between years. To maintain populations, a CFI of 0.8 is needed. It is clear that in England supplies of insects for chicks are still woefully inadequate in

Money spiders are beneficial as controllers of cereal pests such as aphids. (www.gardensafari.net)

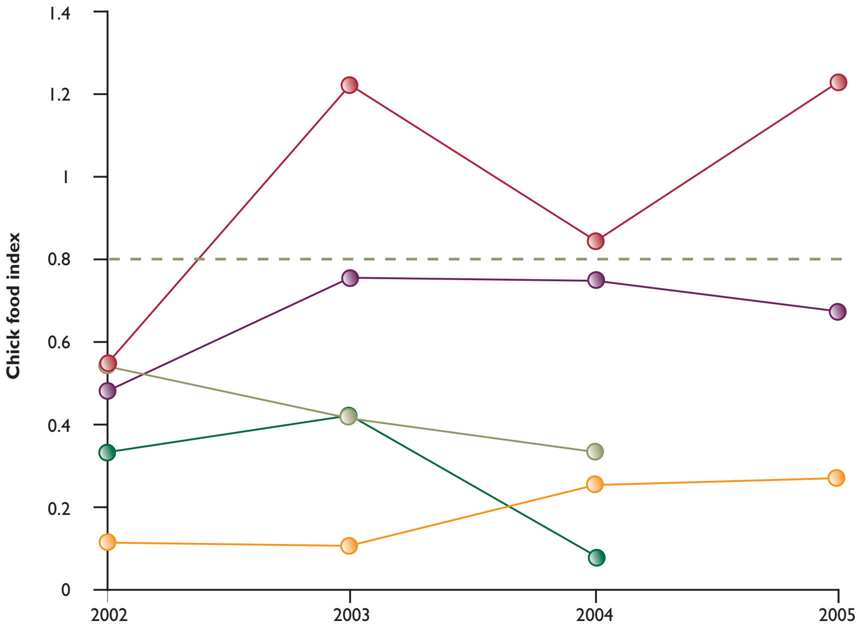


Figure 1

The Chick Food Index in commercially-farmed winter wheat in five study sites, 2002-2005

- Bellicourt, France
- Sussex
- Savvy, France
- Loddington
- Partridge Recovery Project, Royston
- Level required to maintain population

commercially-farmed winter wheat (see Figure 1) and the same is true of many other arable crops. Insect numbers can, however, be sufficiently high in set-aside and other non-crop habitats. However, we are still unsure how such habitats should be arranged across each farm and whether set-aside can be improved to enhance biodiversity. To this end we are being funded by the Sustainable Arable LINK programme, along with our partners The Arable Group, Rothamsted Research and the British Trust for Ornithology, to answer these questions over the next four years.

Farmland research in 2005

Project title	Description	Staff	Funding source	Date
Sustainable arable farming for an improved environment (SAFFIE)	*Enhancing farmland biodiversity by integrating novel habitat management in crop and non-crop margins*	*John Holland, Barbara Smith, Sue Southway, Tom Birkett, Steve Moreby, Steve Bedford*	*Defra, BPC, CPA, HDC, HGCA, LEAF, RSPB, The National Trust, Sainsbury's, Syngenta Ltd*	*2002-2007*
Sawfly ecology	*Investigating the ecology of sawfly over-wintering*	*Steve Moreby, Tom Birkett, Steve Bedford*	*Core funds*	*2000 - on-going*
Individual-based predator-prey spatio-temporal dynamics	*Using laser-marked beetles to investigate spatial-temporal dynamics of a predatory beetle in relation to its aphid prey*	*John Holland Dr L Winder (Plymouth Uni) Prof J Perry (Rothamsted Research)*	*BBSRC*	*2000-2005*
Re-bugging the system	*Investigating large-scale habitat manipulation for biocontrol*	*John Holland, Steve Moreby, Sue Southway, Tom Birkett, Barbara Smith, Steve Bedford*	*RELU*	*2005-2009*
Assessing environmental impact of crop production: beyond the GM crop farm-scale evaluations	*Developing a regulatory scheme to assess undesirable indirect effects on farmland ecology and wildlife changes in crop production*	*John Holland, Barbara Smith, Nicholas Aebischer, Julie Ewald*	*Defra*	*2005-2006*
Quarry restoration project	*Monitoring the recolonisation by wildlife of restored gravel workings*	*Barbara Smith, Steve Bedford, Tom Birkett*	*Tarmac*	*2004-2005*
PhD: Invertebrate aerial dispersal	*Examining the dispersal of beneficial invertebrates within arable farmland*	*Heather Oaten Supervisors: John Holland/GCT Dr M Thomas/Imperial College*	*RELU*	*2005-2007*
PhD: Bumblebee nesting ecology	*Enhancing bumblebee nest site availability in arable landscapes*	*Gillian Lye Supervisors: John Holland/GCT Dr D Goulson/Southampton Univ*	*NERC*	*2005-2008*
PhD: Population genetics of sawflies	*Impact of population dynamics on genetics and the implications for habitat management*	*Angela Gillies Supervisors: David Parish/GCT Steve Hubbard/Dundee Univ*	*BBSRC, core funds*	*2005-2009*

Key to abbreviations:
BBSRC = Biotechnology and Biological Sciences Research Council; BPC = British Potato Council; CPA = Crops Protection Association; HGCA = Home Grown Cereals Authority; HDC = Horticultural Development Council; LEAF = Linking Environment and Farming; PGRO = Processors and Growers Research Organisation; RELU = Rural Economy & Land Use; RSPB = Royal Society for the Protection of Birds; Defra = Department of the Environment, Farming and Rural Affairs; NERC = Natural Environmental Research Council

Floral diversity in a cereal ecosystem, 1970-2004

Key findings

- 83% of weed species have remained stable or increased since 1970.
- Proportionately more annual weeds have decreased and more perennials have increased.
- The proportion of undersown cereals has decreased.
- Perennial weed resistance to herbicides has increased.
- Annual weeds have become more susceptible to herbicides.

Julie Ewald
Dick Potts

The Sussex Study is a large-scale, long-term study on the Sussex Downs to document changes in the biodiversity of the cereal ecosystem with special reference to the grey partridge. In 2005 we analysed changes in arable weed abundance and diversity that have taken place during 1970 to 2004. We compared these changes to changes in cropping and crop management.

We sample insects and weeds in cereal crops during the third week of June. Our timing is designed to coincide with the period when grey partridge chicks are hatching. Insects are the preferred food for grey partridge chicks immediately after hatching because they provide essential protein for growth and feather development. Some of the insects that chicks prefer feed on weeds in the crop. The Sussex weed sampling is designed to collect the maximum information about the presence of weeds in the minimum amount of time. Weed occurrence is recorded in the cereal crops at the same location as insects are sampled, together with separate grass and broad-leaved weed abundance scores (0 to 5, where 0 reflects no weeds of that type present and 5 complete dominance of the crop by the weeds). All in all, there have been 171 species (or groups of species) of broad-leaved weeds and 16 species of grass weeds identified during the 35 years. In this article, we restrict our analysis to broad-leaved weeds as these provide a majority of the food both for chick-food insects and for the partridges themselves.

For each species, we calculated a value for relative change through the 35 years by fitting a curve to its percentage occurrence across the study area, using the difference

Table 1

Status of weed species in cereal crops in the Sussex study: 121 species where trends could be discerned

Category of status	Annuals (85 species)	Perennials (36 species)
Gone prior to study	8	0
Uncommon	40	13
Significant decline	8	2
No change	8	3
Significant increase	21	18
Percentage increasing	24.7 ± 4.7%	50.0 ± 8.3%

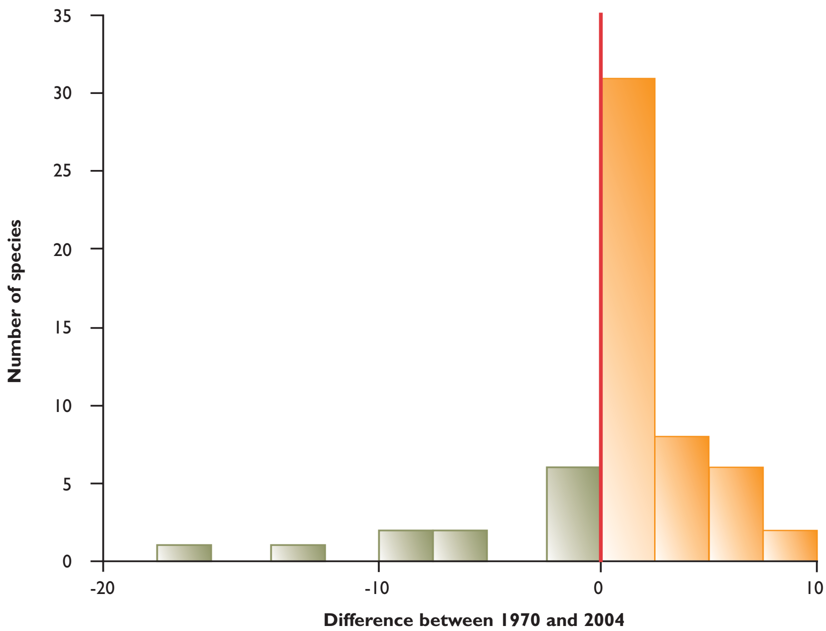
Figure 1

Decrease and increase of broad-leaved weed species in the Sussex study

Weeds that have decreased since 1970

Weeds that have increased since 1970

More broad-leaved species (total 60) have increased than have decreased over the 35 years of monitoring weeds in Sussex.



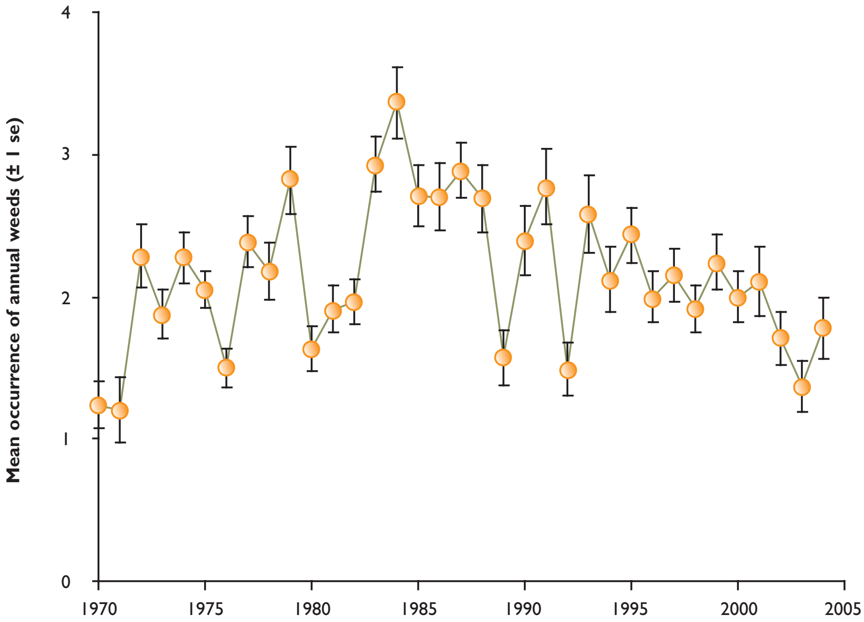


Figure 2

Trend in average overall number of annual weeds in cereal fields in Sussex, 1970-2004

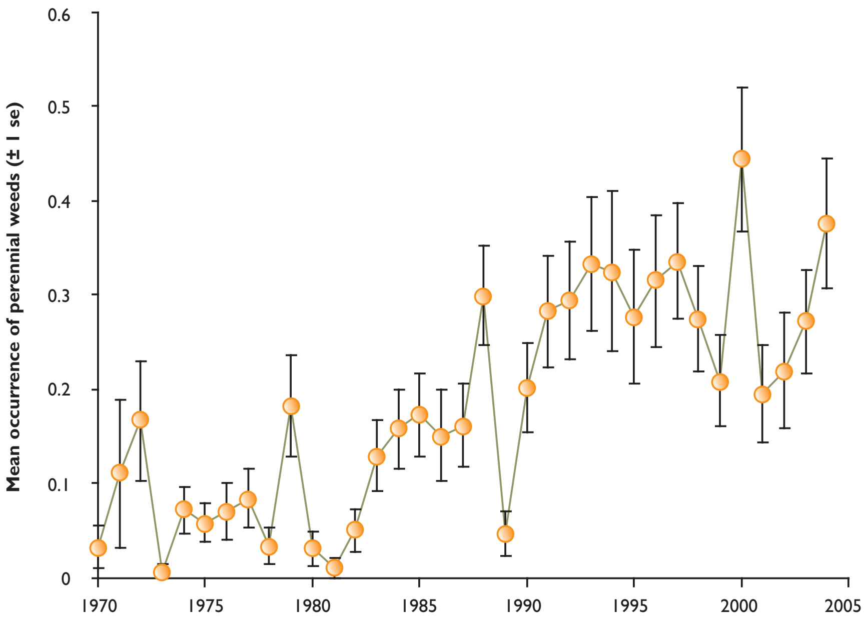


Figure 3

Trend in average overall number of perennial weeds in cereal fields in Sussex, 1970-2004

Figures 2 and 3 show how annuals have declined and perennials have increased.

Mixed weeds in arable on the Sussex Downs. (Neville Kingdon)

between the values calculated at 2004 minus the values in 1970, dividing by the values in 1970. We grouped the species into annuals and perennials (ignoring biennials for the present purposes) and calculated the average relative change in occurrence across the species in each group.

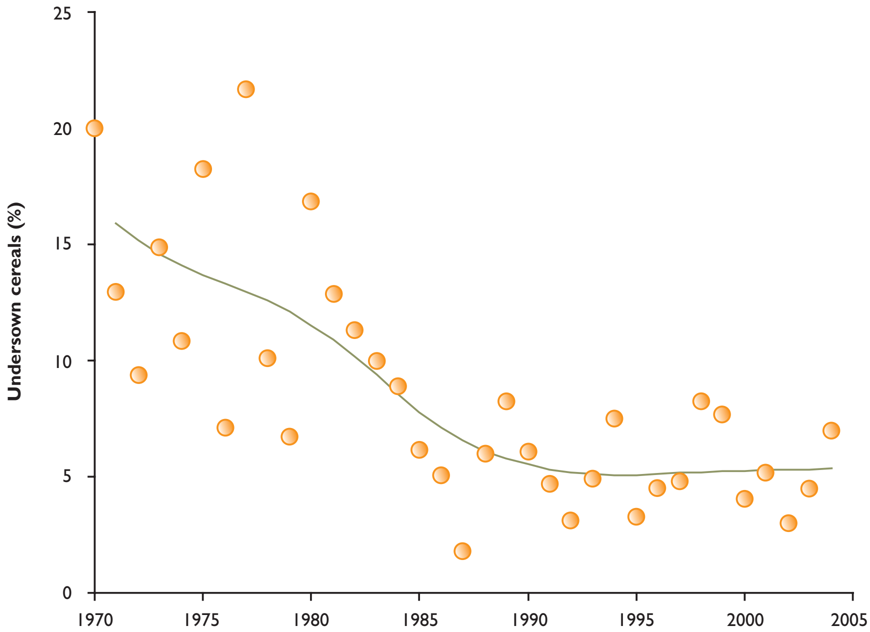
Overall, out of 60 species common enough to measure trend, 50 (83%) were stable or increasing (see Table 1 and Figure 1). Proportionately more declines and fewer increases were seen in the occurrence of annual weeds than in perennials.

Unfortunately for the grey partridge, the weeds that they most prefer are the ones that have declined like chickweed, redshank and pale persicaria.

We compared the changes in the overall number of annual (see Figure 2) and perennial (see Figure 3) weeds identified in cereal fields over this period with cropping and herbicide efficacy. Average yearly occurrences were compared with the proportion of the fields monitored that were undersown – a measure of how much traditional ley farming there was in a given year (see Figure 4 overleaf), the introduction of set-aside (measured as the number of fields monitored for weeds that were in set-aside the previous year), the ratio of spring-sown to winter-sown cereals, and the proportion of annual and perennial weeds that were susceptible or resistant to the herbicide cocktails applied on an average cereal field in each year (see Figures 5 and 6 on page 55). Average annual occurrence decreased as the proportion of spring- to winter-sown cereals

Figure 4

The proportion of cereals that were undersown in Sussex, 1970-2004



increased and the proportion of annuals classified as susceptible to the herbicide cocktail used in Sussex increased. Average perennial occurrences increased as the proportion of set-aside increased and the proportion of undersown cereals decreased.

It appears that changes in the cropping regime and the changes in herbicides used over the period of the study have both had an effect on the weed flora in cereal

The cornflower, once common, became very rare in the study area through the use of herbicides. It received a boost when imported with linseed in 1999 and now thrives on one farm, as Dick Potts discovered. (Neville Kingdon) fields in Sussex. Not all of this is detrimental. Some of the increasing perennials are substantial plants with considerable importance to wildlife, eg. hogweed, mugwort, burdock, and sowthistle. Against this must be weighed the fact that many of the declining annuals are important to farmland birds, especially grey partridge, so it would be a positive step in the conservation of farmland birds if these declines were reversed or alternative food provided. The use of conservation headlands (with their defined herbicide regime, preferably with little nitrogen applied) should allow these annuals, including rare arable weeds, to hold on. The benefits of traditional ley farming for chick food insects are well established. One of the advantages of a ley rotation is the control of pernicious weeds through rotations with cereals and undersown grass fields. The work reported here indicates that the move from a rotational ley farming regime, together with an increase in set-aside, resulted in an increase in perennial weeds. This has not, however, increased the overall annual weed occurrence, with an indication that this is due to the herbicide cocktail applied to cereal fields in Sussex. Further analysis is underway to examine the relationship of both the farming regime and the herbicide cocktail on individual weed species occurrence. The Sussex Study is uniquely placed to examine these relationships and this is due to the patience and co-operation of the farmers within the study area, to whom we would like to extend our thanks.

Nina Graham sampling weeds on the Sussex Study area in the autumn. (Neville Kingdon)

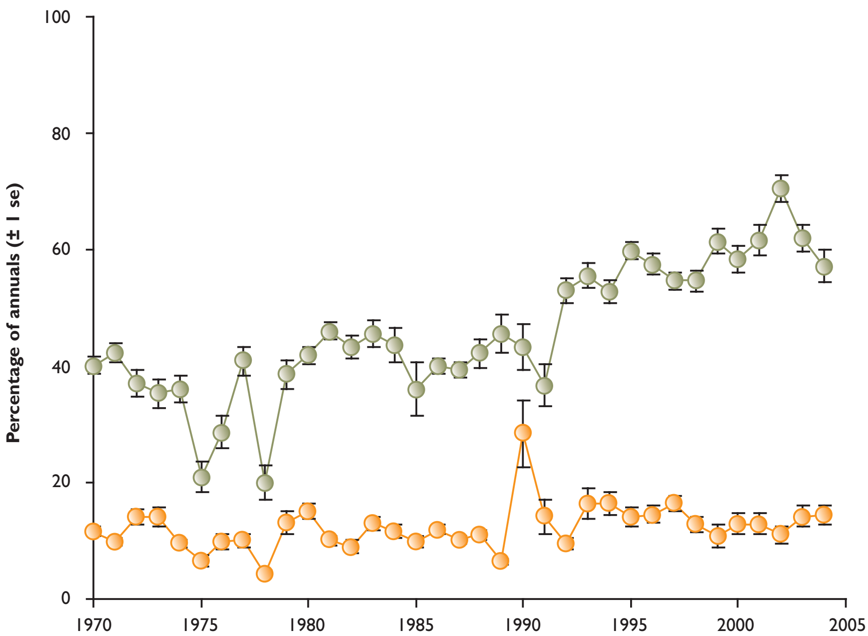


Figure 5

The trend in the proportion of annuals classified as susceptible and resistant to the herbicide "cocktail" used in cereal fields in Sussex from 1970 to 2004

Susceptible

Resistant

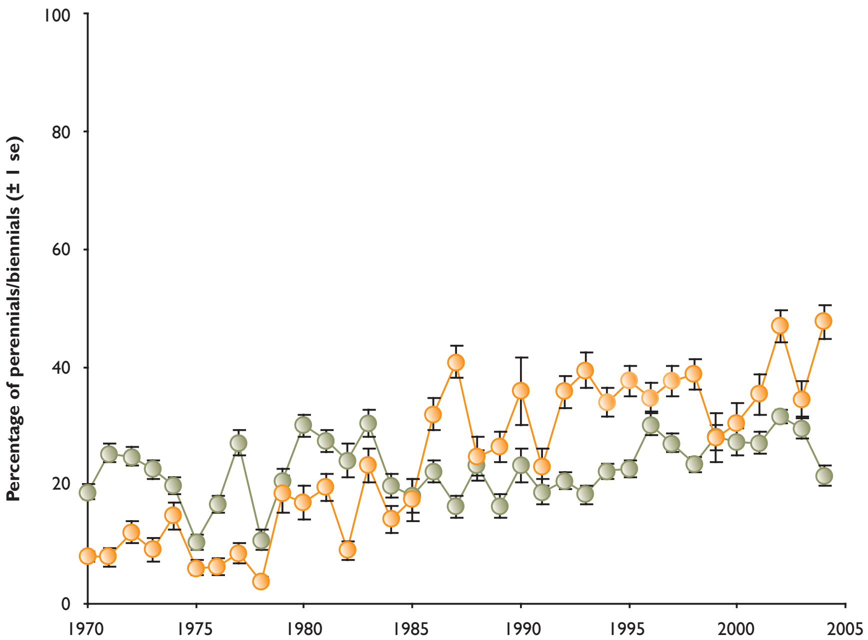


Figure 6

The trend in the proportion of perennials/ biennials classified as susceptible and resistant to the herbicide "cocktail" used in cereal fields in Sussex from 1970 to 2004

Susceptible

Resistant

Figures 5 and 6 show how the proportion of annual weeds classified as susceptible and the proportion of perennials classified as resistant have increased over time.

Arable farming for an improved environment

Key findings

- Undrilled patches and wide-spaced rows do not usually encourage food for farmland birds.
- Invertebrates are encouraged only where weed abundance is high.
- Undrilled patches increase skylark chick productivity and this is probably because of improved access for adult birds.

John Holland

Our work has shown that conventionally-farmed winter wheat does not contain enough invertebrates for farmland birds. However, this can be mitigated by establishing conservation headlands or by creating other insect-rich habitats. The Sustainable Arable Farming for an Improved Environment ('SAFFIE') project is a collaboration which aims to develop these ideas and improve farmland biodiversity. We are partners with, among others (see box opposite), the British Trust for Ornithology (BTO) and the Royal Society for the Protection of Birds (RSPB).

Winter wheat is a poor habitat for birds because the dense canopy shades out weeds, there are few insects, and it prevents access for birds like skylarks. Two approaches that would open the canopy are being tested. These are: undrilled four metre by four metre patches (see picture bottom right) and wide-spaced rows with 25cm spacing (see picture top right).

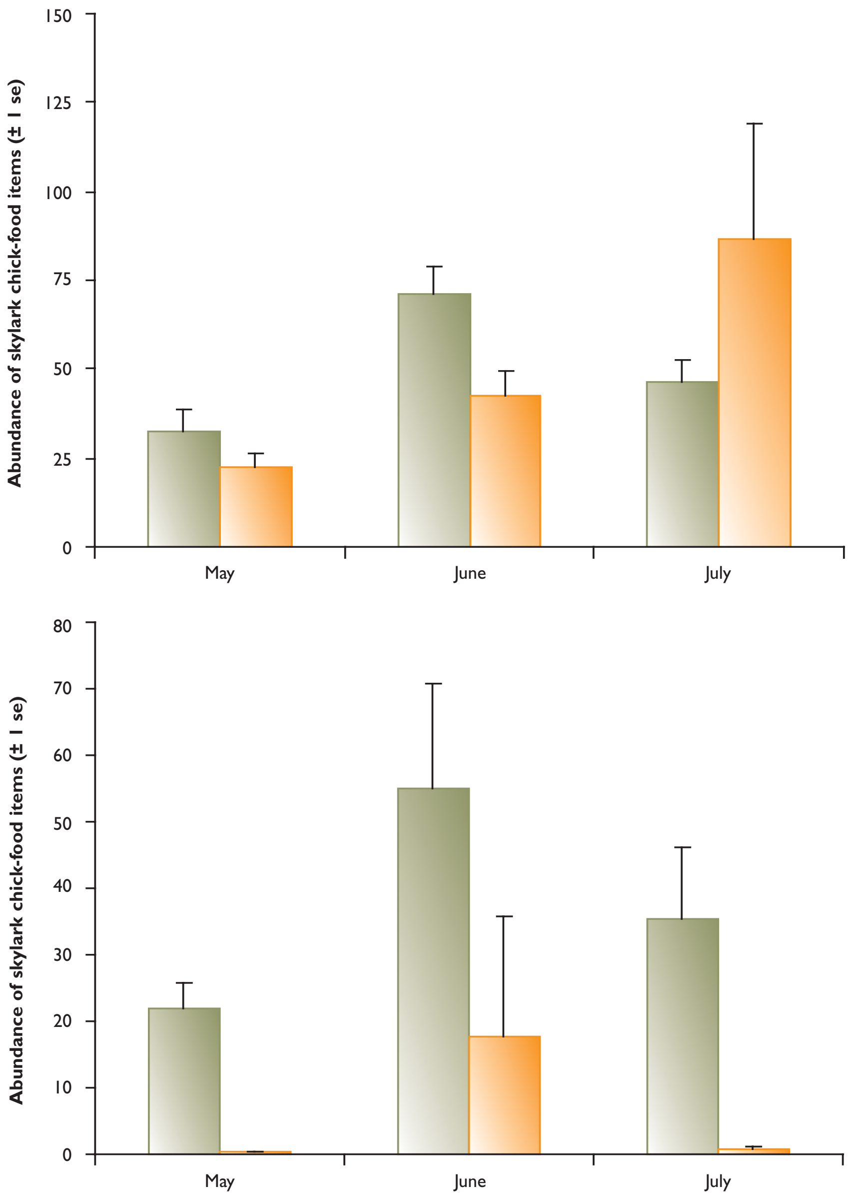
The study found that undrilled patches did not contain consistently more invertebrates than the neighbouring crop (see Figure 1) and invertebrate abundance did not differ between fields containing wide-spaced rows, standard rows or undrilled patches. In both years the weed cover of the preferred species was higher (8 and 13%) in the undrilled patches compared with 1% or less in the conventional or wide-spaced rows, but these weeds supported few invertebrates. Where there were more weeds in the

Figure 1

Abundance of invertebrates important in the diet of skylark chicks in undrilled patches and the adjacent crop in 2002 (top) and 2003 (bottom)

Crop

Undrilled patches



field overall, then this led to an increase in the abundance of predatory and herbivorous insects, many of which are eaten by farmland birds.

We think that undrilled patches would be more useful if the cover of the more desirable weeds could be increased, so improving their value as a foraging resource for birds. However, the patches form only 0.3% of the field and raising the levels of weed cover within the crop may encourage the invertebrate food supplies better. Linked to this, we are experimenting with herbicides and cultivation to try to produce a more desirable weed flora within winter wheat crops.

The BTO and RSPB found that the skylark breeding season was longer in the fields with undrilled patches and their productivity was higher than in conventional fields. Later in the breeding season, nests in these fields produced an average of 1.5 more chicks per attempt than those in the conventional fields. This was probably because of the better access rather than an increased food supply.

We are testing two techniques to open up crop canopy to help skylarks to nest more successfully: above – wide-spaced rows and, below – a skylark patch in June. (John Holland)

Project partners

Research partners: ADAS, British Trust for Ornithology, Central Science Laboratory, The Game Conservancy Trust, Jonathan Tipples, LEAF, RSPB, Syngenta, Centre for Agri-Environment Research - The University of Reading, and Centre for Ecology and Hydrology

Industrial partners: British Potato Council, Crop Protection Association (as part of the Voluntary Initiative), RSPB, Safeway Stores plc, Sainsbury's Supermarkets Ltd, Syngenta, HGCA and The National Trust

Government sponsors: Defra (LK0926), SEERAD, English Nature

What insects do partridge chicks prefer?

Key findings

- Insect choice was primarily influenced by size and colour.
- For similarly sized items, green/yellow was preferred over brown/black.
- Larger items were selected preferentially over small ones.
- Red items were least selected.

Steve Moreby

Studies on bird diet using gut and faecal samples have shown what birds eat, but not necessarily what they prefer. To understand this choice of food, we fed 100 partridge chicks, grouped into threes, pairs of differently sized and coloured insects or coloured food pellets, to see if food choice was related to size, colour or movement. The trial involved seven insect groups that partridges normally eat (see Table 1) along with one that they do not (seven-spot ladybird). We offered over 4,000 pairs of insects to the chicks and over 900 insects were eaten.

First we fed the groups of chicks pairs of all eight insect groups, placing the food on various coloured backgrounds. The chicks selected green-yellow plant bugs over the much larger green-buff sawfly larvae or buff-coloured crickets. Chicks chose all these large items in preference to the smaller dark-coloured insects. They selected red ladybirds least (see Figure 1).

Having found that size and colour both influenced food selection, we wanted to find out what part movement played in choice. We used live insects from five of the groups, two that were preferred in the previous tests (plant bugs and sawfly larvae) and three less chosen ones (ground beetles, ants and ladybirds). Again chicks selected the two larger items in preference to the more active but smaller and dark-coloured ants and beetles and again they chose the large red ladybird least (see Figure 2).

To see how colour only influenced choice we used commercial chick pellets dyed one of seven colours, green, brown, yellow, black, red, blue and natural (buff). Needing

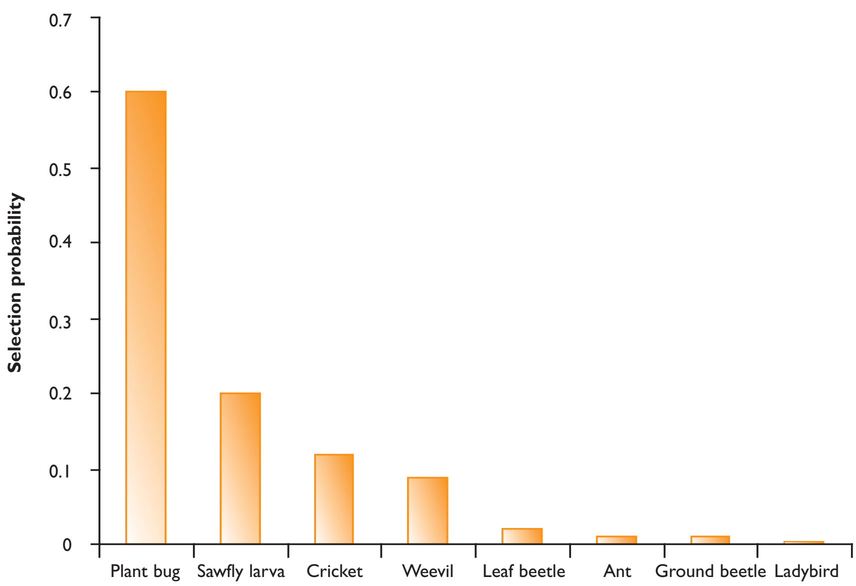
Table 1

Insect food offered to grey partridge chicks

Insect type (taxon)	Size (mm)	Colour
Sawfly larva (Hymenoptera: Sypmphyta)	15-20	light green-buff
Cricket (Orthoptera: Gryllidae)	10-12	light brown-buff
Plant bug (Heteroptera: Miridae)	4-5	light yellow-green
Leaf beetle (Coleoptera: Chrysomelidae)	4-5	blue/orange
Seven-spot ladybird (Coleoptera: Coccinellidae)	6-7	red/black
Weevil (Coleoptera: Curculionidae)	4-5	green
Ant (Hymenoptera: Formicidae)	4-5	brown
Small ground beetle (Coleoptera: Carabidae)	4-5	black

Figure 1

Grey partridge chick preference for food items provided dead (still)



Although partridge chicks prefer yellow-green items, these may be hard for them to detect on vegetation. (Steve Moreby)

the comparisons to be 'realistic', we measured the exact colours of the insects used previously and compared them with the coloured pellets. The colours of the insects and correspondingly coloured pellets were similar in most cases. Green and yellow again ranked highly in the chicks' preferences.

Our trial results generally agreed with findings from gut and faecal studies. However, in the field the chicks may find that their preferred larger green-yellow food items are more difficult to detect especially if immobile on vegetation. Such items may also be above foraging height, so choice may be restricted to the smaller, often active, but less preferred items on the ground or on lower vegetation. In cereal crops, a partridge chick may have little choice between different food types, needing to consume all available items, unless weed patches provide insects in excess allowing chicks to be more selective. Moreover, if feeding time is limited by inclement weather or insect abundance reduced by pesticides, then chicks are likely to consume all suitable items.

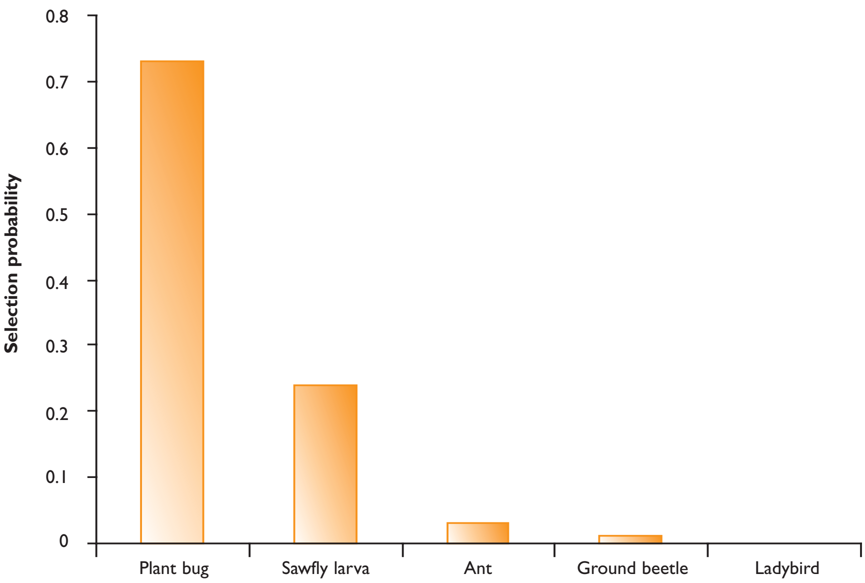


Figure 2

Grey partridge chick preference for food items provided alive (moving)

The role of beetles in cereal aphid control

Key findings

- We have developed a sophisticated marking technique for mark-recapture studies.
- By eating aphids, ground beetles can control their distribution.
- Aphid abundance did not influence how far beetles moved.

John Holland

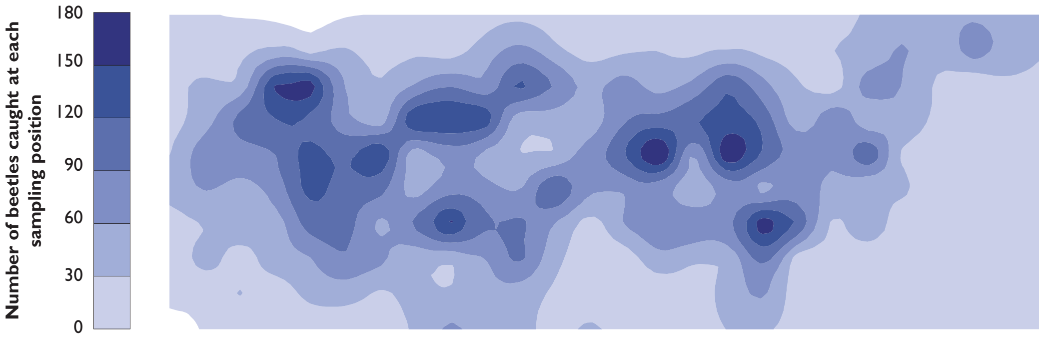
Hundreds of different invertebrate species live within cropped fields, but fortunately few ever become pests because they are killed by other invertebrates. The beetles are one of the most important group of predatory insects because they are numerous with species active throughout the year. There is now more emphasis on maximising natural pest control because of the drive towards using fewer insecticides and with the low value of most crops, a need to cut costs.

This beetle has been laser-marked with a three-digit code. (John Holland)

Figure 1

Field distribution of the beetle *Poecilus cupreus*

The field distribution of these beetles shows a high population activity-density in the field centre. Contours are derived from the total number of beetles caught at each sampling position.

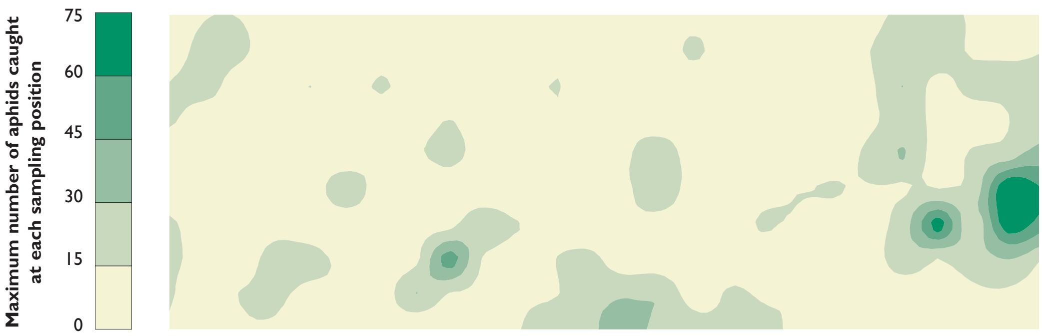


Our beetle project started because we needed to understand movement patterns of beetles to evaluate their value for aphid control. In the study, we used an automated laser, developed by a team at Seale-Hayne, that could mark each beetle with a unique three-digit code. We tracked the beetles by recapturing them in a grid of pitfall traps across a field and monitored the number of cereal aphids at each trapping location. In 2003, we marked a total of 8,046 ground beetles (*Poecilus cupreus*), of which 2,270 were recaptured at least once. This information allowed us to determine that there were 17,199 beetles within the 2.75 hectare field. Where beetle activity was highest (see Figure 1) there were fewer aphids or the aphid population

Figure 2

Field distribution of the aphid *Metopolophium dirhodum*

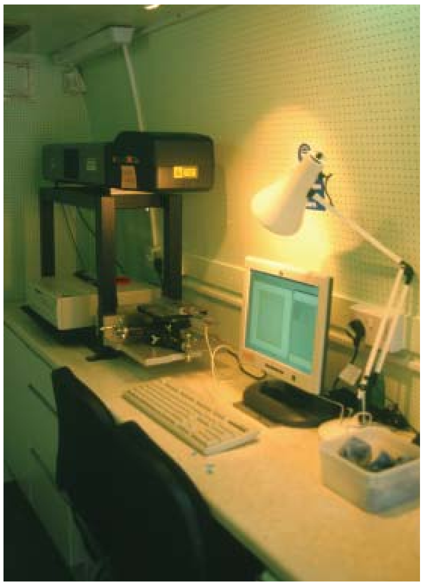
The field distribution of this aphid shows a high population activity-density where numbers of the beetle were lowest. Contours are derived from the maximum number recorded at each sampling position.



peak was delayed. Indeed there was a clear relationship between the total number of beetles and maximum number of cereal aphids (*Metopolophium dirhodum*) (see Figure 2) and an obvious disassociation in their distribution. We doubt whether this one species of beetle was responsible for all the aphid control because many beetle species eat aphids. Nevertheless, our study clearly showed that predatory beetles can reduce cereal aphid numbers.

In 2004, we tested the extent to which the beetles respond to aphid patches. We did this by spraying parts of the field with an aphicide to create aphid-free gaps. We then established two sampling grids with differently sized patches in a field of winter wheat and released laser-marked beetles into it. We tracked their movement in relation to the aphids over the following two weeks and found that they moved only short distances regardless of the aphid densities around them. We learnt that these beetles do not alter the way that they search for aphids as aphid abundance changes, unlike aphid-feeding specialists, which move less when they find an aphid patch. Aphids are not, therefore, an especially sought-after food item. Nevertheless, of the 6,792 beetles that we released, 31% were recaptured and two-thirds of these had eaten aphids.

Our study confirms that beetles reduce cereal aphid numbers, probably in conjunction with a large number of other insects and spiders and explains the patchiness of aphid distribution. As large numbers of beetles over-winter in the soil as well as the margins, less disruptive soil tillage should improve their survival and boost numbers for aphid control.



A laser-marking device, set up in a vehicle, enabled us to mark beetles on site. (John Holland)

Our study area in Devon. (John Holland)

Acknowledgements

Thanks to the Biotechnology and Biological Sciences Research Council, Drs Linton Winder and Georgianne Griffiths at Seale-Hayne, University of Plymouth, Prof Joe Perry and Colin Alexander at Rothamsted Research and Drs Pete Kennedy and Andrew Birt of Syngenta.

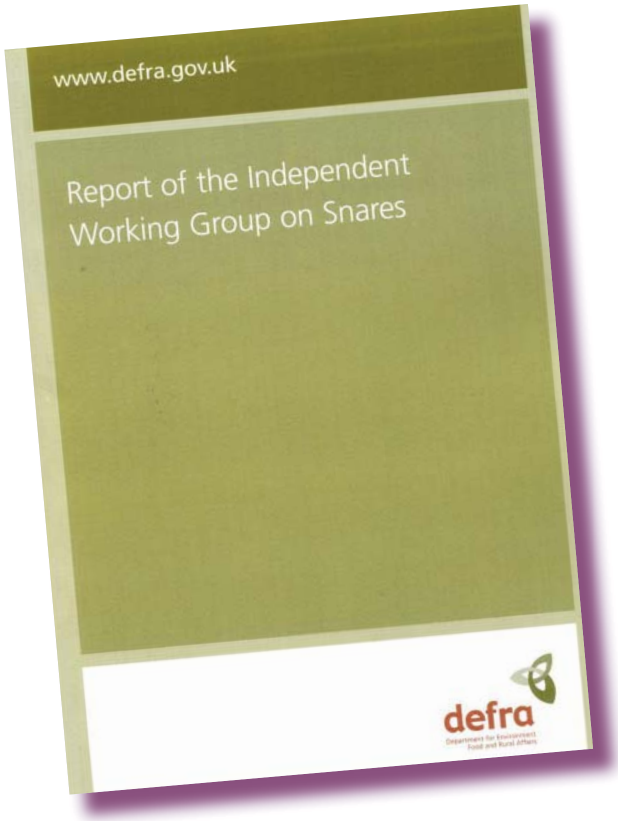
Predation research summary for 2005

Key achievements

- We were the main provider of data to the Independent Working Group on snares for development of a Code of Practice.
- We improved snare design to avoid non-target captures.
- We furthered our understanding of the impact of swans on water crowfoot (see page 72).
- Our mink control on the River Itchen expanded to the river's upper reaches.

Jonathan Reynolds

Fox snares dominated activity for our Predation Control Studies team in 2005. The Independent Working Group on Snares was convened by Defra at the end of 2004 under the Chairmanship of James Kirkwood, Chief Executive of the Universities Federation for Animal Welfare. Its brief was to develop a Code of Practice, based on a thorough round-up of all available information and expertise. We were represented and were the main provider of data from our studies of snaring practice in the early 1990s. The IWG submitted its report in August, and the code was launched in October as a Defra Code of Practice. This has been accepted by all the main organisations, and now features in educational material on snaring techniques. It is likely to receive legal backing after the passage of the Animal Welfare Bill in the early 2006 session of parliament. Meanwhile we are trying to improve the design of fox snares, so that they catch fewer non-targets and are less likely to injure animals that are held captive (see page 63).



The report of The Independent Working Group on Snares, which occupied considerable time in 2005.

Our work on swans and water crowfoot (see page 72) continued throughout the year and we are making genuine headway towards understanding the issue.

Our work on mink control continues to attract interest, although our research programme in 2005 on this issue was small. We expanded the use of GCT Mink Rafts into the upper part of the River Itchen in Hampshire. Mink visits to rafts were infrequent, perhaps owing to the very obvious presence of otters in this river section.

Further information

The IWG Report illustrated in the picture and the Code of Practice on Snaring are both available on the Defra website, www.defra.gov.uk

Predation research in 2005

Project title	Description	Staff	Funding source	Date
Mink control strategies	*Experimental eradication of mink on parts of Itchen and Avon catchments*	*Jonathan Reynolds, Mike Short, Tom Porteus*	*Environment Agency, Core funds*	*2003-2006*
Fox control methods (see page 63)	*Experimental field comparison of fox capture devices*	*Jonathan Reynolds, Mike Short, Austin Weldon*	*Core funds*	*2002-2006*
Swans and water crowfoot (see page 72)	*Quantifying 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*	*2004-2005*

Designing the perfect fox snare

In fox snaring, performance (target capture rate, non-target involvement, and the welfare of captured animals) is chiefly dependent on operator skills and practices. As such, the Independent Working Group on Snares addressed these with its Code of Practice. However, snare design also makes a difference.

Although there have been attempts in the past to improve snares in various ways, new designs were only attractive to operators if they promised better catching ability. Now, however, the IWG Report and the Animal Welfare Bill place responsibility for welfare of the captured animal morally and legally (respectively) on the shoulders of the operator. One recommendation of the IWG was to explore any modifications to the snare that might conceivably reduce non-target captures and lessen the risk and severity of injuries for captured animals. There are two main concepts, neither of them new:

1. Break-away devices, which release species stronger than the target species by building a weak link into the snare.
2. Cushioning springs, which dampen the physical strain incurred by captured animals when struggling against the snare.

The keys to successful development of such devices must be accurate specification, and correspondingly precise manufacture. With break-away snares, for example, the aims are to release non-target species such as badgers and deer easily, and to retain foxes reliably. The distinction between target and non-target species is unlikely to be clear cut. Some species may challenge the snare with a steady pull, others with stronger but briefer lunges. There are big foxes and small badgers. Even among members of a species, the pull exerted by different individuals varies not only with size and build, but also with motivation. Any specification is therefore likely to compromise one aim or another. However, once the optimum specification has been chosen, it needs to be consistently achieved. The finished product must be dependable, not a lottery.

It is hard to add anything to a snare without destroying its essential minimalist nature. For this reason too, it is important to have high quality components that

Key achievements

- Developed the design for effective break-away snares to allow non-target animals to break free.
- Achieved high capture rates compared with averages from gamekeepers.
- Developed the design for a cushioning spring to avoid injuring the caught animal.
- We are close to having a new, more humane snare ready for field-testing.

Jonathan Reynolds
Mike Short
Austin Weldon

Predation by foxes continues to be a prime focus of our research. (Laurie Campbell)

Austin Weldon's efforts are making snares more humane. (Louise Shervington)

are dependably strong while also simple, small and discrete. In our research, we are indebted to DB Design for advising us and supplying suitable components.

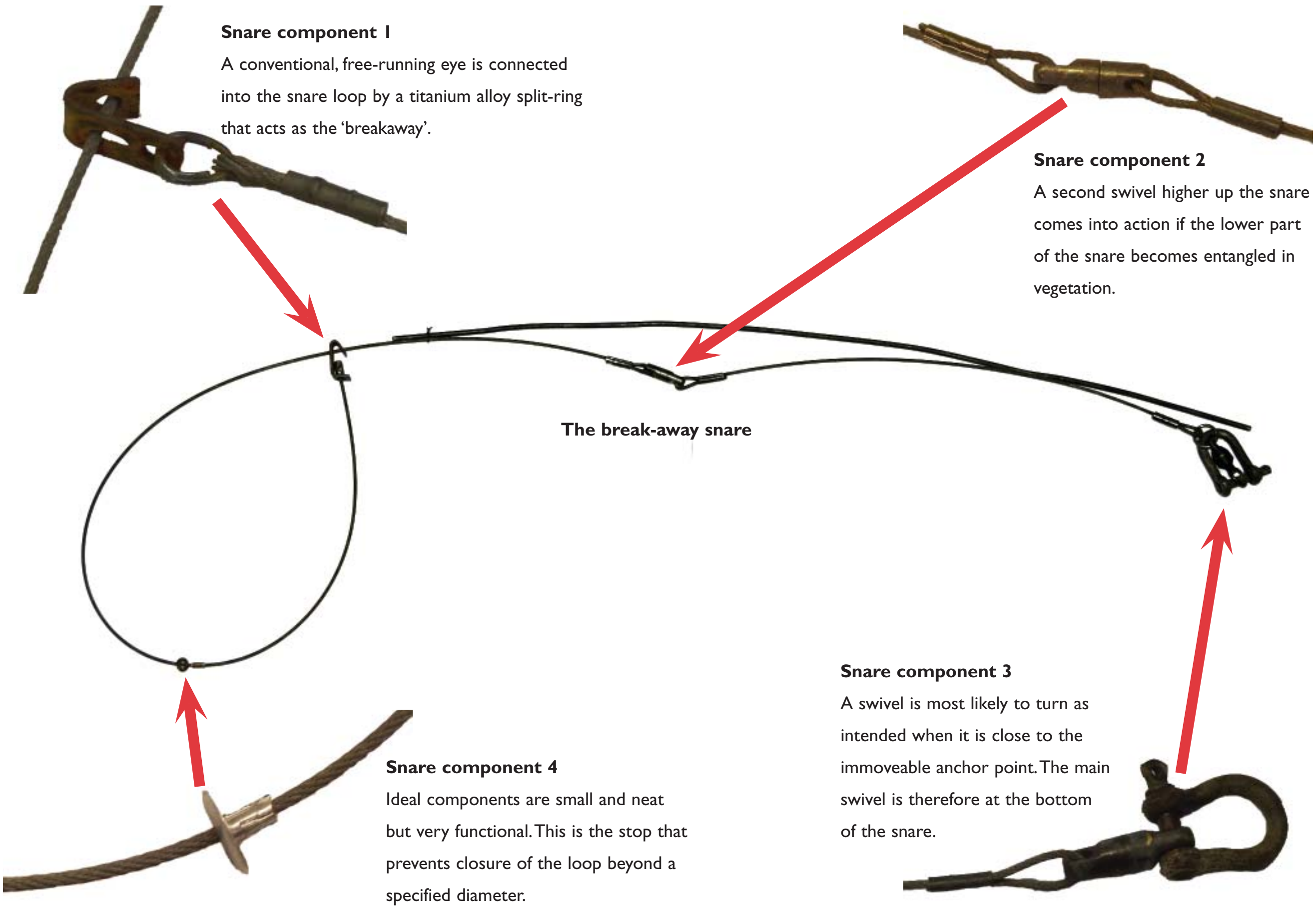
Developing the break-away specification (see Figure 1) has been a steady but frustrating process. Prototype snares are necessarily hand-made. At each change of specification, an adequate number of snares had to be prepared for use, but the entire batch could be consigned to the rubbish bin by a capture on the first night of deployment. We began these cycles of development using break-away snares at the 'weak' end of the spectrum. From a research viewpoint it was important to know which species broke free and which were restrained, so we also had to devise a way of retaining the animal in the snare even though the break-away device had released it. This added yet more components. Despite these handicaps, we achieved high capture rates (27.5 foxes per thousand snare-days, or 38 snare-days per fox) compared with average figures from gamekeepers (1.1 and 3.5 foxes per thousand snare-days in two previous studies).

Developing a cushioning spring has to follow the specification of the break-away device. The only way to assess its benefit would be to compare the condition of samples of foxes taken in normal practice using snares with and without springs. Because foxes are variable in size, strength and motivation, quite large samples would be necessary, and because it is a big investment even to organise such a trial among gamekeepers, we need to make a very close guess at the correct specification for the spring. A spring that is either too weak or too strong will be inoperative for much of the time, so the ideal may be one that is progressive in action. However, we can also foresee a complex relationship with the break-away device. The break-away snare can open predictably only if pulled against a dead weight, so spring strength must be chosen so that it is inoperative under the strong pulls exerted by large non-target animals.

We believe we are close to a final design that will be ready for widespread field testing late in 2006.

Figure 1

The break-away snare, showing the component parts



Main photograph: Louise Shervington; component part photographs: Austin Weldon

River ecology summary for 2005

In recent years one of the most important issues in fisheries management has been the debate over the stocking of farmed trout on rivers with wild stocks. Where rivers have low levels of wild production, perhaps owing to siltation or poor habitat, stocking is thought essential to maintaining angling interest and consequent habitat management, which is also important to other wildlife.

Based largely on the precautionary principal, the Environment Agency's *Trout and Grayling Fisheries Strategy* suggests restricting stocking on many rivers. For the past three years stocking has been the main focus of our fisheries research. We hope that it will lead to better informed policies on stocking rivers for fishing.

The improvement of river habitats for trout, salmon and other species has been a theme of our work. We lead the River Monnow Project, based in south-west Herefordshire, which includes Wild Trout Trust, Salmon and Trout Association, The Grayling Society, The Monnow Fisheries Association and The Environment Agency – Wales. By June 2006, we will have completed over 60 kilometres of riparian habitat improvement on more than 60 farms. This work is accompanied by a programme to monitor the effects of habitat improvement on trout, bullhead and crayfish. The project is intended to be a demonstration of the economic benefits of wild trout angling to local rural communities.

Key achievements

- Stocking research results should lead to better informed policies on stocking rivers for fishing.
- 60 kilometres of habitat improvement on River Monnow nearly complete.

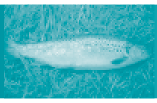
Ian Lindsay

It is usually fishing which drives habitat improvements on rivers. (Sophia Gallia/Natterjack Publications Limited)

The River Monnow Project is a partnership, funded by the Defra Rural Enterprise Scheme, between The Wild Trout Trust, The Salmon and Trout Association The Salmon and Trout Trust, The Grayling Society, Environment Agency Wales, The Monnow Fisheries Association, and is led by The Game Conservancy Trust.

Fisheries research in 2005

Project title	Description	Staff	Funding source	Date
Fisheries research	*Developing wild trout fishery management methods, including reports of historical fisheries research*	*Dyland Roberts, Dominic Stubbing*	*Core funds, GC London Fish Group, Reseach 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 the river Clywedog 1997-2000*	*Dylan Roberts*	*Environment Agency Wales*	*1998-2005*
Monnow Improvement Project	*Large-scale conservation and scientific monitoring of 30km of river habitat on the River Monnow in Herefordshire*	*Dylan Roberts*	*Defra, Rural Enterprise Scheme, Monnow Improvement Partnership*	*2003-2006*
Trout stocking Project 1 (see page 68)	*Triploid stocking*	*Dylan Roberts, Dominic Stubbing, Ravi Chatterji, Steffan Jones*	*Environment Agency, Riparian owners*	*2005-2007*
PhD: Trout stocking Project 2 (see page 66)	*Investigating the impact of stocking on wild trout stocks to identify optimal stocking strategies*	*Ravi Chatterji (Supervisors: Prof Peter Williams and Dr Tony Bark, Kings College, London) and Dylan Roberts, Dominic Stubbing*	*Wild Trout Trust, British Trout Farmers Restocking Assoc, GC London, regional fisheries clubs, regional fundraising events*	*2002-2005*



Stocking rivers with trout for fishing

Key findings

- There was no statistically significant drop in abundance, biomass or growth of wild fish in upland and lowland rivers when stocking took place.
- Stocking did not cause displacement of wild fish in upland or lowland rivers.
- Growth of stocked fish once released was negligible.
- Stocked fish sometimes moved a considerable distance from their release site – mostly downstream.

Ravi Chatterji

Farmed brown trout are often stocked into rivers to provide sport for anglers. However, there is concern that such introductions may reduce the viability of wild brown trout populations. Possible impact mechanisms include behavioral interactions, predation effects or genetic interactions. Our study investigated the success of an experimental stocking programme and its affect on the growth and abundance of adult (200mm fork length) wild brown trout over a two year period. We compared non-stocked control sites with stocked treatment sites before and after stocking. We selected 48 sites each of 200 metres long from seven rivers, which represented upland rain-fed rivers and lowland spring-fed chalk streams. Catch and release was normal practice where there was trout fishing.

We used three levels of stocking: high – where stocked fish numbers equalled those of adult wild fish; medium – where they represented 50% of the wild level; and low – where their numbers represented 25% of the wild fish. We replicated these three levels six times for each river category. Average numbers of fish stocked per 200 metres of river for each treatment were: low = 8, medium = 13 and high = 33. Some stocking rates used in fishery management may exceed this range, but a survey of 13 fisheries operating on the study rivers revealed an average stocking rate of 39 fish per 500 metres (16 per 200 metres).

Using electro-fishing, we estimated the abundance of adult wild fish before and after stocking during the summers of 2002, 2003 and 2004. We anaesthetised the brown trout and counted, measured, weighed and marked all those longer than 100mm. We assessed habitat using the HABSCORE index and this did not differ significantly between sites.

We introduced fertile (diploid), mixed-sex stocked fish in spring 2003 and 2004. We used two strains of stocked fish, one from an upland fish farm (strain U; farmed for around 15 years) and another from a lowland fish farm (strain L; farmed for around 30 years). Before stocking we anaesthetised, measured, weighed and individually-marked the pound-sized trout.

We looked at the abundance, growth, biomass and displacement of wild fish, along with the growth and site retention of stocked fish. We also checked the movement of fish between experimental sites and looked at pectoral fin length in the two strains of stocked fish and the wild ones.

Neither abundance, biomass, growth nor the displacement of wild fish were significantly affected by stocking in either upland (see Figure 1) or lowland (see Figure 2) sites in the periods 2002-2003, 2003-2004 and 2002-2004. There was an apparent drop in wild fish abundance at upland sites that were stocked (see Figure 1) – but this was not statistically significant. Wild fish grew very quickly in the lowland rivers, putting

Figure 1

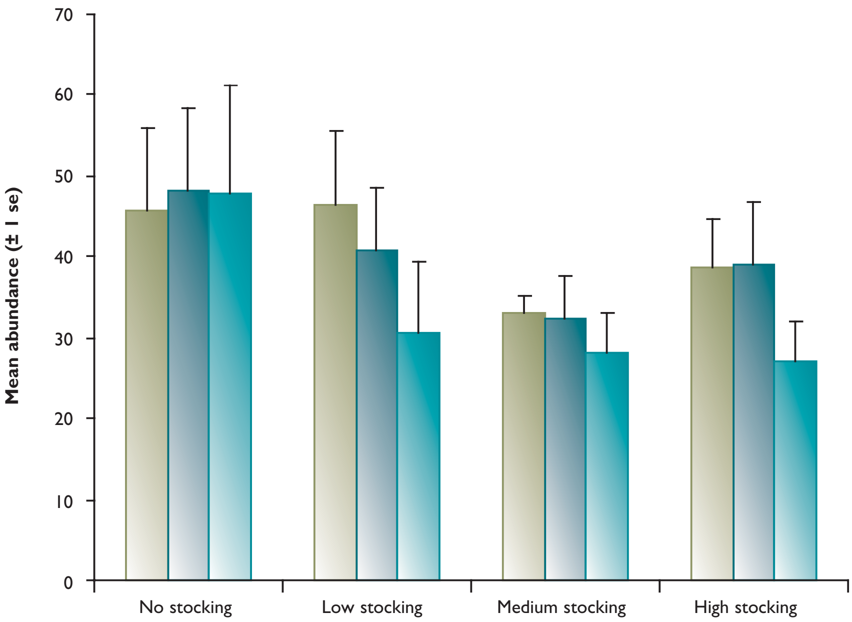
Abundance of adult (200mm) wild brown trout at upland sites by treatment, 2002-2004.

Pre-treatment 2002

Post-treatment 2003

Post-treatment 2004

Fish were stocked into the low, medium and high sites in spring 2003 and 2004.



Left and below: before stocking we anaesthetised, measured, weighed and marked all the fish. (Ravi Chatterji)

on 92% of their initial weight in one particular year – three times that of upland sites.

There were also differences in growth and site retention of stocked fish between strains and river types depending on the year in question. Strain U grew more in lowland sites than upland sites. Strain U grew more in lowland sites than strain L in 2004. Growth of stocked fish was negligible. Overall, in the short term (two to six months) they lost weight (-2%) in upland sites, but gained weight (2%) in lowland sites. 25% of stocked fish in 2003 and 18% in 2004 remained where they were put; the rest either died or emigrated. Site retention in upland streams was higher for strain U (21% and 26%) than strain L (6% and 6%), and site retention for strain U was significantly better in upland sites (26%) than in lowland ones (12%) in 2004.

Stocked fish sometimes moved quite long distances (as far as five kilometres upstream and nine kilometres downstream) – most movement was downstream. This phenomenon was not exhibited by wild fish. Only one stocked trout remained in its release site over winter. Wild fish had significantly longer pectoral fins than either of the stocked strains, but strain U had longer fins than strain L. This may be important as fin length probably affects hydrodynamic ability.

The absence of a statistically significant effect of stocking on adult wild trout may be because of the poor performance of the stocked fish, which displayed low growth and quite poor site retention. Laboratory-based experiments also show that wild fish often out-perform farmed fish. The better performance of strain U, its better fin size and the fact that the strain has only been farmed for 15 years suggests that provenance may be an important consideration. However, although improving the performance of stocked fish may seem desirable, it could result in them being more likely to affect wild fish.

Acknowledgements

King's College London, the Wild Trout Trust, the British Trout Farmers Restocking Association, members of various angling associations, the Environment Agency, and riparian owners of the study sites.

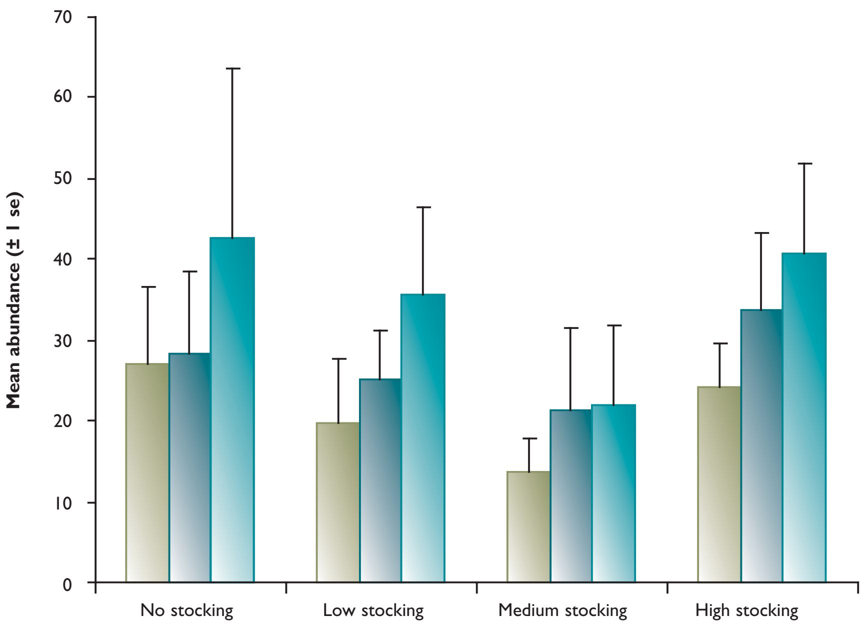
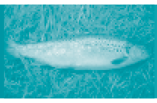


Figure 2

Abundance of adult wild brown trout at lowland chalk stream sites



Fertile versus infertile trout for stocking

Key findings

- Farmed diploid (fertile) and triploid (infertile) trout are equally likely to take dry flies.
- The fighting ability of farmed diploid and triploid trout is similar in anglers' experience.
- The visual condition of farmed diploid and triploid trout is similar in anglers' experience.

Ravi Chatterji

We have started to investigate the performance of stocked triploid (infertile) brown trout compared with normal diploid (fertile) ones and any effects they may have on wild brown trout. The study was commissioned by the Environment Agency (EA) which is our partner in the project and our findings will help to guide the EA's *National Trout and Grayling Fisheries Strategy*.

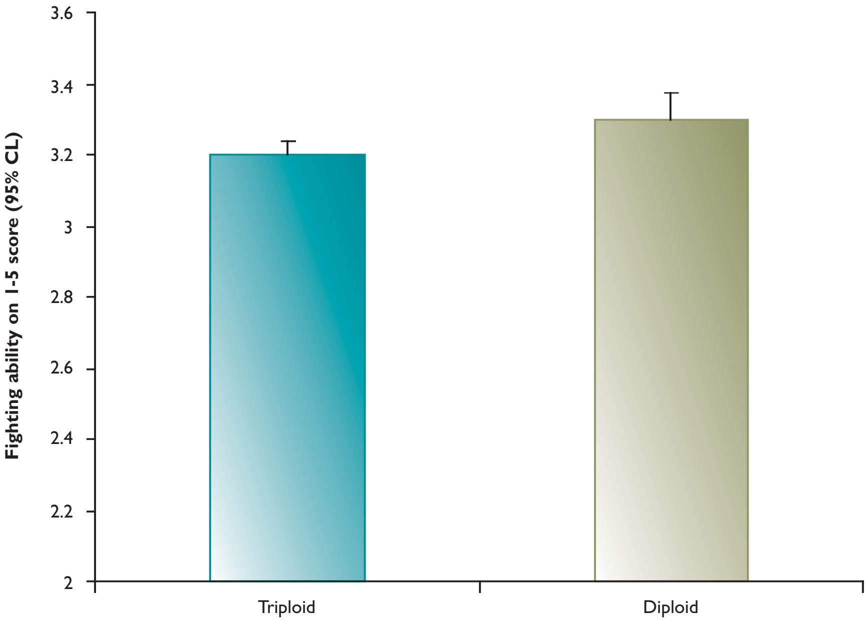
Work began in March 2005, runs until May 2006, and consists of three individual studies. The first study adopts many of the sites and techniques used in our diploid stocking project (see page 66) and aims to investigate the effects of stocking with diploid and in particular triploid fish on the abundance and growth rates of wild fish. We are also comparing the relative diets of wild and farmed diploid brown trout and farmed triploid brown trout using a non-lethal technique called 'stomach flushing'.

The second study involves radio-tracking to monitor fish movement and behaviour. This began in September 2005 on two rivers, the River Allen in Dorset (a chalk-stream) and the River Arrow, near Kington in Herefordshire (a rain-fed river). We released into each river 60 radio-tagged brown trout consisting of 20 local wild fish, 20 farmed diploid fish and 20 farmed triploid fish in the autumn and monitored behaviour and interactions of the fish over the winter spawning season using fixed 'listening stations' and hand held mobile tracking equipment. We will report on the first two studies in a future *Review*, when data are analysed.

Figure 1

Relative fighting ability of farmed triploid and diploid brown trout

Among the anglers surveyed, there was very little perceived difference between triploid and diploid trout in terms of fighting ability or visual condition.



A radio-transmitter used in our radio-tracking experiment with a 20p piece for size comparison. (Brian Shields)

The third study is a survey of angler log books, for which we asked anglers at a fishery in the Salisbury area to fill in angler return forms. The fishery had been stocked over a number of visits with a mixture of farmed diploid and farmed triploid brown trout, each about 400g in weight and separately marked. There were spaces on the return form for the anglers to grade the visual condition and fighting ability of any fish caught, using a scoring system ranging from 1-5 where 1 = poor, 2 = below average, 3 = average, 4 = above average, 5 = excellent. There was also space on the form to include the number of hours fished. This study allows us to investigate whether catch returns of diploid and triploid farmed fish are different and whether the angling experience differs depending on the type of farmed trout.

The initial results from the angler survey show that out of the 52 farmed brown trout that were caught and identified as being experimental fish, 31 were triploid and 21 were diploid. Anglers caught 25 fish of which 12 were triploid and 13 diploid during a 'dry-fly only' period, which suggested that both types are equally likely to be caught by this method. In terms of fighting ability (see Figure 1) and visual condition (see Figure 2), triploid and diploid trout scored equally with average scores of just over three (ie. just above average on the 1-5 score).

Diploid and triploid trout are equally likely to be caught on a dry fly. (Sophia Gallia/Natterjack Publications Limited)

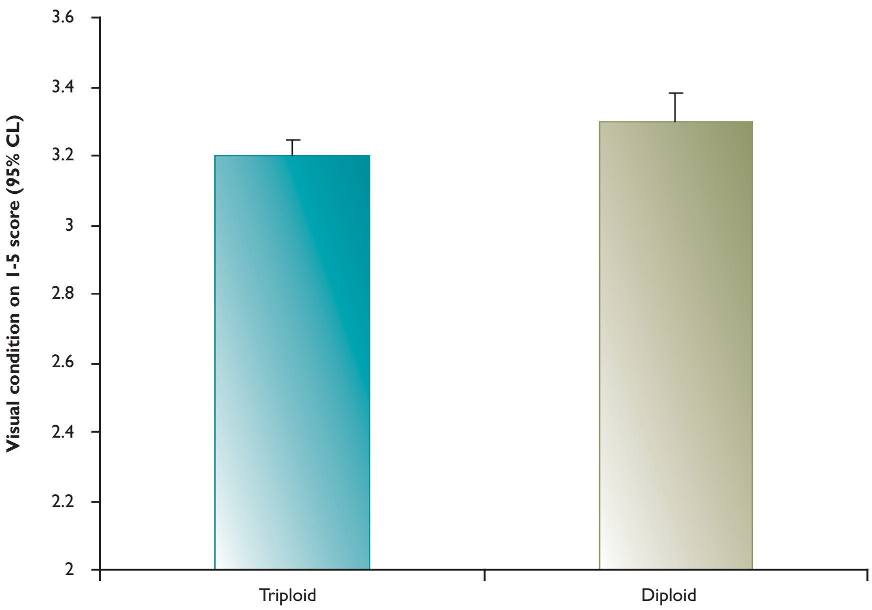
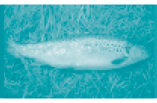


Figure 2

Relative visual condition of farmed triploid and diploid brown trout

Acknowledgements

The Environment Agency, the British Trout Farmers Restocking Association, the Salmon and Trout Association, the Salisbury and District Angling Club, members of various angling associations, and riparian owners of the study sites.



Marking fry using the calcein bath treatment

Key findings

- Calcein marks remained detectable in all marked fish for 12 months.
- After 19 months, a third of fish still retained an identifiable mark.
- Fish growth not time causes the mark to disappear.
- Marked fish were no more vulnerable to predation by trout than unmarked ones.
- The calcein technique provides a reliable, unbiased method for marking large numbers of small fish.

Dominic Stubbing

The calcein bath, into which fry are placed for marking. (Jerre Mohler)

Marking fish is essential in fisheries research and management. However, marking juvenile fish is difficult because they are small and have to be marked in large numbers. From a range of techniques, bathing in a fluid called calcein seems to offer a good way to mark large numbers of small fish. Calcein is a fluorochrome, which binds with calcium and fluoresces. The compound has been used in quantifying calcium content of stone, for tracing blood flows within the eye and for examining bone growth in animals. Its application to fish using a salt bath before calcein immersion, produces a mark that is detectable without having to sacrifice the fish.

Jerre Mohler of the Northeast Fishery Center, Lamar, Pennsylvania, USA has developed the method on Atlantic salmon and has found no adverse effects. When we first tried the treatment on brown trout fry we were unable to detect the mark despite trying various types of illumination.

Figure 1

Length, weight and calcein retention in brown trout fry

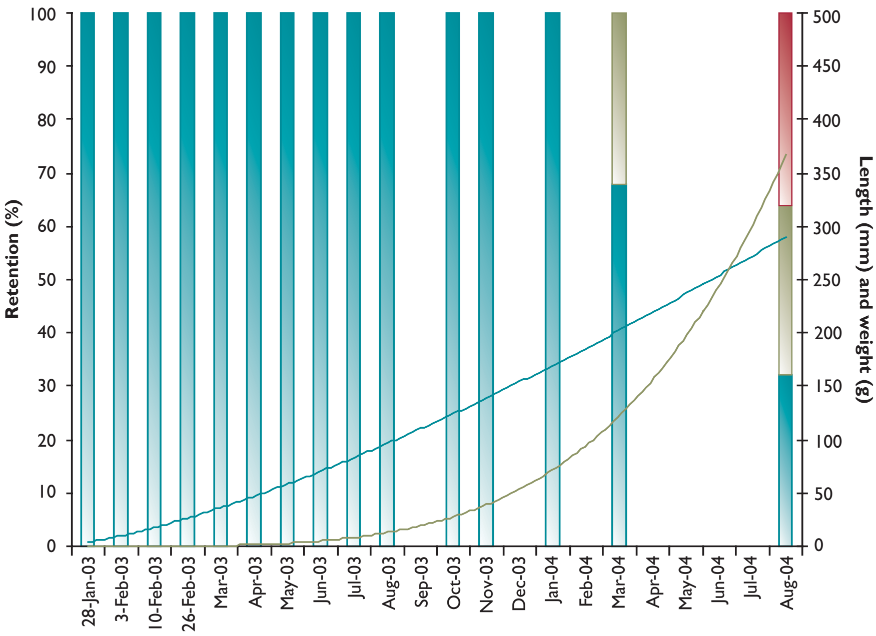
Recognisable mark

Questionable mark

No mark

Length

Weight



In 2005, we visited Jerre Mohler's laboratory to see how he detected the marks. His salmon had apple-green fluorescent marks when looked at using his prototype viewing device. So, we tried the technique out again on brown trout, with no mortality and 100% marking rate over 24 hours. When we tried Jerre's viewer on our original fish we discovered that they had been marked perfectly. We decided to develop this technique for brown trout by checking for effects on mortality, mark retention and predation by adult brown trout.

We conducted these studies at Watergates Fish Farm in Dorset during 2003 and 2004. We marked some groups of fish and left others unmarked. We then checked them for mark retention (using Jerre's device) several times in the first month and then every one to two months for a year and a half.

We found that after 12 months, all marked fish were still identifiable as marked. At 19 months, 32% of fish still had an identifiable calcein mark. Over the last seven months of the trial, the marked fish had an average weight increase of about seven-fold to 430g (about 1lb) and length two-fold to 310mm (about 12") (see Figure 1). We found no difference in survival, length and weight over 19 months between marked fish and fish left unmarked as a control. Jerre finds that salmon of a similar age (17 months) retain all their marks, but they are still small at this age being only 232mm long and 126g in weight. This suggests that it is growth that causes the mark to disappear, not time.

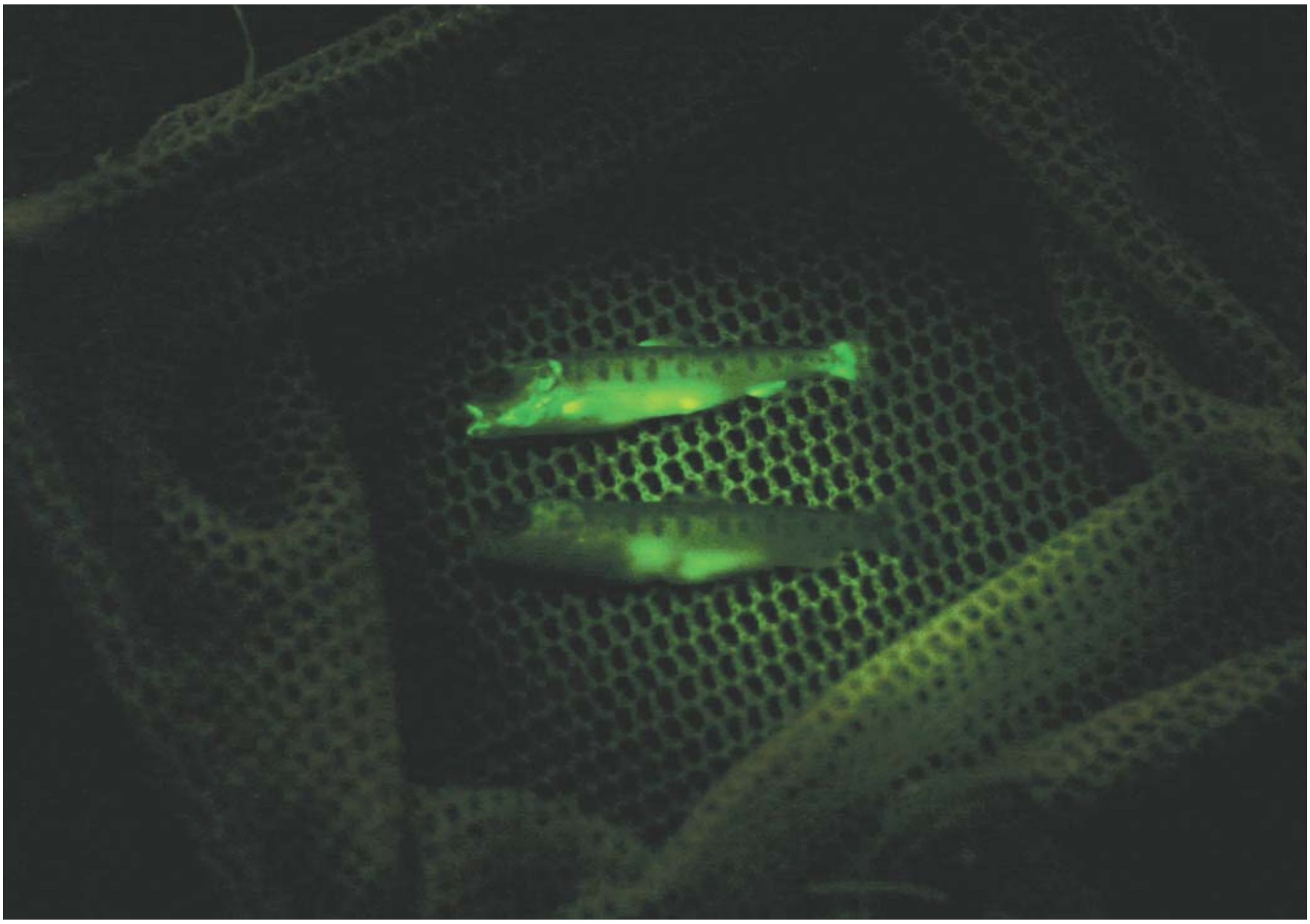
To see if marked fry were more vulnerable to predation than unmarked ones, we set up six small raceways, included some natural river habitat, and introduced two adult brown trout of about a pound in weight as predators. We then placed marked and unmarked fry into each raceway. After three days we removed the fry and counted what was left.

We could find no difference in the proportions of marked and unmarked fry that had been eaten, which suggests that calcein marking provides a reliable and unbiased method of assessing survival of trout fry in the wild. We intend to use this marking method in our research on fry stocking.

Acknowledgements

Thanks to The Wild Trout Trust and The British Trout Farmers Restocking Association, and especially to Jerre W Mohler (Northeast Fishery Center) and Reuben Moss (Watergates Fish Farm).

Calcein is visible in marked fish when using a specialised viewing device. (Jerre Mohler)



Mute swans and *Ranunculus*

Key finding

- Swan grazing pressure during the first half of the year has a reduces the subsequent growth of *Ranunculus*.

Mike Short

Chalk rivers are characterised by their species-rich macrophyte communities, dominated by water crowfoot (*Ranunculus*). Traditionally, river keepers have carefully managed this plant to provide favourable conditions for angling, to control water levels and reduce flood risk. A national decline in *Ranunculus*, coupled with the apparent deterioration in condition of chalk rivers prompted their UK Biodiversity Action Plan (BAP) status. A significant component of the BAP requires the maintenance of the *Ranunculus* community.

The issue of swan grazing on *Ranunculus* has been a controversial subject on the River Wylye (a tributary of the Hampshire Avon in Wiltshire) and elsewhere, since the early 1970s. Where herds of non-breeding swans congregate, they can deplete *Ranunculus* beds by over-grazing, reducing structural and biological habitat diversity. The associated loss of weed-dependent invertebrates and cover for fish has made swans unpopular with the fly-fishermen.

Previous research on the Wylye sought to clarify aspects of swan population biology and to consider how the effects of grazing might be relieved. Currently Wessex Water have an invertebrate study on the Wylye, and its data are available to us, so we decided that the most useful approach would be to quantify the biomass of *Ranunculus* that may be lost through grazing.

We monitored swans at 46 sites, at two-weekly intervals from January 2004. Sites were located approximately a kilometre apart and were randomly located relative to swans.

There is no established method to measure macrophtye biomass. Previously, *Ranunculus* has been measured by estimating its cover. However, this lacks precision, there are inconsistencies between observers and it ignores *Ranunculus* volume. Destructive sampling risks consuming what you are trying to measure and is labour intensive. We therefore devised a new method using percentage cover and small samples. The samples were oven-dried and this gave us an index of biomass at each site between May and September.

Water crowfoot is very important in-stream vegetation, but is easily over-grazed by swans. (Jonathan Reynolds)

A large number of swans resides in the Wylye valley, perhaps thanks to palatable crops, such as this oilseed rape, grown close to the river. In the river, grazing by swans severely inhibits the growth of Ranunculus. *(Mike Short)*

In spring 2004 the resident swans comprised 17 pairs and around 65 non-breeders, including two herds of approximately 15 and 40 swans respectively. From January to April 2004, the large herd appeared to feed almost exclusively on silage grass and oilseed rape adjacent to the river. During the breeding season, when *Ranunculus* started growing, aggressive behaviour by territorial cobs restricted the movements of non-breeders.

For each site we calculated *Ranunculus* growth rates and related these to swan presence. The number of swans present had a significant negative effect on biomass growth from May to July (see Figure 1). Biomass at some sites showed a steady decline. Where swan herds were active, this was more severe. At an 'average' site (ie. mid-range in terms of starting biomass), biomass in July was halved by the presence of just one swan between January and June. The comparative approach across sites suggested no impact of swan numbers on change in biomass from July to the end of September. However, we believe that we missed the dramatic effect of herds at sites where we were unable to sample biomass for practical reasons.

This was a preliminary study. We would like to see more work to clarify the impact of swans on *Ranunculus*. We would also like to know the ecological and hydrological consequences of the 'lost' *Ranunculus*.

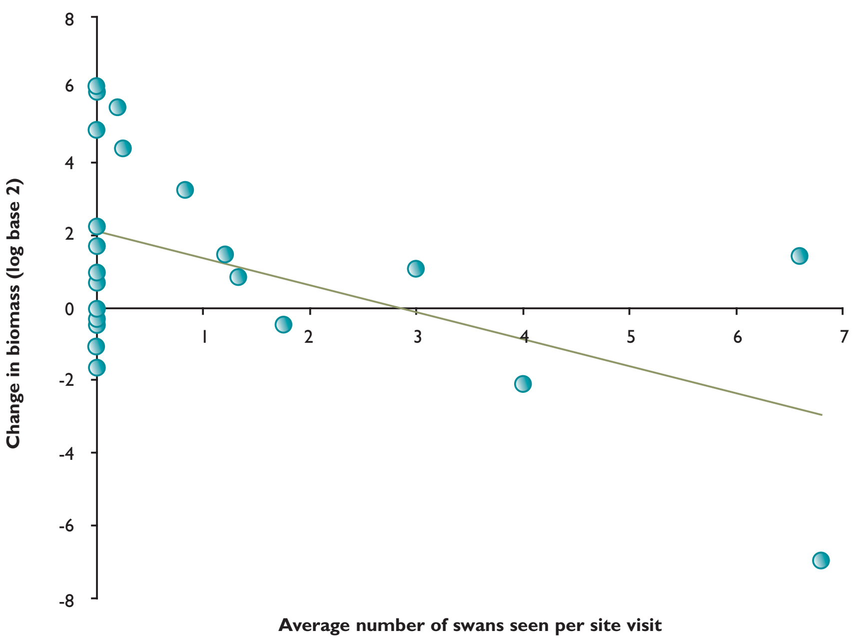


Figure 1

Relationship between *Ranunculus* growth and number of swans at two sites between July and the end of September

Acknowledgements

Thanks to the Environment Agency and Wiltshire Fisheries Association for supporting this work.

Upland ecology summary for 2005

Key achievements

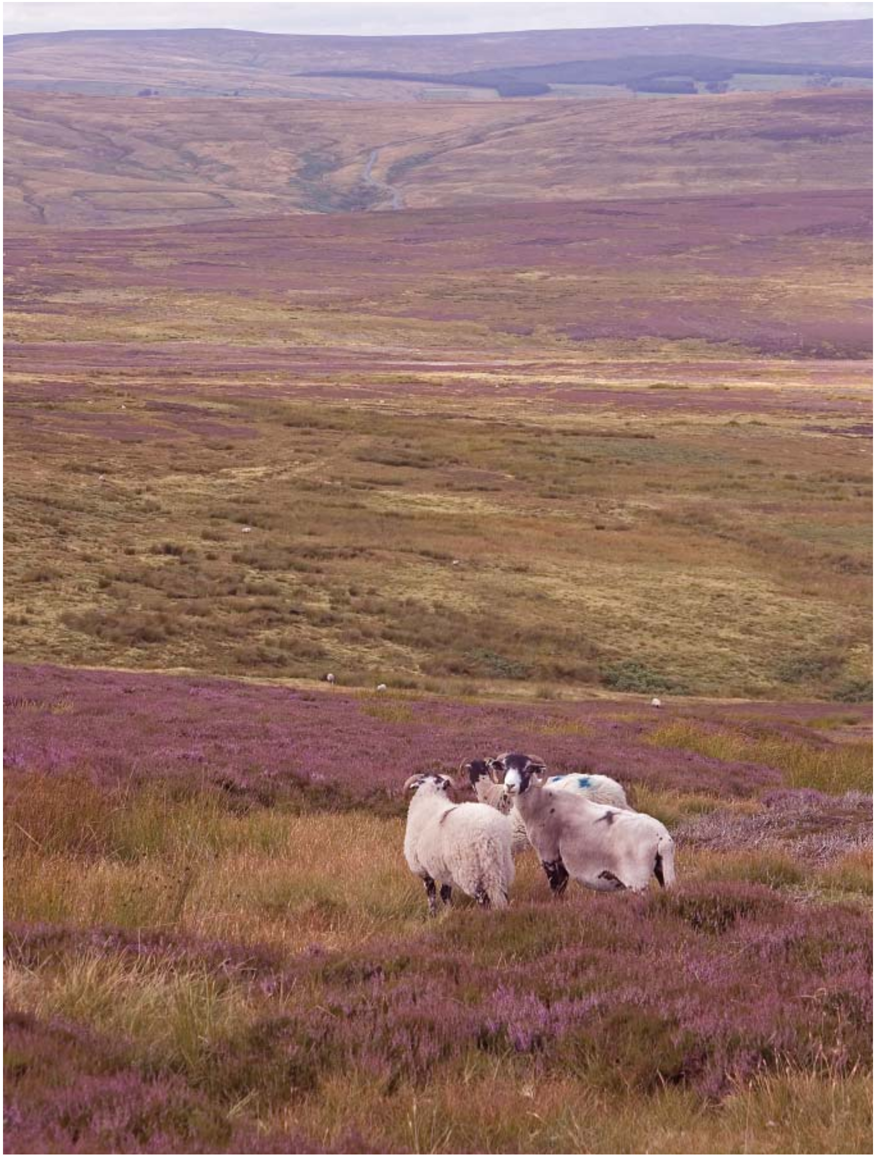
- Our research into disease came into sharp focus in a year when red grouse experienced one of the most dramatic and widespread population crashes caused by the strongyle worm.
- On-going research is combating strongyle worms and ticks.

David Baines

2005 was the year of grouse diseases. A mild, wet winter and spring in 2005 resulted in high survival of free-living larvae of the parasitic strongyle worm, *Trichstrongylus tenuis*. This, combined with high densities of red grouse, culminated in one of the most dramatic and widespread grouse crashes experienced in northern England within living memory. On some moors, birds started dying in mid-January, whereas others were still dying in late July. Monthly counts of worm eggs within grouse caecal droppings in autumn and winter 2005 indicate that worm burdens remain high in surviving grouse.

In Scotland, grouse densities generally remain low. Here, although strongylosis was evident on some moors, the greatest concern was the continued escalation in tick abundance. On many moors these ticks are vectors for louping ill.

The increased severity of parasite infection, whether it be by strongyle worms, ticks, or both, may be a product of progressive climate change with milder, more humid winters and early springs extending parasite activity and survival. Certainly, these weather patterns appear more common in recent years and if climate is indeed changing in this manner, then it may result in more and stronger outbreaks of strongylosis and extensions in altitudinal and geographical range of the tick and tick-borne diseases. Some have predicted that the range of red grouse may contract at the southern end of its range in England because of this, and moors at low altitudes everywhere may fare less well in terms of grouse production.



Grouse moor. (David Mason)

To avoid this, we are focusing greater attention on combating both strongyle worms and ticks. Several of our current and future research initiatives are concentrating on achieving a greater understanding and ultimately better control of these grouse diseases. Increased disease outbreaks may have repercussions for much of our other key work on biodiversity. This year we observed large numbers of strongyle worms in some of our Pennine black grouse, which also have *Heterakis* worms, a common nematode parasite of released pheasants. Meanwhile in Scotland, probable increased tick burdens on capercaillie, apparent through bald-headed adults seen during our annual counts, may in part account for a succession of poor breeding seasons.

Upland research in 2005

Project title	Description	Staff	Funding source	Date
Stongylosis research	*Developing strongylosis control techniques*	*David Newborn, David Baines, Mike Richardson*	*Core funds*	*2006-2011*
Grouse monitoring (see page 76)	*Annual long-term counts and parasite monitoring in England*	*David Newborn, David Baines*	*Core funds, Gunnerside Estate*	*1980 - on-going*
Black grouse research (see page 78)	*Ecology and management of black grouse*	*David Baines, Mike Richardson*	*English Nature, Private donors*	*1989 - on-going*
North Pennines black grouse recovery	*Black grouse restoration*	*Phil Warren*	*MoD, English Nature, RSPB, Northumbrian Water*	*1996-2006*
Release of low-ground gamebirds	*Effects of releasing on wild gamebirds of moorland and moorland margins*	*David Baines Annelie Jonsson*	*Various charitable trusts*	*2005-2006*
Upland Predation Experiment (see page 80)	*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*
PhD: Red grouse	*Grouse population dynamics in relation to shooting*	*Nils Bunnefeld Supervisors: David Baines/GCT; E J Milner-Gulland/Imperial College*	*John Stanley Trust*	*2005-2007*
PhD: Red grouse populations	*Grouse dispersal and mortality in relation to parasite management*	*Philip Warren Supervisors: David Baines/GCT; Dr C Thomas, Durham Univ*	*Private donors*	*2000-2005*
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/GCT; E J Milner-Gulland/Imperial College*	*ESRC*	*2005-2007*
Scottish grouse research (see page 76)	*Long-term monitoring of red grouse and worm burdens*	*Adam Smith, David Howarth*	*Scottish Trustees, Core funds*	*1985 - on-going*
Diversionary feeding of hen harriers	*Developing a hen harrier diversionary feeding trial*	*David Baines*	*SNH*	*2004-2005*
Mountain hare ecology	*Effects of supplementary feeding on mountain hare demography*	*Scott Newey*	*NERC*	*2005-2006*
Tick control (see page 86)	*Tick control in a multi-host system*	*Adam Smith, Scott Newey*	*Scottish Trustees*	*2000-2007*
Woodland grouse (see page 78)	*Ecology and management of woodland grouse*	*David Baines, Allan MacLeod, Martin Dalimer*	*The Dulverton Trust, LIFE, SNH, Forest Research*	*1991-2006*
Langholm	*Montoring raptors, grouse, voles, pipits, waders and foxes*	*David Baines Mike Richardson*	*SNH*	*1992 - on-going*
PhD: Muirburn	*Examining fire behaviour characteristics*	*Matt Davies Supervisors: Adam Smith/GCT; Colin Legg, Edinburgh Univ*	*NERC, Core funds, Scottish Trustees, SNH*	*2002-2005*
PhD: Tick ecology	*Spatial ecology of sheep ticks*	*Ellie Watts Supervisors: Adam Smith/GCT; Justin Irvine, CEH; Alan Bowman, Aberdeen Univ*	*NERC*	*2003-2006*

Key to abbreviations: LIFE = European Union Financial Instrument for the Environment; SNH = Scottish Natural Heritage; NERC = Natural Environmental Research Council; MoD = Ministry of Defence; RSPB = Royal Society for the Protection of Birds; ESRC = Economic and Social Research Council; CEH = Centre for Ecology & Hydrology.

Red grouse monitoring

Key findings

- Grouse numbers and breeding success crashed in northern England, but were similar to last year in Scotland.
- Very low summer worm pick-up rates were encountered in both Northern England and Scotland compared with 2004.
- Parasite control in the Pennines, northern England. improved both grouse breeding success and autumn densities, but not in the North York Moors.

David Baines
Adam Smith

Red grouse in Northern England

Red grouse numbers crashed in most of northern England in 2005. High grouse numbers in autumn 2004, together with wet and mild weather, allowed large increases in parasite burdens. We counted red grouse at 23 sites in spring and in July 2005 and analysed these data relative to the equivalent data on the same moors in 2004.

In spite of signs of strongylosis before spring counts, with large numbers of birds being picked up dead from mid-January onwards, there was no difference in spring densities between the two years, with an average of 70 birds per 100 hectares. The percentage change in the number of adults between spring and July counts is an index of adult mortality; and the loss was 52% in 2005 compared with 14% in 2004.

Breeding success was a third lower in 2005 than in 2004, with an average of 1.56 young grouse per surviving adult compared with 2.38. Lower breeding success resulted in lower July densities, with an average of 89 birds per 100 hectares (adults and young) compared with 220 in 2004 (see Figure 1).

Strongylosis was worst on the North Pennine moors and mildest on the North York Moors. Within regions, breeding success was generally 55% higher on moors where parasites were controlled, with an average of 1.9 young per adult compared with 1.2 where parasites were not controlled. July grouse densities (adults plus young) were 40% higher, with an average of 118 birds compared with 84 (see Table 1).

Few estates had a full shooting programme in 2005 and many had none at all. Consequently, we could only assess worm burdens from five of our 10 long-term sample moors, all of which used medicated grit. A comparison of the moors sampled for worms in both 2004 and again in 2005 showed no significant difference in worm burdens among adult grouse, but six-fold fewer worms in young birds (see Figure 2).

Figure 1

Average density (per 100 hectares) of young and adult grouse in July using dog count data from 25 sites in northern England 1990-2005

Young

Adult

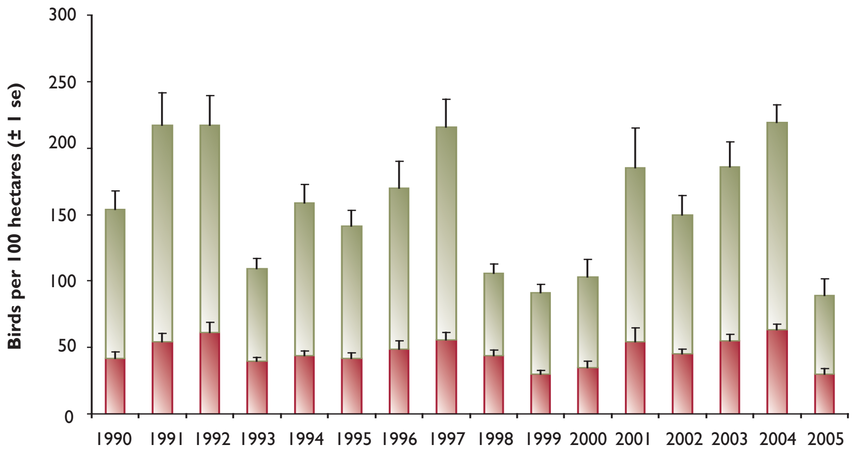


Figure 2

Mean worm burdens in adult and young grouse on 10 moors in northern England 1990-2004 and five moors in 2005

Adult

Young

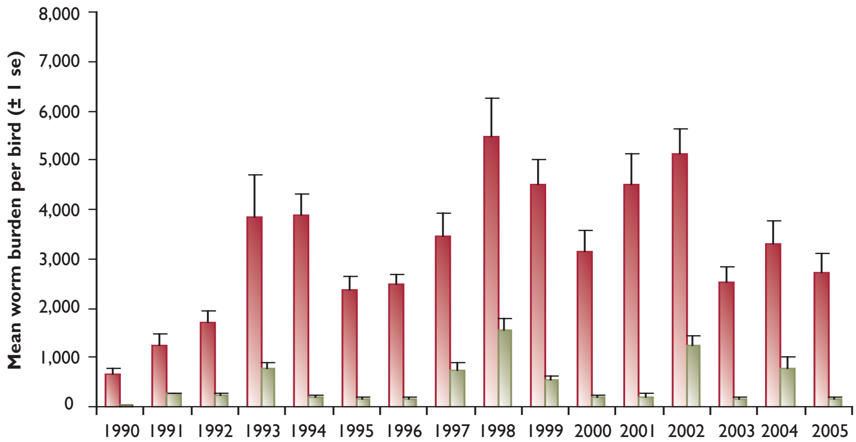
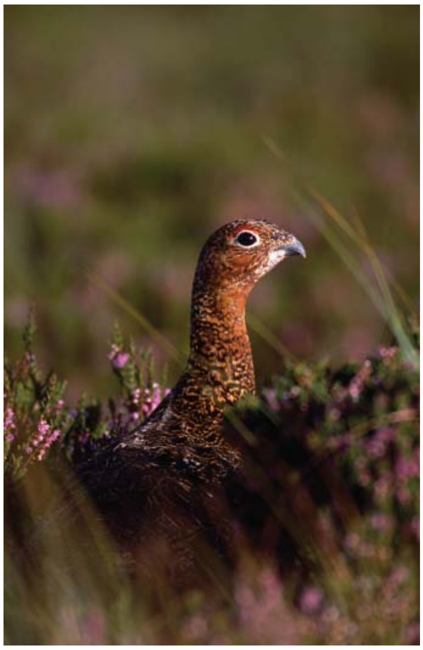


Table 1

Mean (± 1 se) red grouse breeding success (young-to-old) and July densities (young and adult birds per 100 hectares) on 28 moors in Northern England in 2005 in relation to their parasite control management. Numbers of moors are given in parentheses

	Young-to-old		Density	
Region	**Control**	**No control**	**Control**	**No control**
South Pennines	(6) 1.20 (0.28)	(5) 0.68 (0.31)	84 (27)	64 (30)
North Pennines	(6) 2.02 (0.28)	(7) 1.05 (0.26)	136 (26)	24 (25)
North York Moors	(2) 2.19 (0.49)	(2) 2.12 (0.49)	135 (47)	163 (47)



Red grouse had a testing year in 2005. (Laurie Campbell)

Scotland

We counted grouse on 41 sites in Scotland in 2005 and obtained comparable figures for 2004 and 2005 from 23 sites (see Figure 3).

The poor productivity in 2004 meant that few new birds were recruited and average numbers of spring pairs in 2005 were similar to those in 2004 (12 per 100 hectares compared with 13 in 2004). There was no difference in grouse productivity, the average young-to-old ratio changing from 0.9 in 2004 to 1.0 in 2005. The long-term trend over 20 years suggests little change except a cyclic one.

Strongyle worm counts

We monitor shot grouse on five moors in Scotland each year to assess strongyle worm burdens. Worm burdens in adult grouse were at their lowest for six years although there was little difference between 2004 and 2005 (see Figure 4). Burdens in young grouse in 2005 were very low, probably because of drier weather reducing worm up-take.

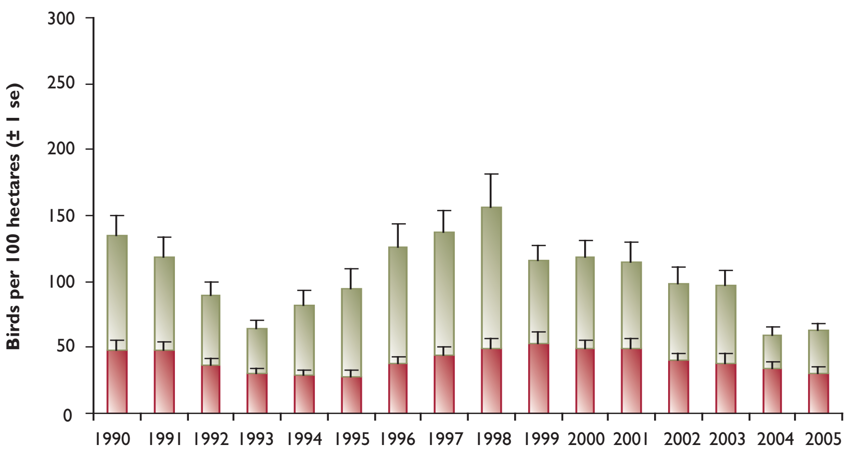


Figure 3

Average density (per 100 hectares) of young and adult grouse in July/August from 23 sites in Scotland 1990-2005

Young

Adult

Note: these data include only one moor south of the Scottish central belt.

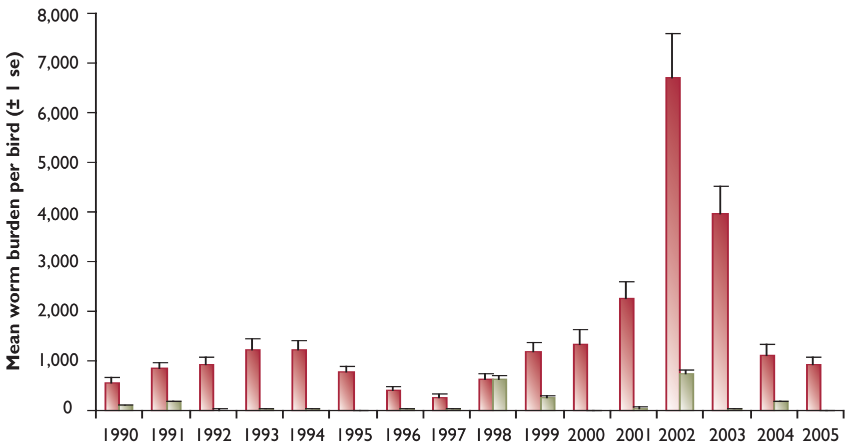


Figure 4

Mean strongyle worm burdens from shot grouse (young and adults) sampled at five moors in Scotland 1990-2005

Adult

Young

Black grouse and capercaillie

Key findings

- Latest black grouse surveys show stability in England, increase in Wales and decline in Scotland.
- We have provided management advice on 75% of black grouse range in England.
- Capercaillie breeding success in 2005 was more than double that in 2004.

David Baines

Current status of black grouse in the UK

A survey of randomly selected five-kilometre grid squares within the known and historic range of black grouse in 1995/6 estimated a UK population of 6,510 lekking males. Of these 4,660 were in Scotland, 1,700 in England and 150 in Wales. Results from the 2005 repeat UK survey revealed stability in England, a 39% increase in Wales, but a 29% decline in Scotland over the last 10 years. Scotland still supports two-thirds of the UK's black grouse, but declines have been severe in south-east (-69%) and south-west Scotland (-49%), with only northern Scotland remaining stable. A revised estimate of black grouse in Scotland is now 3,344 males, with 1,521 in England and 213 in Wales, providing a combined UK total of 5,078 males.

Grouse moor management appears to be an important factor in the conservation of black grouse. In England, 90% of black grouse live on the fringes of grouse moors, in Wales 50% are found where gamekeepers control predators, and in Scotland, the only region where numbers have remained stable (north-east) is typified by intensive grouse management.

Black grouse recovery in England 1996-2005

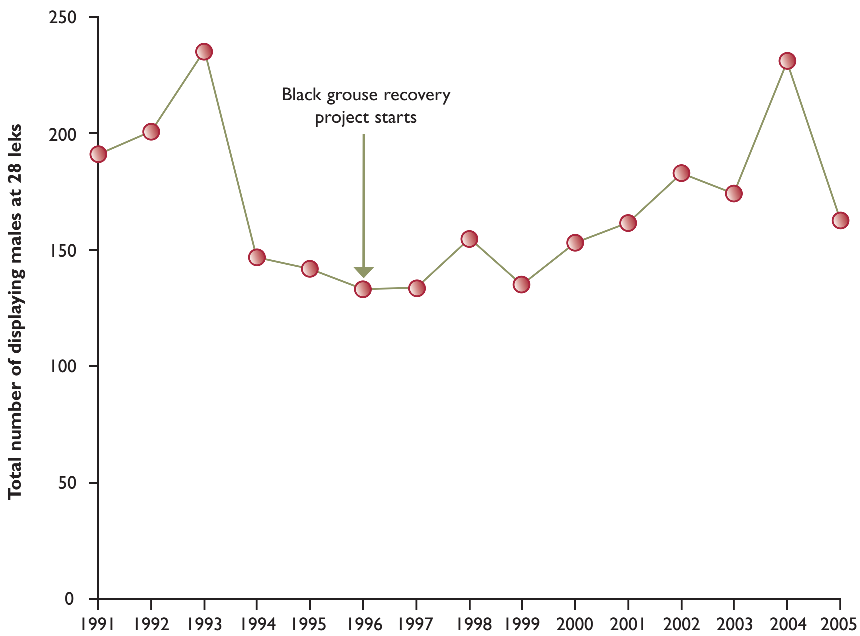
In England, our black grouse recovery project has delivered its primary BAP objective of halting the bird's decline. National surveys in 1998 and 2002 revealed a stable range and a modest increase in numbers from 789 lekking males in 1998 to 893 in 2002. These population sizes for England are based on full lek surveys, rather than partial surveys of only a few sample squares as described above in the UK survey. Accordingly, despite being considerably smaller, these population estimates are more accurate. This success has been achieved by demonstrating that black grouse respond positively to appropriate management. We have given management advice to about 75% of land within the current black grouse range. We have also developed successful working partnerships with the private and statutory bodies within the region to facilitate habitat enhancement and influence land use policies to incorporate black grouse needs. The profile of black grouse, which is now an iconic species in the North Pennines, is that of an indicator of high quality upland landscape.

Black grouse recovery in England 2006-2011

Although the decline in England has been stemmed, the population range is small: 63% of the English population is confined to just three North Pennine Dales – Teesdale, Weardale and South Tynedale. Our surveys show that although this core is robust

Figure 1

Number of black cocks attending 28 leks in northern England 1991-2005



In 2005 Scotland's capercaillie hens produced more than double the number of chicks than they did in 2004. (Laurie Campbell)

and even getting stronger (see Figure 1) the current distribution is at best only being maintained. Population fragmentation and isolation is evident on its southern and northern fringes, where some lekking groups continue to decline despite habitat improvement. Accordingly, the population in England has now fragmented into at least two isolated sub-populations. The long-term sustainability of black grouse in England is dependent on consolidating and expanding the range. The revised BAP objective to expand the current range in northern England depends on implementing three project components: a five-year extension of the existing recovery project; translocation of surplus males from donor sites in the core of the range; and an application to Heritage Lottery Fund to expand the range of black grouse in north-west Northumberland.

The proposal has been well received by our current project partners and we anticipate starting a new phase of work in spring 2006.

The core of the black grouse population is robust, but its distribution is fragmented. (Laurie Campbell)

Capercaillie

During our annual capercaillie brood counts in 2005, we found 94 capercaillie hens and 68 chicks in 20 sites across Scotland. 35% of capercaillie hens reared broods with a mean brood size of 1.65 chicks and breeding success was 0.72 chicks per hen. The capercaillie productivity varied regionally from 0.56 chicks per hen for Easter Ross and Moray through 0.74 for Strathspey, 0.82 for Deeside and Donside, to 1.25 for Perthshire sites.

Capercaillie breeding success across Scotland in 2005 was more than double the 2004 figure of 0.31 chicks per hen (see Figure 2). However, the 2005 estimate remains below the level required to maintain a stable population if significant mortality is still occurring from fence collisions, but is sufficient if those losses are now insignificant.

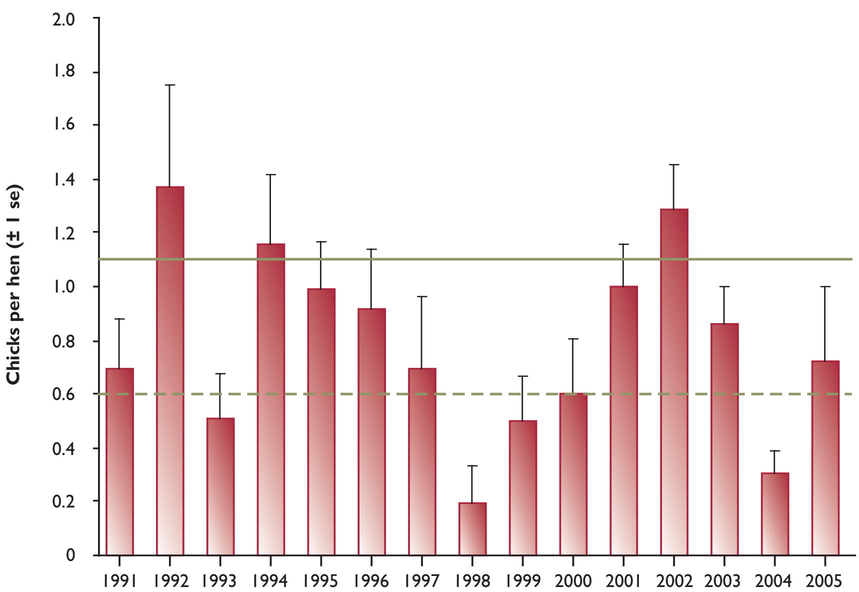


Figure 2

Capercaillie productivity (chicks per hen) 1991-2005

— Chicks per hen required to maintain population where fence collision is a threat

– – Chicks per hen required to maintain population where no fence collisions occur

Predator control and ground-nesting waders

2005 was the sixth year in our Upland Predation Experiment based at Otterburn in Northumberland. This project, funded by the Uplands Appeal, aims to test whether predator removal by grouse moor 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 in this debate. 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 that remain 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

The red grouse is flourishing on plots where predators are controlled. (Laurie Campbell)

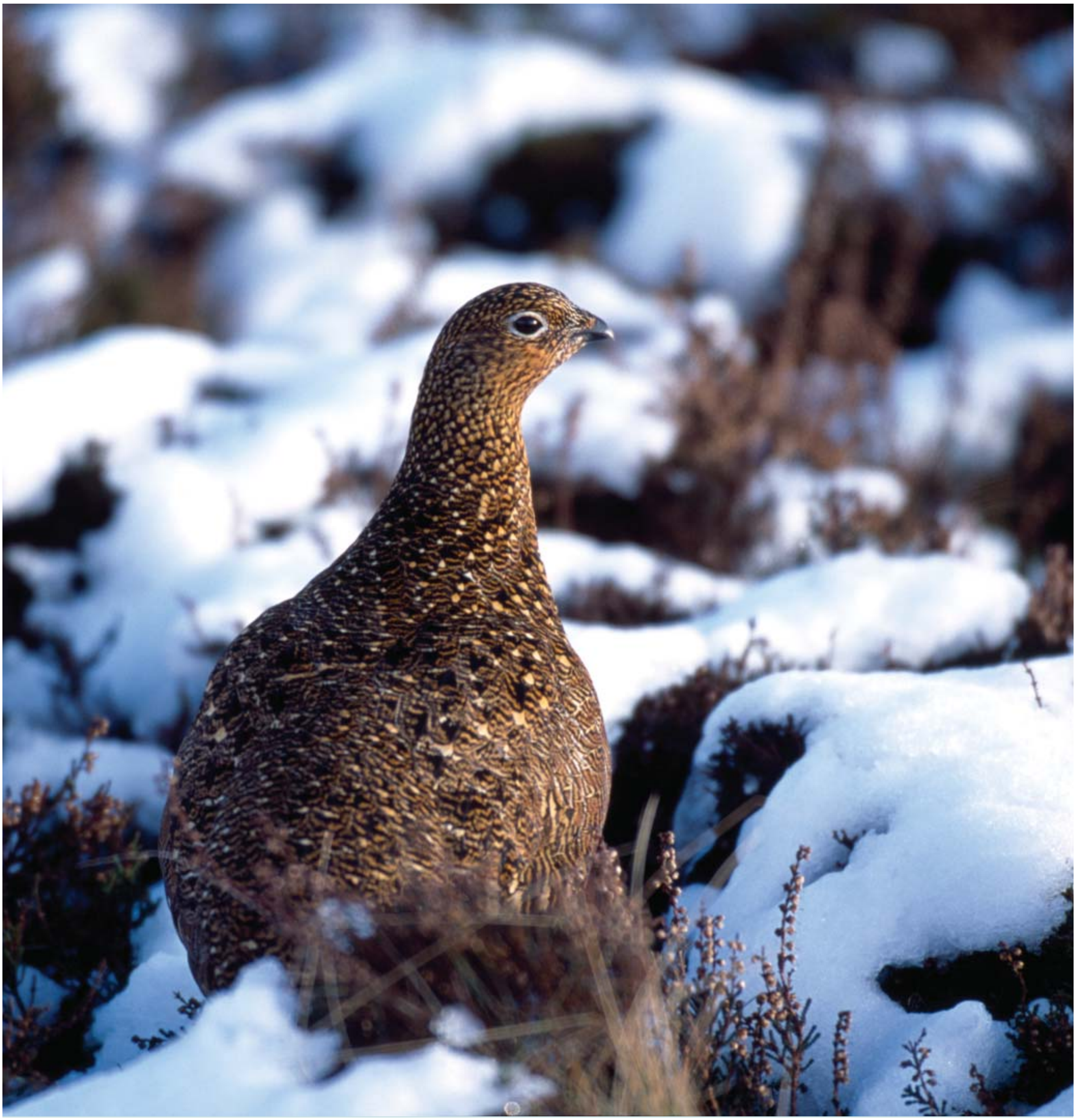


Figure 1

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

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.

Table 1

Spring pair counts in the Upland Predation Experiment, 2000-2005

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

b. Ray Demesne plot (keepered autumn 2000-2005)

	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

c. 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

d. Emblehope plot (unkeepered 2000-2005)

	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

Key findings

- The Upland Predation Experiment has passed the half-way stage so we are starting to see trends in the data, but no firm conclusions can be drawn until the end of the project.
- Gamekeepers continue to appreciably reduce abundance of foxes and crows on the long-term keepered site and on the newly keepered site. Fox and crow abundance on the newly unkeepered site have increased but have not yet returned to pre-keepering levels.
- Waders and meadow pipits show a trend for greater breeding success on sites with predator removal. However, the trend in numbers is not yet clear.
- Red grouse breeding success was poor in 2005, possibly owing to the presence of strongylosis. However, on the new keepered plot a three-fold increase in young per hen was recorded.

Kathy Fletcher

Figure 2

Otterburn plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2005 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered

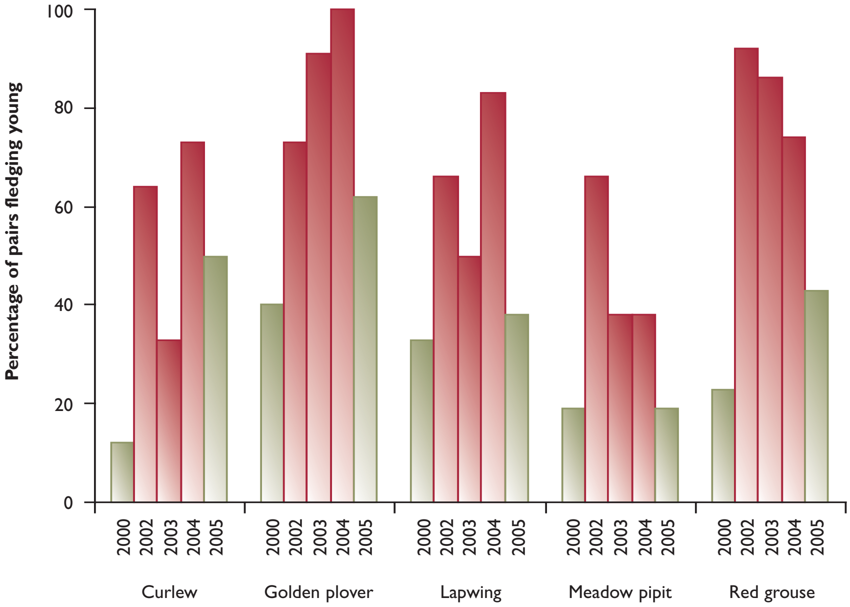
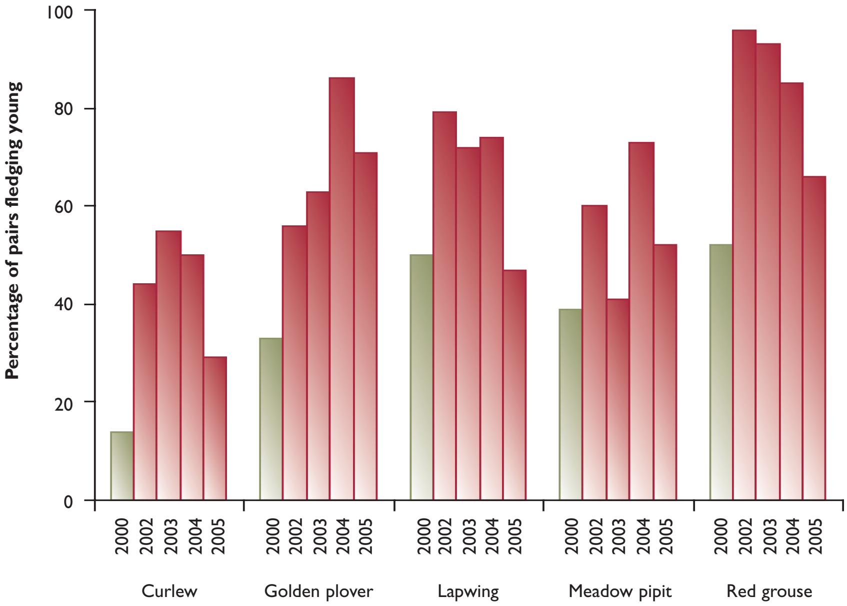


Figure 3

Ray Demesne plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2005 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered



Predator indices from 2005 on Ray Demesne continue to suggest low numbers of all the main predators. The start of keepering on Bellshiel in September led to 80% fewer foxes and 60% fewer crows by the following spring compared with the average during unkeepered years. The stopping of predator control on Otterburn was linked to an increase in foxes (70%) and crows (50%). However, abundance is still at least 40% lower than recorded in 2000 before keepering started. Although stoats and weasels are also culled on the predator removal plots, the abundance indices are not showing consistent trends. The abundance of large birds of prey (peregrine, hen harrier, goshawk and buzzard) has increased four-fold on all plots except Emblehope. However, most of the increases are in buzzards, which seem to feed mostly on rabbits.

In the years with predator control on Ray Demesne, out of the 174 pairs of curlew, golden plover and lapwing, 58% fledged chicks compared with 28% fledging chicks of 39 pairs in 2000 without predator control (see Figure 3). On the unkeepered Emblehope plot, only 11 pairs out of 47 pairs of waders fledged young over the same period (23%, see Figure 5). In 2005, there was a small reduction in breeding success on Otterburn after predator control stopped (see Figure 2), but success was still better than in 2000. It seems that predator numbers have not yet returned to control levels. The numbers of breeding pairs of waders in 2005 were similar to previous years (see Table 1). Compared with numbers of breeding pairs in the baseline year, there is a suggestion of a small increase in golden plovers on Otterburn and lapwings

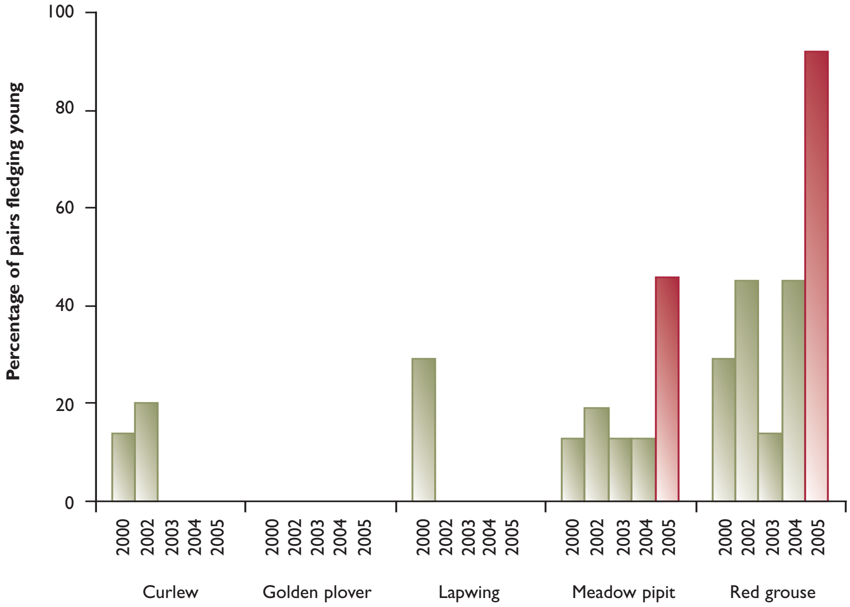


Figure 4

Belshiel plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2005 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered

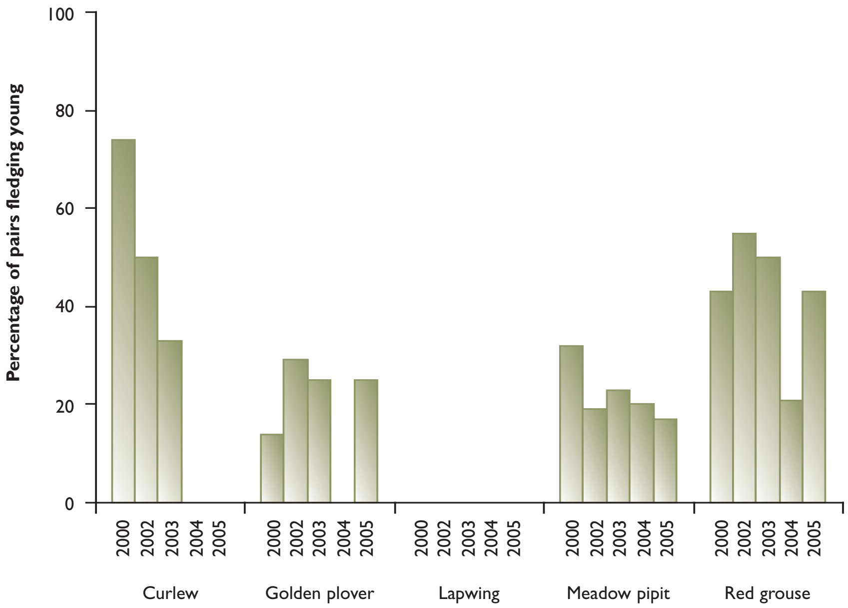


Figure 5

Emblehope plot: percentage of pairs that fledged young for curlew, golden plover, lapwing, meadow pipit and red grouse, 2000-2005 (no data for 2001 owing to Foot & Mouth Disease)

Keepered

Unkeepered

on Ray Demesne, but curlews have declined on all plots (see Table 1). Meadow pipits continue to breed better with predator control, but the small number of nests that we find in each year (on average 60 nests across the four plots) means this trend will only become clear with more data (see Figures 2-5). Trends in meadow pipit abundance are not yet clear with respect to predator control.

For red grouse, breeding success in 2005 was low, particularly on the plots with high spring densities. The average young per hen was just 2.5 on Ray Demesne (see Figure 3) compared with an average of 4.3 in the previous years. On Otterburn there were half as many hens with broods, and a reduction of 60% in young per hen, compared with years with predator control (see Figure 2). It is difficult to know yet how much of this reduction was due to strongylosis as well as increased predation. In contrast, on Bellshiel 92% of hens had broods (compared with a previous average of 40%) and there were almost three times as many young per hen as in the year with no predator control (see Figure 4). There were no grouse shot in 2005 and medicated grit will be used to reduce strongyle worm burdens on all four plots in 2005/06.

At this point in the project, the trends in breeding success suggest that predator removal may benefit at least some species of ground-nesting birds in addition to red grouse. The numbers of pairs of most species on the sites are small and therefore firm conclusions are not possible until the experiment has finished.

Irish hares fit Scottish bags

Key findings

- Abundance of Irish hares fluctuated between 1986 and 1995, but showed no consistent trend up or down.
- Population fluctuations of hares in Ireland mirror National Gamebag Census data for the same species in Scotland.
- The Northern Ireland data illustrate population fluctuations characteristic for this species.

Jonathan Reynolds

In January 2004, Angela Smith, Parliamentary Under-Secretary of State in the Northern Ireland Office, and Minister for the Department of the Environment, imposed a Special Protection Order under the 1928 Game Preservation Act (NI) to protect Irish hares in Northern Ireland. She cited concerns that the hare population had declined and was at very low density. The Order was for 12 months, and would 'buy time' for survey work in spring 2004 and further consideration of the status of the species.

Are hares really at low density in Northern Ireland? What density should we expect? There are no sound estimates of abundance in Northern Ireland from earlier epochs. In 2000, regional surveys in Antrim and Down estimated density at between 0.5 and 3.0 hares per 100 hectares, the higher figures representing upland areas with rough grazing. The Northern Ireland Hare Survey – carried out by Queen's University, Belfast for the Environment Heritage Service – was instigated in 2002, and repeated in 2004 and 2005. The highest estimate of density (in 2004) was 6.0 hares per 100 hectares across all habitats. Such densities are indeed low by comparison with managed heather moors with predator control in Scotland. There bags can exceed 50 hares per 100 hectares even across estates of more than 10,000 hectares, demonstrating that densities can touch at least this level in peak years. In Scandinavia, though, natural densities in boreal forest fringes would be only two to five hares per 100 hectares (six times this in the absence of foxes). In Northern Ireland, only 36% of land area is semi-natural habitat, so low hare density here may well imply a landscape that is degraded from the hare's point of view, where the better patches of habitat are isolated, and where natural predators are common. But it does not imply unsustainability. To make that case, one needs evidence of a biologically significant decline in abundance.

The only time-series available (actually a rabbit survey in which Irish hares were incidentally recorded) had been claimed to provide evidence of a decline in hare numbers. We re-analysed these data, and showed that although they suggested fluctuations in abundance between 1986 and 1995, there was no consistent trend up or down. For comparison, we then examined our National Gamebag Census (NGC) data for the mountain hare in Scotland. The Irish hare and the Scottish mountain hare are sub-populations of the same species – *Lepus timidus* – which occurs across northern Europe and Siberia. Those in Ireland and mainland Britain were isolated 10,000 years ago by the rise in sea level that created the British Isles. Population fluctuations are characteristic of the species throughout its range, and these can appear to be synchronised across regions. One plausible explanation is that they are caused by parasites and synchronised by weather patterns. NGC bag records for *Lepus timidus* in Scotland have shown large fluctuations (see Figure 1).

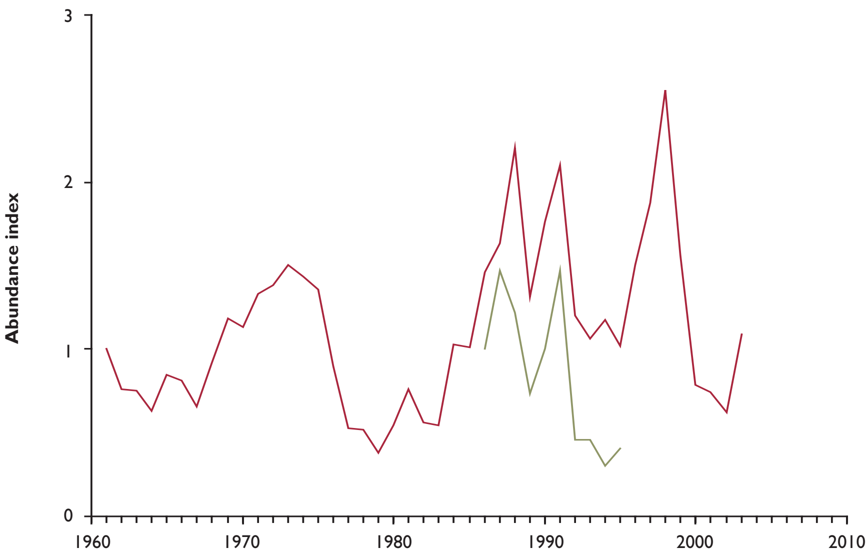
Figure 1

Abundance indices for the hare *Lepus timidus* in Northern Ireland (survey data) and Scotland (National Gamebag Census data).

Northern Ireland

Scotland

Index values are multiplicative effects relative to the start of each series (1961 for Scotland and 1986 for Northern Ireland). Site effects have been removed in calculating the indices. Strong fluctuations lasting several years are characteristic of the Scottish series and, where the Irish hare data are available, the match is striking.



Where the Northern Ireland data overlap this series, the fluctuations fit almost perfectly. The Northern Ireland data therefore seem merely to illustrate population fluctuations that are characteristic of *Lepus timidus*.

Ironically, the Northern Ireland Hare Survey in spring 2004 following the Protection Order found that hares were nearly six times as common as in 2002, whereas that in 2005 found hares to be at three times the 2002 level. At the time of writing, the Order has lapsed, and no further decision had been taken about the future status of the Irish hare. Realistically, too little is known yet to decide whether there is a problem for this species and, if so, whether any possible course of action can remedy it.

A paper on this subject has now been accepted for publication in the *Journal of Zoology*.

Looking at the evidence, it seems that the Irish hare is experiencing a natural cycle in its population, not a crash as has been suggested. (Laurie Campbell)

Are sheep ‘tick-mops’ effective in Scotland?

Key findings

- The use of sheep as ‘tick-mops’ may reduce tick biting rates on grouse chicks where deer densities are lower than five per 100 hectares.
- Red deer densities of 10 per 100 hectares appear to be too high for ‘tick-mops’ to be effective.

Adam Smith

Two studies by us, one in Yorkshire and the other in Morayshire, have been used to support increased tick control on sheep (four treatments with insecticide and vaccination against louping ill virus where appropriate) on many estates in Scotland. But there are few data on how effective this is in relation to other tick hosts, particularly red deer.

We tracked the effects of using these intensively-treated sheep on tick biting and grouse productivity on three moors in Glen Truim, Strathspey between 2002 and 2005. Tick biting rates on grouse on these moors vary between three and 30 ticks per chick. Between 8% and 65% of mountain hares on these sites had been bitten by ticks carrying louping ill. Treated sheep at a density of 50 per 100 hectares were put onto the ‘high deer’ moor in 2002 where deer numbered 10 per 100 hectares. Treated sheep were put on to the ‘low deer’ moor in 2003 where deer were at a density of five per 100 hectares. The ‘control’ moor was an area where sheep treatment was not intensive and where host densities were stable.

We saw a 25% reduction in tick biting rates on grouse chicks on the low deer moor since the introduction of the treated sheep in 2003 (see Figure 1). Accepting that 2004 was a year of overall low grouse productivity in this area, the trend on the low deer moor was for grouse productivity to increase by 30% during the period of sheep treatment (see Figure 2).

There was generally low grouse productivity on the two other moors (see Figure 2). The apparently low tick burdens and high productivity in 2005 on the control moor and low tick burdens 2004 on the high deer moor may reflect that in each case only two broods were caught for tick biting assessment. On the control moor there were only two broods found in 300 hectares of moor; in the case of the high deer moor only two broods of chicks were found in 200 hectares. Overall it appears that large tick burdens and the continuing presence of louping ill has prevented the treated sheep flock, introduced in 2003 on the high deer moor, from reducing tick burdens on grouse chicks (see Figure 1).

Tick burdens may not be reduced if the treatment of the sheep is ineffective. We monitored the efficacy of the sheep treatment regime on the high and low deer moors by counting ticks on both treated sheep and a population of sentinel sheep purposefully left untreated. With the exception of one treatment period on one moor, the acaricide-treated sheep had lower numbers of ticks than the untreated sheep. The continuing presence of ticks on the treated sheep draws attention to the need for high standards of application and for a realistic assessment of the length of time that the treatment gives effective coverage.

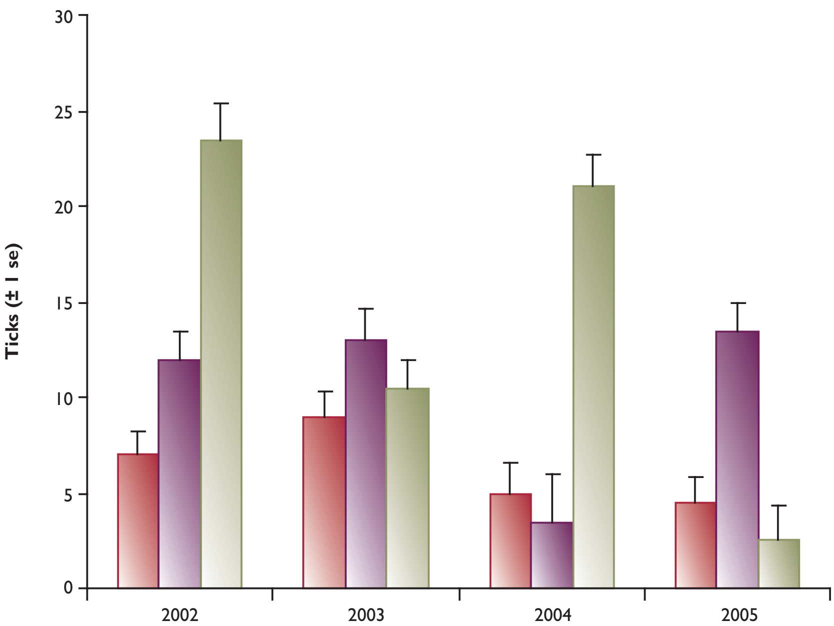
Figure 1

Mean ticks (all stages) on grouse chicks caught on the study moors 2002-2005

Low deer moor

High deer moor

Control



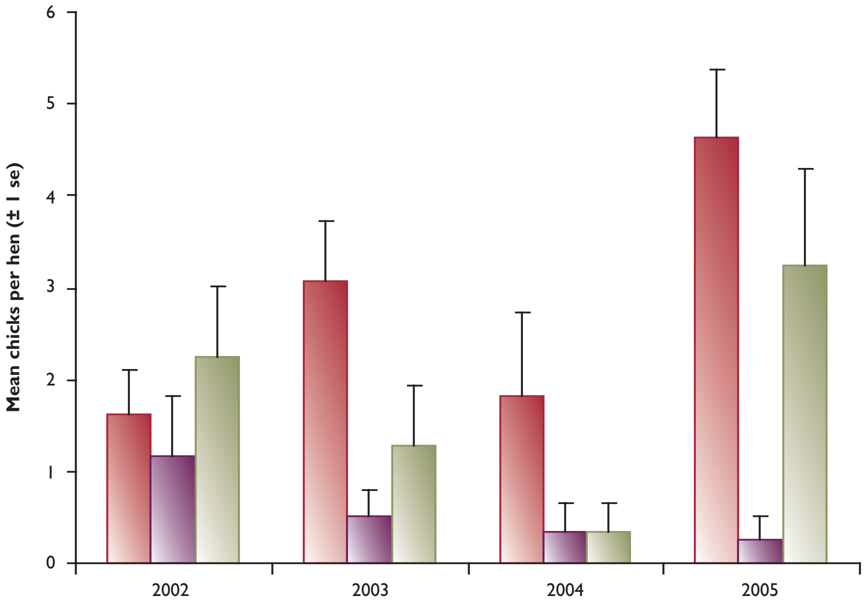


Figure 2

Average number of red grouse chicks per hen on the Glen Truim study moors 2002-2005

Low deer moor

High deer moor

Control

We think that low numbers of deer and hares are unlikely to prevent treated sheep from slowly 'mopping up' ticks on grouse moors, but that high densities of deer may do so. We still need more experiments to find out which are the key hosts that must be controlled to make 'tick mopping' with sheep effective.

Sheep can be effective 'tick-mops' if there are low densities of other host mammals. (Laurie Campbell)

Red grouse success and climate change

Key findings

- Severe weather at the wrong time of year (usually during the early chick period) can reduce grouse productivity.
- We can see the effects of short-term changes in weather in grouse breeding dates.
- Climate change may affect grouse productivity through modifying effects such as parasitism, predation and food quality.

Adam Smith

Until recently, observation of the effects of climate change in the uplands has focused on the likely expansion or contraction of some species of conservation concern such as moss campion or dotterel. However, climate change could be affecting red grouse. It has been suggested that wetter conditions could increase the pick-up of gut worm parasites leading to reduced grouse productivity or even that red grouse become heat stressed above the 8°C mean annual isotherm, and that this isotherm is moving north and uphill. Although unproven, these hypotheses suggest ways in which climate could affect grouse. Chance weather events affect grouse productivity when these occur at critical periods in the lifecycle, such as when chicks are present. But these chance weather events may also be entrained in longer trends in climate.

We attempted to account for this when we investigated whether grouse have begun to nest earlier. We collected nesting data from radio-tagged red grouse for 15 years and these data suggest that there has been a trend towards earlier hatching in Strathspey (see Figure 1) with earlier and later hatching years being linked in turn to cooler and warmer springs. But by back-calculating hatching dates using chick weight in July, we found no discernible trend over 20 years, even though these two data sets were correlated over the last 15 years (see Figure 2). This correlation, together with sampling periods and chick survival patterns that support such analysis, suggests that this longer term trend is robust.

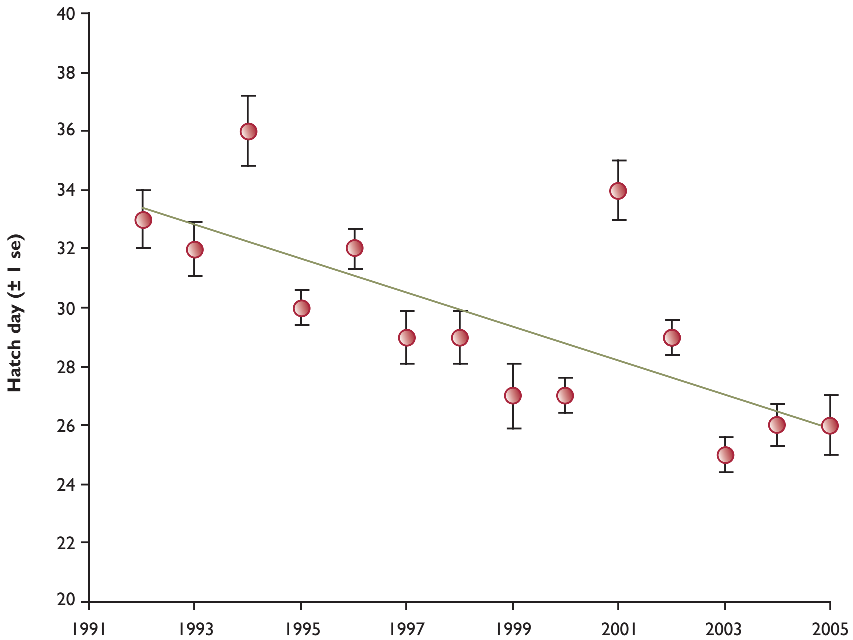
However, there are also likely to be indirect effects of climate change: for example through changes that affect tick host number and distribution. In conjunction with milder weather that promotes a longer tick-feeding season, climate change may be one of the forces resulting in an increase in ticks biting grouse chicks in Scotland over the last 20 years (see Figure 3).

Although there is some evidence that weather events affect grouse, we cannot show that climate change has directly affected grouse biology. We do know that British moors have been subject to varying levels of grazing, predation and grouse parasites, all of which can reduce grouse productivity and that it is possible that climate change may magnify these effects. However, we find that grouse productivity and density can be at their highest on our southern low altitude moors, which are intensively managed, whereas on moors which are neither the highest nor the most northerly within Scotland or England. This is counter to what you would expect if climate was of over-riding importance and suggestive of the continuing importance of intensive moorland management for successful grouse production.

Figure 1

Hatching dates of observed nests in Strathspey, 1991-2005

Evidence from directly observed nests suggests that grouse clutches have been hatching earlier in Strathspey over the last 15 years. These hatch dates are strongly associated with mean April temperature. Hatch day 1 = 1 May; hatch day 32 = 1 June.



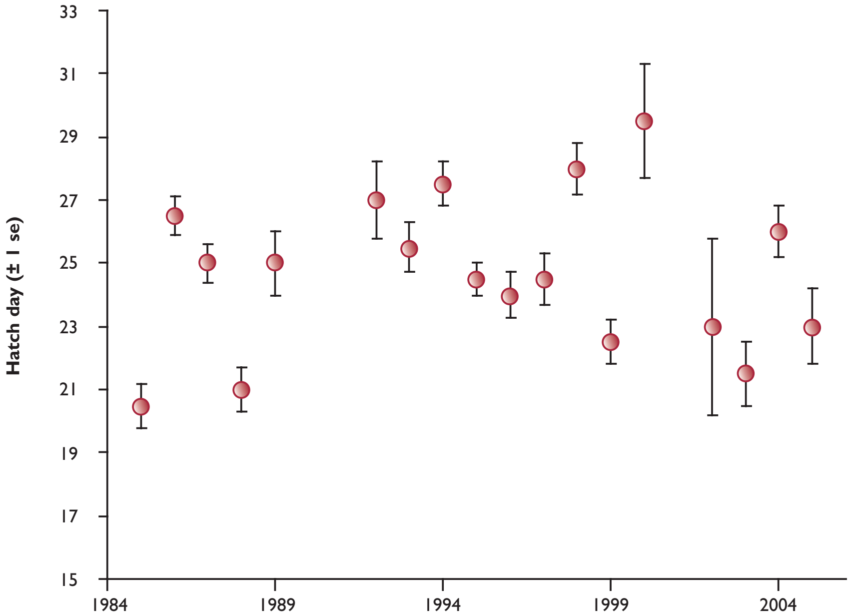


Figure 2

Predicted hatching day calculated from chick size in July

Evidence obtained by back-calculating from chick size in July suggests that there is actually little discernible pattern in hatch date over the last 20 years. Hatch day 1 = 1 May.

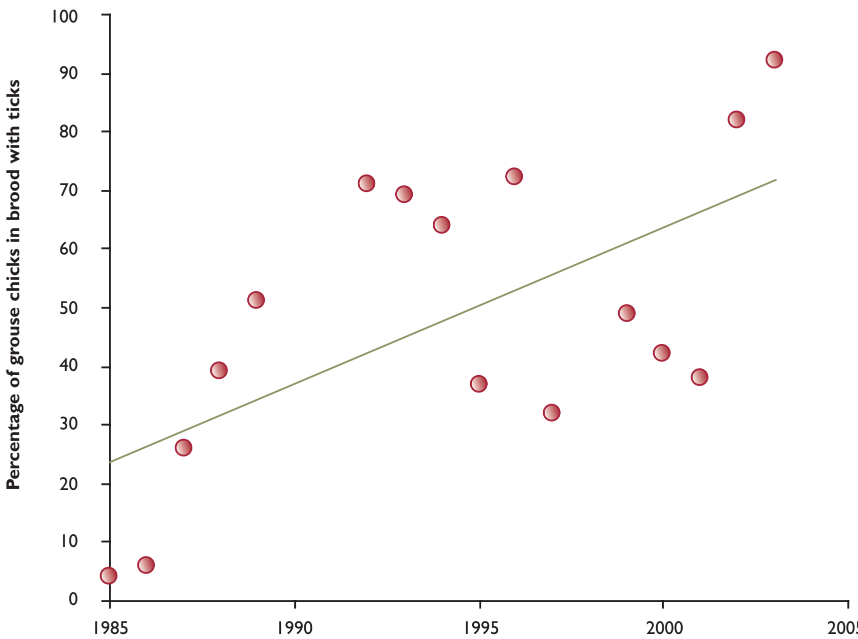


Figure 3

Proportion of chicks carrying at least one tick

The proportion of chicks in a grouse brood with at least one tick on it on our study moors has increased by 55% in the last 20 years.

Evidence of climate change affecting grouse is weak. (Laurie Campbell)

Waders and grouse moors in the Peak District

Key finding

- Golden plover and dunlin are more likely to be found on keepered land than unkeepered land in the Peak District.

Julie Ewald

Golden plover are more common on grouse moors than on other moorland in the Peak District. (David Mason)

The moorlands of the Peak District National Park are designated as a Special Protection Area owing to their national and international importance mainly for waders. This designation is at least partially due to the results of a 1990 survey of upland breeding birds undertaken by English Nature. In 2004, the Moors for the Future Project (a partnership project aimed at restoring large parts of some of the

Figure 1

Percentage of grouse moor and of other moorland that had breeding pairs of different birds in 2004. Significant differences are shown by asterisks.

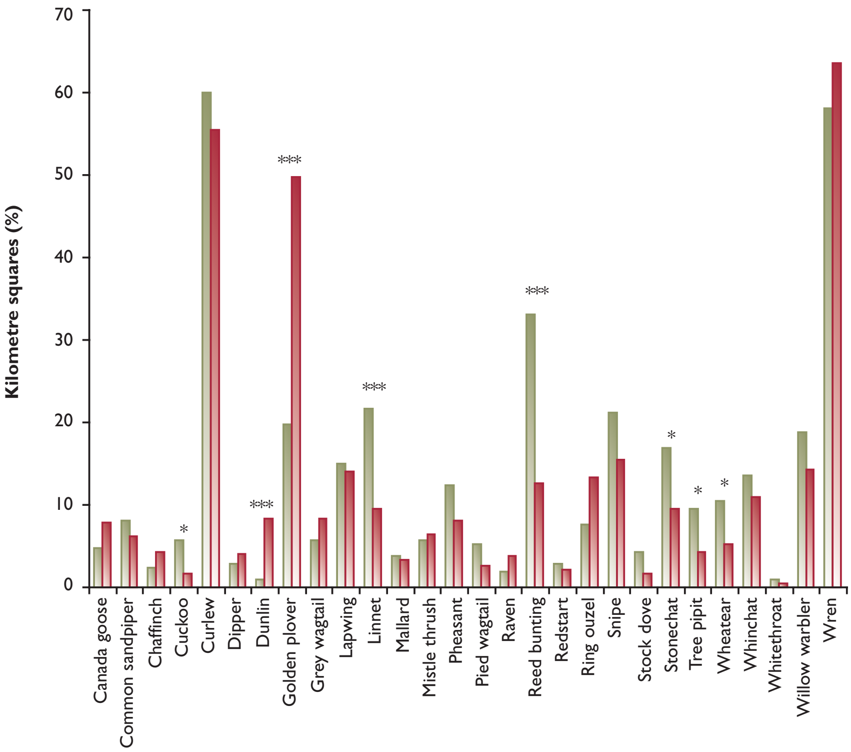
Grouse moor

Other moorland

Significant difference P < 0.05 *

Significant difference P < 0.01 **

Significant difference P < 0.001 ***



Peak District moors) conducted the first full repeat of the 1990 survey and published a report of the findings in the spring of 2005. Moors for the Future and English Nature have kindly allowed us access to this information to compare breeding birds in relation to the management of moorland for grouse, collected through the Mapping Countrysports Project (see *Review of 2003*, page 40-41).

The 2004 survey covered 39 species of breeding birds, more than the 1990 survey, which covered 27 species. The data analysed here are based on one-kilometre squares across the area and, in the case of the 2004 data set, are restricted to those species where over 15 individuals were counted in the survey. Using one-kilometre squares allowed us to compare not only the number of birds on and off grouse moors, but also to examine both the 'range' of each species and the retention or loss of range between 1990 and 2004.

The area managed as grouse moor covered more of the 2004 range of dunlin and golden plover than would be expected by chance alone, whereas the area not managed as grouse moor covered more of the 2004 range of cuckoo, reed bunting, stonechat, tree pipit and wheatear (see Figure 1). Comparison of the 1990 survey data with that collected in 2004 showed no significant differences in the retention or loss of bird species, but there were significant differences in the extension of the range of some species. Areas managed as grouse moors showed an extension in the range of golden plover, whereas areas not managed for grouse showed an extension in the range of reed bunting and wheatear. The densities of red grouse and meadow pipit were significantly higher in kilometre squares managed for grouse.

The analysis reported here does not take habitat into account. We, along with Moors for the Future, are currently undertaking further analysis that will do so.

Acknowledgements

Thanks to Moors for the Future, English Nature, the Countryside Alliance, the National Gamekeepers' Organisation, and the Peak Park Moorland Owners and Tenants Association.

There is a positive relationship between dunlin and moors managed for grouse in the Peak District. (Laurie Campbell)

Scientific publications in 2005

by staff of The Game Conservancy Trust

Alexander, CJ, Holland, JM, Winder, L, Woolley, C & Perry, JN (2005) Performance of sampling strategies in the presence of known spatial patterns. *Annals of Applied Biology*, 146: 361-370.

Barker, AM & Reynolds, CJM (2005) Do host-plant interactions and susceptibility to soil cultivation determine the abundance of graminivorous sawflies on British farmland? *Journal of Agricultural Urban Entomology*, 21: 257-269.

Beeston, R, Baines, D & Richardson, M (2005) Seasonal and between-sex differences in the diet of black grouse *Tetrao tetrix*. *Bird Study*, 52: 276-281.

Bliss, TH, Anderson, BC, Draycott, RAH & Carroll, JP (2005) Survival of wild pheasants (*Phasianus colchicus*) in a managed population in Lower Austria. In: *Extended Abstracts of the XXVIIth Congress of the International Union of Game Biologists*. Ed: K Pohlmeyer. DSV-Verlag, Hannover. 50-51.

Boatman, ND, Crocker, DR, Hart, A, Roelofs, W, Smith, RM, Holland, JM, Lutman, PJW, Brown, VK & Ramsay, A (2004) *Development of a scheme for the assessment of risks to wider biodiversity arising from the use of pesticides*. Final Report to Defra PS 2403, 1-123.

Browne, SJ (2005) Seventy years of researching the grey partridge *Perdix perdix*: what lessons have we learnt and how can they help the conservation of threatened Galliformes? Pp. 226-231 In: *Proceedings of the 3rd International Galliformes Symposium*. Eds: RA Fuller & SJ Browne. World Pheasant Association, Fordingbridge, UK.

Browne, SJ, Aebischer, NJ & Crick, HQP (2005) Breeding ecology of turtle doves *Streptopelia turtur* in Britain during the period 1941-2000: an analysis of BTO nest record cards. *Bird Study*, 52: 1-9.

Browne, SJ & Aebischer, NJ (2005) Studies of West Palearctic birds: turtle dove. *British Birds*, 98: 58-72.

Butler, DA (2005) Incidence of lead shot ingestion in red-legged partridges (*Alectoris rufa*) in Great Britain. *Veterinary Record*, 157: 661-662.

Butler, DA, Sage, RB, Draycott, RAH, Carroll, JP & Potts, GR (2005) Lead exposure in ring-necked pheasants on shooting estates in Great Britain. *Wildlife Society Bulletin*, 33: 583-589.

Cattadori, IM, Haydon, DT & Hudson, PJ (2005) Parasites and climate synchronize red grouse populations. *Nature*, 433: 737-741.

Chhum, S, Browne, SJ, Holloway, SJ & Out, S (2005) The status and threats to the conservation of the chestnut-headed partridge and other Galliformes in the Cardamom Mountain Ranges, Southwest Cambodia. Pp. 69-77 In: *Proceedings of the 3rd International Galliformes Symposium*. Eds: RA Fuller & SJ Browne. World Pheasant Association, Fordingbridge, UK.

Draycott, RAH & Sage, RB (2005) Parasite control and breeding success in pheasants (*Phasianus colchicus*). In: Extended *Abstracts of the XXVIIth Congress of the International Union of Game Biologists*. Ed: K Pohlmeyer. DSV-Verlag, Hannover. 76-77.

Draycott, RAH, Woodburn, MIA, Carroll, JP & Sage, RB (2005) Effects of spring supplementary feeding on population density and breeding success of released pheasants *Phasianus colchicus* in Britain. *Wildlife Biology*, 11: 177-182.

Fletcher, K, Warren, P & Baines, D (2005) Impact of nest visits by human observers on hatching success in lapwings *Vanellus vanellus*: a field experiment. *Bird Study*, 52: 221-223.

Fuller, RA & Browne, SJ (eds) (2005) *Galliformes 2004*. *Proceedings of the 3rd International Galliformes Symposium*. World Pheasant Association, Fordingbridge, UK.

Griffiths, GJK, Alexander, CJ, Birt, A, Holland, JM, Kennedy, PJ, Perry, JN, Preston, R & Winder, L (2005) A method for rapidly mass laser-marking individually coded ground beetles (*Coleoptera: Carabidae*) in the field. *Ecological Entomology*, 30: 391-396.

Holland, JM, Ewald, JA & Aebischer, NJ (2005) Field studies of pesticide effects on terrestrial invertebrates. In: *Effects of Pesticides in the Field*. Eds: M Liess, C Brown, P Dohmen, S Duquesne, A Hart, F Heimbach, J Kreuger, L Lagadic, S Maund, W Reinert, M Streloke & JV Tarazona. Society of Environmental Toxicology and Chemistry (SETAC), Brussels (BE). 70-73.

Holland, JM & Reynolds, CJM (2005) The influence of emptying frequency of pitfall traps on the capture of epigeal invertebrates, especially *Pterostichus madidus* (*Coleoptera: Carabidae*). *British Journal of Entomology and Natural History*, 18: 259-263.

Holland, JM, Thomas, CFG, Birkett, T, Southway, S & Oaten, H (2005) Farm-scale spatiotemporal dynamics of predatory beetles in arable crops. *Journal of Applied Ecology*, 42: 1140-1152.

Hoodless, AN, Aebischer, NJ, Lang, D & Fuller, R (2004) The 2003 breeding woodcock survey in Britain. *Woodcock & Snipe Specialist Group Newsletter*, 30: 1-49.

Kirby, AD & Smith, AA (2005) Evidence of re-nesting after brood loss in red grouse *Lagopus lagopus scoticus*. *Ibis*, 147: 221

Lloyd, S, Irvine, KL, Eves, SM & Gibson, JS (2005) Fluid absorption in the small intestine of healthy gamebirds and those infected with *Spironucleus* spp. *Avian Pathology*, 34: 252-257.

Macleod, CJ, Duncan, RP, Parish, DMB, Wratten, SD & Hubbard, SF (2005) Can increased niche opportunities and release from enemies explain the success of introduced yellowhammer populations in New Zealand? *Ibis*, 147: 598-607.

Macleod, CJ, Parish, DMB, Duncan, RP, Wratten, SD & Hubbard, SF (2005) Do yellowhammers *Emberiza citrinella* achieve higher breeding productivity in their introduced range than in their native range? *Bird Study*, 52: 217-220.

Macleod, CJ, Parish, DMB, Duncan, RP, Moreby, SJ & Hubbard, SF (2005) Importance of niche quality for yellowhammer *Emberiza citrinella* nestling survival, development and body condition in its native and exotic ranges: the role of diet. *Ibis*, 147: 270-282.

Moss, D, Joys, AC, Clark, JA, Kirby, A, Smith, A, Baines, D & Crick, HQP (2005) *Timing of Breeding of Moorland Birds*. BTO Research Report 362, Thetford. 116pp.

Murray, KA (2004) Factors affecting foraging by breeding farmland birds. Unpublished PhD Thesis. Open University, 304p.

Newey, S (2005) *Population Fluctuations in Mountain Hares: a Role for Parasites?* Doctoral Thesis No. 2005:26. Swedish University of Agricultural Sciences. Acta Universitatis Agriculturae Sueciae, Umeå.

Newey, SJ, Shaw, DJ, Kirby, A, Montieth, P, Hudson, PJ & Thirgood, SJ (2005) Prevalence, intensity and aggregation of intestinal parasites in mountain hares and their potential impact on population dynamics. *International Journal for Parasitology*, 35: 367-373.

Potts, GR (2005) Incidence of ingested lead gunshot in wild grey partridges (*Perdix perdix*) from the UK. *European Journal of Wildlife Research*, 51: 31-34.

Sage, RB, Ludolf, C & Robertson, PA (2005) The ground flora of ancient semi-natural woodlands in pheasant release pens in England. *Biological Conservation*, 122: 243-252.

Sage RB, Parish DMB, Thompson PGL & Woodburn MIA (2005) Songbirds in game crops. In: *Proceedings of the XXVth International Congress of the International Union of Game Bioloigsts – IUGB and IXth International Symposium Perdix, Vol II.* Ed: E Hadjisterkotis. Ministry of the Interior, Nicosia.

Sage, RB, Parish, DMB, Woodburn, MIA & Thompson, PGL (2005) Songbirds using crops planted on farmland as cover for gamebirds. *European Journal of Wildlife Research*, 51: 248-253.

Shields, BA, Stubbing, DN, Summers, DW & Giles, N (2005) Temporal and spatial segregation of spawning by wild and farm-reared brown trout, *Salmo trutta L*, in the River Avon, Wiltshire, UK. *Fisheries Management and Ecology*, 12: 77-79.

Smith, BM, Diaz, A, Winder, L & Daniels, R (2005) The effect of provenance on the establishment and performance of *Lotus corniculatus L* in a re-creation environment. *Biological Conservation*, 125: 37-46.

Sotherton, NW (2005) Gamebird conservation through the use of set-aside. In: *Agricultural Landscapes as Habitats*. Eds: Z Holtsak & M Börner. Deutsche Wildtier Stiftung, Hamburg. 175-192.

Sotherton, NW, Leake, AR, Leaper, D & Edwards, RV (2005) The use of sulfosulfuron in conservation headlands to support farmland biodiversity. *The BCPC International Congress - Crop Science & Technology 2005*, 1103-1108.

Stoate, C (2005) Land use and aquatic ecosystem protection within an English lowland catchment: the Eye Brook. In: *Sharing a Common Vision for our Water Resources*. Proceedings of the 6th International Conference of the European Water Resources Association, 7-10 September 2005, Menton, France. European Water Resources Association, Athens. On CD-ROM.

Stoate, C & Szczur, J (2005) Predator control as part of a land management system: impacts on breeding success and abundance of passerines. *Wildlife Biology*, 1: 53-59.

Summers, DW, Giles, N & Stubbing, DN (2005) The effect of riparian grazing on brown trout, *Salmo trutta*, and juvenile Atlantic salmon, *Salmo salar*, in an English chalk stream. *Fisheries Management and Ecology*, 12: 403-405.

Tapper, S (2005) *Nature's gain: how gamebird management has influenced wildlife conservation*. The Game Conservancy Trust, Fordingbridge, Hampshire. 42pp.

Winder, L, Alexander, CJ, Holland, JM, Symondson, WOC, Perry, JN & Woolley, C (2005) Predatory activity and spatial pattern: the response of generalist carabids to their aphid prey. *Journal of Animal Ecology*, 74: 443-454.

Winder, L, Griffiths, GJK, Perry, JN, Alexander, CJ, Holland, JM, Kennedy, PJ & Birt, A (2005) The role of large-scale spatially explicit and small-scale localised processes on the population dynamics of cereal aphids. *Bulletin of Entomological Research*, 95: 579-587.

Note: the publications listed as 2004 did not appear in print before the Review of 2004 went to press. For a complete record of the scientific publications by staff of The Game Conservancy Trust, we therefore include them here.

Financial report for 2005

Summary and key points

- There was a surplus of £142,771 on the general fund.
- Income increased by 7.7% overall, with unrestricted income rising by 9.1%.
- Total costs decreased by 0.5%.

The summarised accounts for the year ended 31 December 2005, set out on pages 96 and 97, 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 Conservancy Trust, The Game Conservancy Trust Limited and the wholly-owned subsidiaries Game Conservancy Limited and Game Conservancy Events Limited. The full annual accounts, which were approved by the Trustees on 26 April 2006, 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.

Review of financial transactions and position

2005 was an excellent financial year for the Game Conservancy Trust. The Trust hit its financial targets and achieved a surplus on the general fund. A surplus was also achieved in restricted funds. However, there was a planned overall decrease in restricted funds from £578,855 to £369,991 due to a transfer of £288,500 to the general fund, which reflected the brought forward restricted funds now spent on the new laboratory.

The Trust spent £3.4 million, or 62% of its total expenditure on its charitable objects this year (2004: 64%).

Total income increased by 7.7% in the year and unrestricted income increased by 9.1%. Increasing unrestricted income was one of the Trust's fundraising aims. Total costs decreased by 0.5% with particular reductions in fundraising costs. There was a small reduction in expenditure on the Trust's charitable objects as a result of one large government-funded conservation project approaching completion.

The Trust's investment managers more than met their objective of achieving double the return on cash with a total return in the year of 22%.

The general fund reserve increased in the year, and unrestricted funds (general and designated) now represent the amount needed to fund fixed assets plus 4.5 months' general fund expenditure. The Trustees have agreed that the unrestricted funds should ideally be six months' general fund expenditure plus the amount used to finance fixed assets. The Trustees are satisfied that the Trust's financial position remains secure, but it is still a priority to build the Trust's reserves to the target level over the next few years.

Following the close of business on 31 December 2005, the Trust's activities and assets were transferred to a company limited by guarantee, The Game Conservancy Trust Limited.

Andrew Christie-Miller

A W M Christie-Miller
Chairman of the Trustees

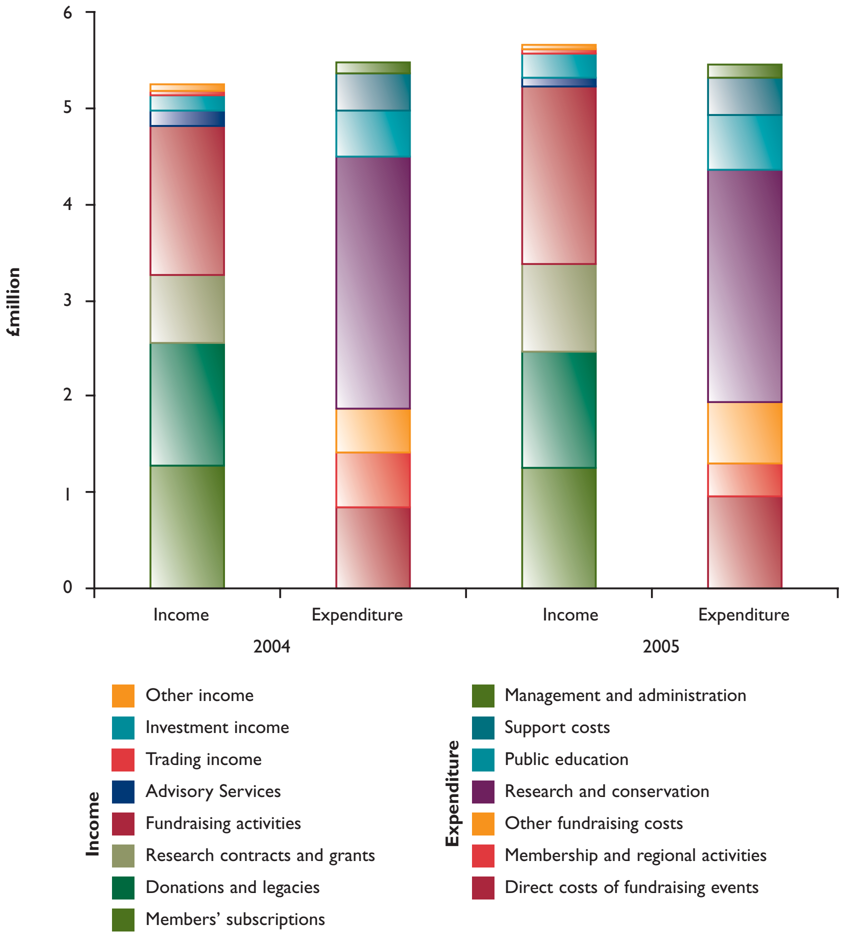


Figure 1

Incoming and outgoing resources in 2005 (and 2004) showing the relative income and costs for different activities

Independent auditors' statement

to the Trustees and Members of The Game Conservancy Trust

We have examined the summarised accounts set out on pages 96 and 97.

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 Conservancy Trust for the year ended 31 December 2005.

FLETCHER & PARTNERS
Chartered Accountants and Registered Auditors
Salisbury, 26 April 2006

consolidated

Statement of financial activities

for the year ended 31 December 2005

	General Fund £	Designated Funds £	Restricted Funds £	**Total 2005 £**	Total 2004 £
INCOME AND EXPENDITURE					
INCOMING RESOURCES					
Voluntary income					
Members' subscriptions	1,264,626	-	-	**1,264,626**	1,281,310
Donations and legacies	352,954	-	844,900	**1,197,854**	1,279,181
	1,617,580	-	844,900	**2,462,480**	2,560,491
Furtherance of charitable objects					
Research contracts and grants	128,662	-	789,034	**917,696**	711,454
Activities for generating funds					
Fundraising events	1,821,946	-	13,994	**1,835,940**	1,539,533
Advisory Service	108,947	-	-	**108,947**	160,120
Trading income	238,253	-	-	**238,253**	169,624
Investment income	50,828	-	-	**50,828**	43,410
Other income	35,292	-	13,843	**49,135**	72,081
TOTAL INCOMING RESOURCES	4,001,508	-	1,661,771	**5,663,279**	5,256,713
RESOURCES EXPENDED					
Costs of generating funds					
Direct costs of fundraising events	959,321	-	-	**959,321**	840,457
Membership	339,354	578	-	**339,932**	317,506
Other fundraising costs	638,342	666	-	**639,008**	721,420
	1,937,017	1,244	-	**1,938,261**	1,879,383
Activities in furtherance of the charity's objects					
Lowlands research	677,381	1,789	727,758	**1,406,928**	1,420,132
Uplands research	415,041	851	253,413	**669,305**	668,064
	1,092,422	2,640	981,171	**2,076,233**	2,088,196
Conservation	83,265	446	267,061	**350,772**	518,442
Public education	481,638	709	75,218	**557,565**	480,253
Support costs	137,214	504	258,685	**396,403**	393,322
	1,794,539	4,299	1,582,135	**3,380,973**	3,480,213
Management and administration	127,181	782	-	**127,963**	117,275
TOTAL RESOURCES EXPENDED	3,858,737	6,325	1,582,135	**5,447,197**	5,476,871
Net incoming/(outgoing) resources before transfers	142,771	(6,325)	79,636	**216,082**	(220,158)
Transfers between funds	288,500	-	(288,500)	-	-
NET INCOME/(OUTGOING) RESOURCES	431,271	(6,325)	(208,864)	**216,082**	(220,158)
OTHER RECOGNISED GAINS AND LOSSES					
Realised gains on investments	57,387	-	-	**57,387**	9,994
Unrealised gains on investments	193,532	-	-	**193,532**	101,470
NET MOVEMENT IN FUNDS	682,190	(6,325)	(208,864)	**467,001**	(108,694)
BALANCES AT 1 JANUARY	1,471,055	243,385	578,855	**2,293,295**	2,401,989
BALANCES AT 31 DECEMBER	£2,153,245	£237,060	£369,991	**£2,760,296**	£2,293,295

consolidated

Balance sheet

at 31 December 2005

		2005		2004
	£	£	£	£
FIXED ASSETS				
Tangible assets		990,470		670,425
Investments		1,407,727		1,265,412
		2,398,197		1,935,837
CURRENT ASSETS				
Stock	30,320		27,509	
Debtors	828,138		640,961	
Cash at bank and in hand	415,230		532,337	
	1,273,688		1,200,807	
CREDITORS:				
Amounts falling due within one year	655,641		680,611	
NET CURRENT ASSETS		618,047		520,196
TOTAL ASSETS LESS CURRENT LIABILITIES		3,016,244		2,456,033
CREDITORS:				
Amounts falling due after more than one year		255,948		162,738
NET ASSETS		£2,760,296		£2,293,295
Representing:				
INCOME FUNDS				
Restricted funds		369,991		578,855
Unrestricted funds:				
Property refurbishment fund	82,088		82,088	
Other designated funds	154,972		161,297	
Total designated funds	237,060		243,385	
General fund	2,155,238		1,490,992	
Non-charitable trading fund	(1,993)		(19,937)	
		2,390,305		1,714,440
TOTAL FUNDS		£2,760,296		£2,293,295

Approved by the Trustees on 26 April 2006 and signed on their behalf

ANDREW CHRISTIE-MILLER
Chairman of the Trustees

Staff of The Game Conservancy Trust

in 2005

CHIEF EXECUTIVE	Teresa Dent BSc, ARAgS
Personal Assistant	Wendy Smith
Head of Finance	Alan Johnson ACMA
Finance Assistant - Trust	Stephanie Slapper
Finance Assistant - Limited	Lin Dance
Accounts Clerk (p/t)	Sue Connelly
Head of Administration & Personnel	Kate Oliver
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
Press Officer	Morag Walker MIPR
Press & Publications Assistant	Louise Shervington
DIRECTOR OF RESEARCH	Nick Sotherton BSc, PhD
Secretary (p/t)	Lynn Field
Head of Fisheries Conservation	Ian Lindsay BSc *(until September)*
Secretary to Ian Lindsay (p/t)	Mandie Pritchard *(until September)*
Fisheries Research Scientist	Dylan Roberts BSc
Fisheries Biologist (p/t PhD student)	Dominic Stubbing HND, MIFM
PhD student *(King's College)* - Trout Stocking	Ravi Chatterji BSc, MSc *(until May)*
Fisheries Research Scientist	Ravi Chatterji BSc, MSc, PhD *(from June)*
Fisheries Biologist - on secondment from Environment Agency	Dominic Longley BSc *(from July)*
Project Assistant - Fisheries	Stefan Jones BSc *(from March)*
Research Assistants	Jean Carson BSc *(Jun-Aug)*, Adam Cleal *(Aug-Sep)*
Monnow Project Co-ordinator	Gill Watkins
Monnow Team Leader	Ben Rodgers
Monnow Senior Tree Worker	Oliver Watkins *(until March)*
Monnow Habitat Workers	Robert Powell, Philip Howells *(until April)*, William Evans *(from May)*
Head of Lowland Gamebird Research	Rufus Sage BSc, MSc, PhD
Ecologist - Pheasants, Wildlife (p/t)	Maureen Woodburn BSc, MSc, PhD
Ecologist - Partridges, Pheasants	Roger Draycott HND, MSc, PhD
Ecologist - Pheasants, Woodcock	Andrew Hoodless BSc, PhD
Project Ecologist - Energy Crop Studies	Mark Cunningham BSc, MSc
PhD Student *(Imperial College)* - Pheasant Releasing Studies	Clare Turner BSc
PhD Student *(Reading)* - Gamebird Releasing Studies	Sarah Callegari BSc, MSc
PhD Student *(Kent)* - Game and Wildlife	Tracy Greenall BSc, MSc
PhD Student *(John Moore's, Liverpool)* - Quail Chick Ecology	Dave Butler BSc *(until August)*
Seasonal Research Assistant	Diane Ling BSc, MSc, MIBiol, CBiol
Placement Student - University of Liverpool	Rob Lewis BSc *(from June)*
Placement Student - Harper Adams	James Palmer BSc *(from September)*
Placement Student - Bath	Courtney Kennedy BSc *(until September)*
Student - University of Liverpool	George Unwin MSc, BSc *(May-June)*
Ecologist - Scottish Lowland Research	David Parish BSc, PhD
PhD Student *(Dundee)* - Sawfly Genetics	Angela Gillies BSc *(from October)*
Head of Wildlife Disease & Epidemiology	Chris Davis BVM&S, MRCVS
Game Technician/Stockman	Des Purdy BSc, PhD
Rearing Field Assistant	Matt Ford *(May-September)*
Project Officer - Bitting Project	Dave Butler BSc, PhD *(from August)*
Head of Predation Control Studies	Jonathan Reynolds BSc, PhD
Research Assistant	Mike Short HND
Research Assistant	Thomas Porteus BSc, MSc
Research Assistant	Austin Weldon BSc
Head of Entomology	John Holland BSc, MSc, PhD
Post Doctoral Entomologist	Barbara Smith BSc, PhD
Senior Entomologist	Steve Moreby BSc, MPhil
Entomologist	Sue Southway BA
Entomologist	Tom Birkett BSc, PgC
PhD Student *(Imperial College)* - Insect Dispersal	Heather Oaten BSc, MSc
Assistant Entomologist	Steve Bedford
Research Assistant	Antonio Fernandez *(Aug-Sep)*;
Placement Student	Euan Douglas *(until August)*; Freya McCall BSc *(from October)*
Director of Upland Research	David Baines BSc, PhD
Office Manager, The Gillett	Julia Hopkins
Black Grouse Recovery Officer	Phil Warren BSc
Research Assistant - Black Grouse	Michael Richardson BSc
Seasonal Research Assistant - The Gillett	Alisa Thomas BSc *(April-July)*
Senior Scientist - Upland Predation Experiment	Kathy Fletcher BSc, PhD
Research Assistant - Upland Predation Experiment	Robin Foster HND
Seasonal Research Assistants - Upland Predation Experiment	Helen Foster *(May-Aug)*; Stephanie Coates BSc, MSc *(May-July)*; Annelie Jonsson BSc, MSc *(May-July, and from October)*
Head Gamekeeper - Upland Predation Experiment	Craig Jones
Gamekeeper - Upland Predation Experiment	Philip Chapman *(from February)*

Trainee Gamekeeper - Upland Predation Experiment	Joe Pattison
Senior Scientist - North of England Grouse Research	David Newborn HND
PhD Student *(Imperial College)* - Red grouse population dynamics	Nils Bunnefeld
PhD Student *(Imperial College)* - Grouse moors (social/economic)	Julie Black
Placement Students	Deborah Coldwell *(until October);* William Watson *(from July)*
Senior Scientist - Scottish Upland Research	Adam Smith BSc, MSc, DPhil
Ecologist - Mountain Hares	Scott Newey BSc, MSc
Woodland Grouse Scientist	Martin Dallimer BSc, MSc, PhD *(from May)*
Research Assistant - Scottish Upland Research	David Howarth
Seasonal Research Assistants	Allan MacLeod BSc *(Apr-Sep);* Ross Hunt; Valerie Relf; Mose Nodari
Placement Students - Drumochter	Ella Steel *(until Aug);* Emily Mockford *(from Sep);* Peter Allison *(from Sep)*
PhD Student *(Edinburgh)* - Muirburn	Matthew Davies BSc, MSc
PhD Student *(Aberdeen)* - Tick Ecology	Ellie Watts BSc *(April-August)*
MSc Student *(Reding)* - Heather Beetles	Annabel Heseltine MA *(April-July*
BSc Student *(Edinburgh)* - Heather	James Hughes *(March)*

DEPUTY DIRECTOR OF RESEARCH	Nicholas Aebischer Lic ès Sc Math, PhD
Secretary & Librarian	Gillian Gooderham
Assistant Biometrician	Peter Davey BSc
Grey Partridge Ecologist	Stephen Browne BSc, MSc, PhD
PhD Student *(Oxford)* - Grey Partridges	Elina Rantanen MSc *(from July)*
Westminster Fellow - Grey Partridges	Francis Buner Dipl Biol, Cand Dr Phil II
Placement Student *(Centre National pour la Promotion Rurale)*	Pierre Damiens *(from October)*
BA Student *(Oxford)* - Grey Partridges	Felicita Wallace *(July-August)*
BSc Student *(Bristol)* - Grey Partridges	Arthur Scott *(Nov-Dec)*
BSc Student *(Bristol)* - Grey Partridges	Joss Spilman *(Nov-Dec)*
Head of Geographical Information Systems	Julie Ewald BS, MS, PhD
Partridge Count Scheme Co-ordinator	Neville Kingdon BSc
Research Assistant - GIS	Nina Graham BSc
Placement Student *(Bath)* - GIS	Courtney Kennedy *(until February)*
Placement Student *(Harper Adams)* - GIS	James Daplyn *(until September)*
MST Student *(Rouen)* - Grey Partridges	Hugues Santin-Janin *(May-August)*

as at 1 May 2006

DIRECTOR OF FUNDRAISING	Edward Hay	020 7290 0110, ehay@gct.org.uk, 07717 856951
Personal Assistant	Gemma Mason BA	020 7290 0116, gmason@gct.org.uk
London Event Manager	Sally Thomas	020 7290 0110, sthomas@gct.org.uk, 07734 537586
London Events Assistant	Mima Lopes	020 7290 0110, mlopes@gct.org.uk
Corporate Sponsorship Manager	Liz Scott	01425 651037, lscott@gct.org.uk, 07803 180958
Sponsorship Assistant	Wendy Jefferd (p/t)	01425 652381
Northern Regional Fundraiser	Henrietta Appleton BA, MSc	01833 622028, happleton@gct.org.uk, 07889 891956
Southern Regional Fundraiser	Max Kendry	01789 840348, mkendry@gct.org.uk, 07803 180957
Eastern Regional Fundraiser	Lizzie Herring	01284 831028, lherring@gct.org.uk, 07885 897647
Fundraiser - Scotland	Andrew Dingwall-Fordyce	01771 613263, 07831 707501
Sales Centre Manager	Mike Davis	01425 651003, mdavis@gct.org.uk
Head of Membership Records/Funding Manager/Legacies	Corinne Duggins Lic ès Lettres	01425 651012, cduggins@gct.org.uk
Database Administrator - Membership	Lisa Roberts	01425 651024, lroberts@gct.org.uk
Membership Records Assistant: Gift Aids/MRs/New Members (p/t)	Bridget McKeown	01425 651010, bmckeown@gct.org.uk
Membership Records Assistant: Renewals	Jenny Bowen-Jones	01425 651011, jbowen-jones@gct.org.uk
Membership Records Assistant (p/t)	Theresa Lewis	01425 651016, tlewis@gct.org.uk

DIRECTOR ADVISORY SERVICES & SCOTLAND	Ian McCall BSc[1] *(until September)*
DIRECTOR SCOTLAND	Ian McCall BSc *(from September)*
Secretary - Scottish HQ	Irene Johnston
Secretary - Scottish Auction	Miranda Fox *(from October)*
PR & Education - Scotland	Katrina Candy HND
Acting Director of Advisory & Education	Ian Lindsay BSc[3] *(from September)*
Co-ordinator Advisory Services (p/t)	Lynda Ferguson
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
North of England Regional Advisor & Biodiversity Officer	Mike McKendry ARICS
Secretary to Mike McKendry (p/t)	Gillian Robson

[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.

Staff of the Allerton Research and Educational Trust

The Game Conservancy Trust manages the Allerton Project for the Allerton Research and Educational Trust

Head of the Allerton Project	Alastair Leake BSc (Hons), MBPR (Agric), PhD, ARAgS
Secretary (p/t)	Jenny Kipling
Head of Research	Chris Stoate BA, PhD
Research Ecologist	Kate Driver BSc
Ecologist	John Szczur BSc *(from Nov)*
Research Assistant	Anthony Mould BSc *(April-July)*
Research Assistant	Mark Speck HND, BSc *(April-July)*
MSc Student	Alex Berry BSc, MSc *(June)*
Placement Students	Caroline Sherrott *(until June);* Ben Gibson *(from September)*
Game Manager - Royston	Malcolm Brockless
Farm Manager	Philip Jarvis HND
Farm Assistant	Michael Berg
Catering Assistant (p/t)	Jeanette Parr

Index of research projects

covered in this Review